Revised RCRA Facility Investigation
Phase II Report
North Colony Landfarm
Navajo Refinery, Artesia, New Mexico

prepared for:

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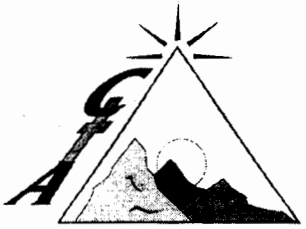

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1.0 EXECUTIVE SUMMARY

From 1980 to 1990 the RCRA-permitted hazardous waste treatment unit known as the North Colony Landfarm (NCL), located at Navajo Refining Company's Artesia refinery, received and managed several RCRA-listed refinery wastes. The NCL has not received such wastes since 1990, but continues to be managed for biodegradation of residual hydrocarbons. Beginning prior to 1982 and continuing to the present, numerous soils and hydrogeologic studies have been conducted at the NCL.

The earliest studies reviewed for the revised Phase II report included installation of soil lysimeters and groundwater monitor wells interior to and on the periphery of the landfarm in 1982 followed by soil coring and analyses in 1989 and 1990. Also in 1990, a hydrogeologic study was conducted that was the basis of the Alternative Source Demonstration submitted to the New Mexico Environment Department (NMED).

In 1994 and 1995 Phase I and Phase II RCRA Facility Investigations (RFI) were required to be conducted at the site. The RFI process was initiated in response to environmental sample data which indicated the presence of hazardous waste constituents in soils and groundwater beneath the unit that were similar to those applied to the unit. The Phase I RFI included trench excavations, and shallow and deep soil coring. Phase II activities included the installation of additional groundwater monitor wells followed by groundwater sampling, expanded soil coring away from the landfarm, and collection of aquifer data including continuous water levels and hydraulic conductivity measurements.

In response to a Notice of Deficiency from the NMED Hazardous and Radioactive Materials Bureau (HRMB) in April 1997, RFI supplemental investigation activities were performed in the Summer of 1997. These included compilation and review of past soils and groundwater analytical data, collection of additional groundwater water level data, further soil and groundwater sampling, statistical analysis of data, and, finally, modeling of contaminant transport in the vadose and saturated groundwater zones.

A summary of the activities, results and conclusions from each of the RFI investigative studies is provided below. The conclusions arising from the various investigative phases may have been modified due to more recent information from subsequent study. The earlier conclusions are listed as modified if they are no longer valid.

1.1 RFI Phase I

RFI Phase I investigation activities at the unit in Spring 1994 included the completion of four observation and sampling trenches, 24 soil borings, a deep (100-feet) geotechnical boring, groundwater elevation contour mapping based on measurements obtained from existing monitoring wells, and the survey and mapping of current surface elevations.

The soil sample analytical results for chromium and lead indicate that landfarm soils have adequately immobilized chromium and lead within the unit treatment zone. No evidence was found to indicate that either of these metal constituents has migrated below the base of the unit.

The unit is underlain by a near-surface saturated zone (NSSZ) consisting of interbedded zones of clayey sand and caliche gravel bounded above and below by much less permeable clayey silts and clays. A large portion of the NSSZ underlying the unit has been impacted by one or more petroleum product releases originating from a source located upgradient to the unit. The NSSZ appears to respond rapidly to local precipitation events, suggesting that this water-bearing zone is directly associated with a local recharge area located upgradient of the NCL. Results of the deep geotechnical boring completed to the north of the unit indicate that the NSSZ is underlain by at least 60-70 ft. of impermeable clay. In addition, other geotechnical borings completed in conjunction with refinery construction activities located upgradient of the unit yield a similar geological profile.

Prior to the performance of the NCL RFI, a significant hydrocarbon release to the NSSZ, which consisted of a refined petroleum product originating from an unrelated source located partially upgradient (south) of the NCL, was had been partly characterized. This refined-product release resulted in the presence of free-phase product in groundwater monitoring wells located immediately downgradient of the NCL.

A comparison of historic groundwater elevation measurements with more recent (1994) measurements from the same monitoring wells demonstrates that the upper surface of the NSSZ is capable of significant fluctuations in elevation. On at least one occasion (in 1982), fluids in the NSSZ were documented to rise to an elevation which would place it within a few feet of the base of the NCL treatment zone. Furthermore, inspection of the excavation sidewall at one of the observation trenches completed during the RFI field investigation provided strong visual evidence to indicate that hydrocarbon contamination present in the NSSZ had apparently migrated upwards through the soil profile to at least within approximately 2 ft. of the base of the treatment zone.

Evidence of subsurface hydrocarbon contamination was found in six of eight deep soil borings completed at the unit. However, in four of the six borings, organic constituents were reported only at the lowest sample interval, between 13 and 15 ft., suggesting that the source for these contaminants was not from wastes applied to the NCL, but originated instead in the upgradient hydrocarbon plume present in the NSSZ. Evidence of hydrocarbon contamination immediately below the base of the unit in a manner consistent with a potential release from the unit was observed in only one of eight deep soil borings.

Subsequent to the completion of RFI field investigation activities, the site was revisited in June 1994 and a series of observation trenches were completed south of the NCL between the unit and the source area for the upgradient hydrocarbon plume which partially underlies the unit. Subsurface soils sampled at these upgradient trench locations exhibited hydrocarbon contamination that was highly similar to that observed beneath the NCL in terms of existing constituents, the magnitude of contamination, and the subsurface elevations at which

contamination occurred. Furthermore, analysis of free-phase hydrocarbons sampled from a recovery trench constructed to intercept the upgradient plume also demonstrated that constituents present in the plume were identical to those identified in subsurface soil samples collected at the NCL.

Based on the available information, the Phase I study concluded that existing subsurface contamination underlying the NCL is primarily, if not entirely, the result of subsurface migration of an unrelated hydrocarbon product plume (most likely consisting of a mid-range, diesel-like fuel product) transported to the NCL in the NSSZ underlying the unit. Hydrocarbon contaminants contained in the upgradient plume are highly similar to contaminants that could potentially have been released from the base of the NCL treatment zone. Periodic fluctuations in the level of the NSSZ have previously caused its upper boundary to approach at least within a few feet of the base of the unit in areas where subsurface clay is not present to act as a low permeability layer, or where clay contains sufficient coarse material and root channels to allow upward fluid penetration under hydraulic pressure. As a result, unambiguous evidence of a release from the unit is unlikely to be obtained. However, given the nature of the waste constituents that could potentially have been from the NCL (i.e. refinery waste residuals consisting of heavier-end hydrocarbons), it is likely that the impact of any potential releases from the unit on the unrelated subsurface plume would be minimal. In effect, the converse is true: The off-site hydrocarbon plume has severely impacted soils beneath the landfarm treatment zone.

In consideration of the findings detailed above, the Phase I report concluded that most if not all the existing contamination present in groundwater underlying the NCL is the result of an unrelated hydrocarbon release that has migrated on-site. From the viewpoint of overall environmental risk to human health and the environment, it is highly unlikely that the quality of the existing groundwater beneath the unit has been, or is likely to be, affected by any potential releases from the unit in any meaningful way. Therefore, the Phase I report recommended that future remedial investigations and actions should be directed to delineation, interception, and treatment or recovery of the hydrocarbon product contained in the NSSZ present in the vicinity of the unit.

1.2 RFI Phase II

The initial NCL RFI study included the completion of a series of soil borings and trench excavations at the NCL. NMED concluded that the possibility could not be ruled out that a release of unit-applied waste constituents had contaminated the near-surface saturated zone (NSSZ) underlying the unit to some extent. NRC was not able to state with absolute assurance that no release had occurred, although the preponderance of evidence showed that this was not the case. Consequently, NMED required the execution of a second RFI phase for the NCL in order to further characterize and delineate the released hydrocarbon product contaminants in the vicinity of the NCL.

The RFI Phase II required to be performed in 1995 was a follow-up to the initial RFI effort conducted at the unit in 1994, and was intended to further characterize and delineate the extent of hydrocarbon contamination in groundwater underlying and downgradient of the NCL. To

achieve those objectives, the RFI Phase II involved the completion of a series of 24 soil borings downgradient of the NCL, installation of one upgradient and four downgradient groundwater monitoring wells, environmental analysis of groundwater samples obtained from those wells, and groundwater elevation measurements and aquifer tests conducted to describe key aquifer characteristics.

The findings of the RFI Phase II study further verified the initial findings and conclusions of the RFI Phase I investigation. As reported in the Phase II summary, the combined observations and data generated from the Phase I and II RFI efforts at the NCL yielded the following major findings:

1. Observations from soil borings and observation trenches completed at the NCL indicate that hydrocarbon contamination found in or immediately above the water table underlying the unit originates from a contaminant source which is unrelated to former waste management activities at the NCL. Rather, the evidence suggests that contamination beneath the unit primarily results from migration of hydrocarbon contaminants originating from a previously identified product release located upgradient and cross-gradient to the NCL.

2. The NSSZ in the vicinity of the NCL consists of a highly variable network of caliche gravel and fine-grained clayey sand and silt seams located at depths ranging between approximately 15 to 35 feet below surface grade. These water-bearing seams are typically limited in vertical and horizontal extent, and are interbedded with extensive zones of relatively tight clays and silts.

3. The bulk of the hydrocarbon release (in the form of free-phase product) is found in a subsurface plume that conforms to the prevailing direction of groundwater movement. The boundaries of the product plume have been delineated by a series of soil observation borings and groundwater monitoring wells completed during the RFI Phase II activities.

4. The NSSZ exists under distinctly semi-confined conditions, and is subject to potentially rapid and highly variable potentiometric fluctuations in response to local precipitation events. Portions of a municipal stormwater ditch located south and west of the NCL are a possible source for transient fluctuations in both the direction of local groundwater movement and the hydraulic potential; which, in turn, has driven hydrocarbon contamination horizontally to points under and beyond the NCL, as well as upward towards the base of the unit.

1.3 RFI Supplemental Investigation

RFI supplemental activities were performed during June through October 1997 in response to the April 21, 1997 HRMB letter of deficiency and a follow-up letter of violation dated May 21, 1997. Following receipt of those letters, NRC provided the HRMB with a proposed Plan of Corrective Action dated June 13, 1997, which required additional investigation at the NCL. The

work involved data collection, compilation and analysis of existing technical material, and further on-site investigations.

Technical data and information generated during previous work efforts were utilized to assess contaminant occurrence, concentrations and frequency. All readily available hydrogeologic and soils reports directly pertinent to the NCL site beginning in 1982 were compiled and copies are provided with this investigation report. NCL groundwater monitoring reports beginning in 1990 were collected, reviewed, and are tabulated for this report. Statistical analyses were performed on current and past soil and groundwater data to evaluate the probability of a release from the unit to soils and groundwater. Modeling of vadose and saturated zone flow processes was performed to determine fate and transport of contaminates in the event of releases from the landfarm.

Further on-site investigation was conducted to provide data to correct deficiencies identified by the HRMB. This included soil sampling to collect additional background data for metal constituents, placement of temporary well points beneath the landfarm to determine hazardous constituent concentrations in groundwater, and installation of water level data recorders in several monitor wells to determine response of the NSSZ to precipitation.

The results of the RFI Supplemental Investigation support and validate information generated by the previous studies and investigations at the site. Specifically, the information reviewed and data generated as a result of the 1997 activities produce the following major findings:

1. Review of historical groundwater monitoring data from background well NCL-31 reveals elevated levels of organic constituents (including benzene at 26 ug/L) from 1990 through 1994. The well was replaced as a background monitor well by MW-53 in 1995. Similarly, downgradient wells NCL 33 and 44, located immediately outside of the perimeter fence in the northeast and north-central areas of the landfarm, recorded significant detections of organic constituents during the same time period. MW-34, located south of the landfarm entrance gate along the east perimeter fence, contains measurable levels of free-phase hydrocarbons

2. Benzene and total BTEX concentration maps of groundwater quality beneath the NCL show elevated concentrations of these constituents under the central and southern portion of the landfarm with the highest concentrations occurring along the southern (upgradient) boundary of the site. The landfarm location is partially downgradient from an area of above ground storage tanks containing various refined petroleum products some of which have experienced product releases in the past.

3. Analysis of the free-phase hydrocarbon product found in monitor well NCL-34 has determined that the product is a biologically degraded crude oil with approximately 48 percent of the sample occurring in the diesel range organics. The approximate range of product mix is 70 to 80 percent crude oil and 20 to 30 percent diesel fuel with the diesel fuel of more recent origin.

4. Based on review of information from the available studies, sections of the NSSZ beneath the unit have been affected by at least two unrelated hydrocarbon excursions that have migrated under the site from other areas of the refinery. These include a diesel fuel release prior to 1990 from an underground line in the area of Tanks 834 and 838 which apparently impacted the south central and southeastern portion of the NCL, and a crude oil release (date and source unknown) currently affecting NCL-34. There is a possibility of other undocumented older release(s) from a source likely further south than the area of Tank 838. As a result of these leaks, in 1990 NRC installed two product recovery trench systems in the area directly south of the NCL.

5. Comparison of groundwater elevation data from several up- and down- gradient monitor wells immediately adjacent to the NCL shows an immediate significant response to precipitation in MW-19 (upgradient) and lessor but measurable responses in two other wells (NCL-32 and NCL-44) located on the opposite side of the landfarm. The elevated hydrograph peaks noted on the hydrographs for these wells show that a rainfall-induced pulse mechanism provides a steep but temporary hydraulic gradient moving contaminants northeasterly from the southern edge of the landfarm.

6. Review of the lithologic boring logs and chemical data reveals that while soil material immediately above the base of the treatment zone and deeper in the vicinity of the NSSZ is contaminated, the intermediate material generally does not exhibit discoloration or odors and is mostly free of detectable concentrations of hydrocarbons.

7. Statistical analysis of soil data from landfarm and background core samples was performed that shows no statistically significant increase in chromium and lead concentrations in samples from beneath the landfarm treatment zone as compared to background soil concentrations.

8. Statistical analysis of groundwater sample data shows no statistically significant increase in chromium and lead concentrations in upgradient and downgradient monitor wells. Monitor well NCL-34, containing a mixture of crude and diesel oil free-phase hydrocarbons, exhibits highly variable and elevated metals concentrations, and was not included in the statistical analysis.

9. Even for those borings where the intermediate zone exhibited some evidence of hydrocarbons, the similarity of the chemical constituents in the contaminants is such that it is not possible to differentiate between possible sources based solely on chemical analysis of the material.

10. Vadose zone modeling performed with an EPA-approved model (VLEACH) using conservative assumptions shows that concentrations of organic constituents detected in soils immediately beneath the landfarm treatment zone would result in concentrations in groundwater less than Safe Drinking Water Act maximum contaminant levels (MCLs). For benzene (the most sensitive drinking water constituent), the model predicted the maximum concentration in groundwater would be 2.6 micrograms per liter (ug/L) which is less than the MCL of 5 ug/L. The worst-case scenario modeled assumes constituents

are immediately transported from beneath the treatment zone to groundwater by a hypothetical preferential pathway (such as a root hole). Although structures believed to be root holes were detected in some Phase I observation trenches, there is no evidence that such channels are continuous from surface to the groundwater surface. Therefore, even assuming that releases from the treatment zone were responsible for the contamination immediately beneath the zone (and there is strong evidence that the contamination originated from the unrelated plume below), such releases would have had no significant impact on groundwater.

11. Saturated zone groundwater modeling was performed using an U.S. Geological Survey flow model (MODFLOW) as modified for contaminant fate and transport (MT3D). Using a benzene concentration derived from the vadose zone model as a starting value (2.6 ug/L), 30-year simulated contaminant fate and transport will result in decreasing concentrations downgradient. Contaminant movement will be less than 200 feet before they are dissipated to less than 0.05 ug/L (50 parts per trillion) due to natural advective and dispersive processes.

1.4 Investigation Conclusions

The scientific data and technical information collected and generated during previous RFI and other investigations conducted at this facility demonstrated the impact that migration of offsite hydrocarbons under the NCL have had on soils and groundwater beneath the unit. Because landfarm constituents contain similar hydrocarbon contaminants, the effect of minimal releases from the base of the unit, if any, on underlying soils and groundwater has not been quantifiable. The most that could be concluded was that, in relative terms, the environmental significance of any release from the unit to the subsurface was negligible compared to the effect of the offsite hydrocarbons.

Using the maximum contaminant values from existing soils data, and EPA-approved statistical and computer modeling techniques employing conservative assumptions, the RFI supplemental investigation quantified the impacts of the postulated releases and concludes that the maximum possible effect on near-surface groundwater beneath the site would not cause an excedance of EPA drinking water standards. Additionally, the computer modeling predicted that such contamination would be dissipated within 200 feet of the unit boundaries and on property currently owned by Navajo.

Because of the similarities of the types of hydrocarbons, it still not possible to demonstrate absolutely that a release of hydrocarbons from the NCL has not occurred. However, the information generated for this report now provides a scientific estimate as to the maximum possible magnitude of such a release and the impacts on soil and groundwater media surrounding the site. This will allow decision-making regarding the future of the NCL to proceed, and the RCRA issues of unit Closure and Post-closure care to be resolved.

1.5 Recommendations

Even to the extent that releases may have occurred, the available environmental observations and environmental data indicate that the product plume is contained entirely within the confines of the NSSZ, and poses no threat of contamination to deeper groundwater resources. The NSSZ primarily consists of a highly variable network of relatively low-volume, semi-confined channels contained within a surrounding matrix of low-permeability silts and clays, such that petroleum product is distributed in a discontinuous manner within the delineated plume. Therefore, the construction of interception trenches across the product flow path has been recommended as the only feasible option for capture and recovery of released hydrocarbon product.

Based on the location of free-phase product within the NSSZ, and physical constraints imposed by Eagle Draw and various surface and subsurface refinery installations, two separate trench installations have been recommended for the interception and recovery of the hydrocarbon product. A primary trench located 400 feet east of the NCL and immediately west of Eagle Draw would recover product and contaminated groundwater. In addition, a secondary trench located east of Eagle Draw and 850 feet northeast of the NCL would serve as a recovery system to collect contamination which migrated beyond the primary trench prior to its installation. NRC is currently evaluating several hydrocarbon recovery proposals and expects to complete installation of recovery systems during the first quarter of 1998.

In addition to the trenches, it is suggested that hydrocarbon recovery be initiated at NCL-34 using a skimmer system. The diameter of the well (2 inches) will limit available recovery options, but the product in that well continues to be pervasive. Due to the well's proximity to the landfarm, some portion of the hydrocarbon product no doubt extends under the site and should be removed so as to facilitate any further investigation which might be necessary as well as to prevent future downgradient hydrocarbon movement.

2.0 INTRODUCTION

The following sections provide a brief introduction to the background and the scope and goals of the RFI investigation reported herein and to the organization of the report.

2.1 Background to the RCRA Facility Investigation

Navajo Refining Company (NRC) operates a petroleum refinery (EPA ID No. NMD 048918817) located at 501 East Main Street, Artesia, New Mexico (Figure 2-1). The refinery is regulated under the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984 (HWSA).

This document addresses the North Colony Landfarm (NCL) which is a land treatment unit located in the northwest portion of the refinery that was operated by Navajo between 1980 and 1990 under the auspices of New Mexico Hazardous Waste Permit No. NMD048918817-1.

Subsequent to the generation of environmental monitoring data which suggested a potential release to subsurface soils underlying the base of the unit, a RCRA Facility Investigation (RFI) was required to be conducted for the NCL. The purpose of the RFI was to determine whether releases of hazardous waste or hazardous waste constituents have occurred from the unit and to determine the nature and extent of any release found to have occurred. The RFI was based on the approved workplan submitted to the Hazardous and Radioactive Materials Bureau (HRMB) of the New Mexico Environment Department (NMED) in March 1994. The RFI was performed in 1994 in accordance with the workplan and the RFI findings were subsequently presented in the report entitled "RCRA Facility Investigation, North Colony Landfarm, July 1994."

After submittal of the NCL RFI report and review by the HRMB, the agency in a letter dated December 30, 1994, required that a second phase of the RFI be undertaken to collect additional information regarding the extent of hydrocarbon contamination in shallow groundwater beneath the unit. A technical workplan designed to obtain the required environmental information was developed, was incorporated into the original RFI workplan (re-titled as the RFI Phase I and Phase II workplan), and was subsequently approved by NMED in April 1995. RFI field work was performed in the Summer and Fall of 1995, and the "RCRA Facility Investigation, Phase II Report, North Colony Landfarm, February, 1996" was submitted to the agency on February 28, 1996.

By letter dated April 21, 1997, the NMED disapproved the February 1996 report and required that a revised report addressing the deficiencies listed in the disapproval letter be submitted to the HRMB for further review. Subsequently, on May 21, 1997, the agency issued a Letter of Violation reiterating the deficiencies in the April 21 letter but waiving enforcement action if corrective actions are completed voluntarily. NRC responded by letter dated June 13, 1997, that included a Proposed Plan of Corrective Action. The additional investigative work completed and the results presented in this report were undertaken pursuant to the Plan of Corrective Action proposed in the June 13 letter.