U.S. Department of Energy/ National Nuclear Security Administration

P A N T E X P L A N T

Environmental Assessment for Proposed Perched Groundwater Corrective Measures

at the

U.S. Department of Energy/ National Nuclear Security Administration Pantex Plant Amarillo, Texas

February 2007

BWXT Pantex, L.L.C.
Pantex Plant
P.O. Box 30020
Amarillo, Texas 79120

BWXT Pantex

TABLE OF CONTENTS

LIST OF FIGURES iii
LIST OF TABLES iii
ACRONYMS AND ABBREVIATIONS iv
GLOSSARY vi
MEASUREMENTS AND CONVERSIONS xi

EXECUTIVE SUMMARY ES-1

1.0 INTRODUCTION 1-1
1.1 BACKGROUND 1-1
1.2 PURPOSE AND NEED FOR THE PROPOSED ACTION 1-3

2.0 DESCRIPTION OF THE PROPOSED ACTION 2-1
2.1 NO ACTION 2-1
2.2 PROPOSED ACTION 2-1
2.2.1 Corrective Measure Options 2-2
2.2.1.1 Corrective Measure Option 1: Monitored Natural Attenuation (MNA) 2-8
2.2.1.2 Corrective Measure Option 2: Existing Pump and Treat with MNA 2-8
2.2.1.3 Corrective Measure Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA 2-11
2.2.1.4 Corrective Measure Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA 2-13
2.2.1.5 Corrective Measure Option 5: Targeted Treatment with MNA 2-14
2.2.1.6 Corrective Measure Option 6: Enhanced Pump and Treat with Targeted *In Situ* Treatment and MNA 2-20
2.2.2 Summary of Construction Elements for the Corrective Measure Options 2-28
2.3 TECHNOLOGIES CONSIDERED BUT DISMISSED FROM FURTHER CONSIDERATION 2-28
2.4 RELATED ACTIONS 2-30
2.4.1 NEPA Documentation 2-30
2.4.2 RCRA/CERCLA Documentation 2-31

3.0 AFFECTED ENVIRONMENT 3-1
3.1 REGULATORY INITIATIVES 3-1
3.1.1 National Environmental Policy Act 3-1
3.1.2 Resource Conservation and Recovery Act 3-2
3.1.3 Comprehensive Environmental Response, Compensation, and Liability Act 3-2
3.1.4 State of Texas Risk Reduction Rule 3-2
3.2 GENERAL PLANT DESCRIPTION AND REGIONAL SETTING 3-3
3.2.1 Land Use 3-3
3.2.2 Geology and Soils 3-6
3.2.3 Water Resources 3-6
3.2.4 Floodplains and Wetlands 3-7
3.2.5 Biological Resources 3-7
3.2.6 Air Quality 3-9
3.2.7 Visual Resources 3-10
3.2.8 Cultural Resources 3-10
3.2.9 Utility Infrastructure 3-11
3.2.10 Noise 3-12
3.2.11 Human Health 3-12
3.2.12 Waste Management 3-13
3.2.13 Transportation 3-13
3.2.14 Socioeconomics 3-14
3.2.15 Environmental Justice 3-14

4.0 POTENTIAL ENVIRONMENTAL ISSUES AND EFFECTS DISCUSSION 4-1
4.1 NO ACTION IMPACTS ANALYSIS 4-1
4.2 PROPOSED ACTION IMPACTS ANALYSIS 4-1
4.2.1 Land Use 4-1
4.2.2 Geology and Soils 4-6
4.2.3 Water Resources 4-9
4.2.4 Floodplains and Wetlands 4-11
4.2.5 Biological Resources 4-12
4.2.6 Air Quality 4-14
4.2.7 Visual Resources 4-16
4.2.8 Cultural Resources 4-17
4.2.9 Utility Infrastructure 4-18
4.2.10 Noise 4-21
4.2.11 Human Health 4-22
4.2.12 Waste Management 4-23
4.2.13 Transportation 4-25
4.2.14 Socioeconomics 4-26
4.2.15 Environmental Justice 4-27
4.3 COMPARISON OF SUMMARIZED IMPACTS FOR EACH CORRECTIVE MEASURE OPTION 4-29
4.4 ANALYSIS OF INTENTIONAL DESTRUCTIVE ACTS RELATED TO PROPOSED ACTION 4-30

5.0 CUMULATIVE IMPACTS 5-1

6.0 AGENCIES CONSULTED 6-1

7.0 REFERENCES 7-1

APPENDIX A - VEGETATION AND WILDLIFE SPECIES A-1

A.1 Vegetation A-1
A.1.1 Native Vegetation A-1
A.1.2 Managed Vegetation A-1
A.2 Wildlife A-2
A.2.1 Upland Game A-2
A.2.2 Invertebrates A-2
A.2.3 Amphibians A-3
A.2.4 Reptiles A-3
A.2.5 Birds A-3
A.2.6 Mammals A-8
A.3 Wetland Resouces A-10
A.3.1 Playa Biota A-11
A.4 References A-17

APPENDIX B - ASSESSMENT OF IMPACT TO THE PLAYA 1 FLOODPLAIN B-1

B.1 Background and History B-1
B.2 Description of Work B-2
B.2.1 Physiography B-2
B.2.2 Existing Conditions B-2
B.2.3 Land Use B-2
B.2.4 Hydrogeologic Conditions B-3
B.2.5 Soils B-3
B.2.6 Flora B-3
B.2.7 Fauna B-3
B.3 Floodplain Effects, Alternatives, and Mitigation B-3
B.3.1 Effects of Floodplain Activities on Lives and Property B-4
B.3.2 Alternatives B-4
B.3.3 Mitigation B-5
B.4 Summary B-5

LIST OF FIGURES

Figure 1-1. Location of Pantex and Key Areas....1-2
Figure 2-1. Existing Groundwater Pump and Treat System....2-4
Figure 2-2. Location of Proposed Monitoring Wells....2-6
Figure 2-3. Location of Proposed Retention Basins and Irrigation Systems....2-9
Figure 2-4. Location of Proposed Horizontal Wells for Option 3....2-12
Figure 2-5. Location of Proposed Vertical Wells for Corrective Measure Option 4....2-15
Figure 2-6. Location of Proposed Treatment Zone for Corrective Measure Option 5....2-18
Figure 2-7. Location of Proposed Vertical Extraction Wells, Treatment Areas, and Monitoring Wells for Corrective Measure Option 6....2-22
Figure 2-8. Approximate Area for Placement of Corrective Measures under the Proposed Action....2-29
Figure 3-1. Land Use within a 10-Mile Radius of Pantex....3-4
Figure 3-2. Onsite Land Use at Pantex....3-5

LIST OF TABLES

Table 2-1. Estimated Resource Requirements for Installation of Additional Perched and Ogallala Monitoring Wells....2-7
Table 2-2. Estimated Construction Resource Requirements for Corrective Measure Option 2....2-10
Table 2-3. Estimated Annual Operational Resource Requirements for Corrective Measure Option 2....2-11
Table 2-4. Estimated Construction Resource Requirements for Corrective Measure Option 3....2-13
Table 2-5. Estimated Annual Operational Resource Requirements for Corrective Measure Option 3....2-13
Table 2-6. Estimated Construction Resource Requirements for Corrective Measure Option 4....2-16
Table 2-7. Estimated Annual Operational Resource Requirements for Corrective Measure Option 4....2-16
Table 2-8. Estimated Annual Operational Resource Requirements for Corrective Measure Option 5....2-17
Table 2-9. Estimated Construction Resource Requirements for Corrective Measure Option 5....2-19
Table 2-10. Estimated Construction Resource Requirements for Enhanced Pump and Treat....2-24
Table 2-11. Estimated Annual Operational Resource Requirements for Enhanced Pump and Treat....2-24
Table 2-12. Estimated Construction Resource Requirements for the Upgraded PGPTS....2-25
Table 2-13. Estimated Annual Operational Resource Requirements for the Upgraded PGPTS....2-25
Table 2-14. Estimated Construction Resource Requirements for *In Situ* Bioremediation....2-26
Table 2-15. Estimated Annual Operational Resource Requirements for *In Situ* Bioremediation....2-26
Table 2-16. Estimated Construction Resource Requirements for the Permeable Reactive Barrier....2-27
Table 2-17. Estimated Annual Operational Resource Requirements for the Permeable Reactive Barrier....2-27
Table 2-18. Summary of Construction Elements for Each Corrective Measure Option....2-28
Table 2-19. Initial Screening of Groundwater Technologies....2-30
Table 3-1. Endangered, Threatened, and Candidate Species and Species of Concern Known to Appear on or Near Pantex....3-9
Table 3-2. Site-Wide Environmental Impact Statement Projected Utility Consumption and Capacities, 1996 through 2006....3-12
Table 3-3. Non-Hazardous Waste Volumes Generated at Pantex....3-13
Table 4-1. Estimated Criteria Pollutant Emissions for Enhancing Extraction and Additional Treatment Components....4-15
Table 4-2. Potential Human Health Effects of Implementing Proposed Corrective Measure Options....4-23
Table 4-3. Potential Transportation Impacts of Implementing Proposed Corrective Measure Options....4-26
Table 4-4. Summary of Impacts for Each Corrective Measure Option....4-29
Table A 1. Pantex Plant All-Time Bird List....A-4
Table A 2. Mammals Observed at Pantex Plant Since 1994....A-9
Table A 3. Wetland Species Observed in the Pantex Playas....A-11
Table A 4. Amphibians Associated with Playas....A-14
Table A 5. Amphibians Encountered during 1994 Herpetofaunal Survey of Pantex Plant....A-15
Table A 6. Reptiles Associated with Playas....A-15
Table B 1. Playa 1 Floodplain Cumulative Impacts Table....B-4

ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
ARCH	Air Rotary Casing Hammer
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	Constituent of Concern
COPC	Constituent of Potential Concern
CMS/FS	*Corrective Measure Study/Feasibility Study for the Pantex Plant*
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	United States Environmental Protection Agency
ESL	Effects Screening Level
FM	Farm-to-Market
GAC	Granulated Activated Carbon
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	High Density Polyethylene
HE	High Explosive
HHRA	Human Health Risk Assessment
ICM	Interim Corrective Measure
MNA	Monitored Natural Attenuation
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NWAR	Nuclear Weapons Accident Residue
PA/CRMP	Programmatic Agreement and Cultural Resource Management Plan
PGPTS	Perched Groundwater Pump and Treat System
PL	Public Law
PM_{10}	Particulate Matter
PQL	Practical Quantitation Limit
PVC	Polyvinyl Chloride
RCRA	Resource Conservation and Recovery Act
RDX	Research Development Explosive

RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RFIR	RCRA Facility Investigation Report
RI	Radiological Investigation
ROD	Record of Decision
ROI	Region of Influence
RRR	Risk Reduction Rule
RRS	Risk Reduction Standard
SA	Supplement Analysis
SCADA	Supervisory Control and Data Acquisition
SPS	Southwestern Public Service
SWEIS	Site-Wide Environmental Impact Statement
SWMU	Solid Waste Management Unit
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality (previously known as the Texas Natural Resource Conservation Commission and Texas Water Commission)
TNT	Trinitrotoluene
TPDES	Texas Pollutant Discharge Elimination System
TTU	Texas Tech University
TTRF	Texas Tech Research Farm
USDOE	United States Department of Energy
USDOE/NNSA	United States Department of Energy/National Nuclear Security Administration
USFWS	United States Fish and Wildlife Service
VOC	Volatile Organic Compound

GLOSSARY

Aquifer	A geological formation, group of formations, or part of a formation capable of yielding a significant amount of groundwater to wells or springs.
Attenuation	The process by which a compound is reduced in concentration over time, through absorption, adsorption, degradation, dilution, and/or transformation.
Basin	A topographic or structurally low area compared to the immediately adjacent areas.
Caliche	Calcium carbonate ($CaCO_3$) deposited in soils of arid or semiarid regions.
Concentration	The relative amount of a substance in a unit quantity (mass or volume) when combined or mixed with other substances.
Contaminant	Any physical, chemical, biological, or radiological substance or matter that has an adverse effect on air, water, or soil.
Constituent of Concern	A substance detected at a site that has the potential to affect human health and ecological receptors adversely due to its concentration, distribution, and mode of toxicity.
Constituent of Potential Concern	Contaminants that are potentially site-related and have data of sufficient quality for use in a quantitative risk assessment.
Contamination	Introduction into water, air, and soil of microorganisms, chemicals, toxic substances, wastes, or wastewater in a concentration that makes the medium unfit for its next intended use. Also applies to surfaces of objects, buildings, and various household and agricultural use products.
Corrective Action	Any action taken in accordance with a permit, including but not limited to: Resource Conversation and Recovery Act facility investigations, a corrective measures study, corrective measures implementation, corrective measures, and confirmation studies.
Critical habitat	The specific areas within the geographical area occupied by a species at the time it is listed as threatened or endangered on which are found those physical or biological features that are essential to the conservation of the species and that may require special management considerations or protection. It also includes specific areas outside the geographical area occupied by the species at the time it is listed if these areas are determined to be essential for the conservation of the species.
Disposal	The discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste, or any constituent thereof, may enter the environment or be emitted into the air or discharged into any water, including groundwater.
Dockum Group	Triassic sedimentary rocks that underlie the Ogallala Formation at Pantex Plant. The Dockum Group rocks consist of shale, clayey siltstone, and sandstone.
Effluent	Liquid or airborne material released to the environment.

Endangered Species	Plants and animals that are threatened with extinction, serious depletion, or destruction of critical habitat. Requirements for declaring a species endangered are contained in the Endangered Species Act.
Exposure Pathway	The course a chemical or physical agent takes from a source to an exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium (e.g., air) or media (in cases of intermedia transfer) are also included.
Floodplain	The base for regulation is the 100-year frequency flood, which is the flood that would have a 1 percent chance of being equaled or exceeded in any 1-year period.
Granular Activated Carbon Treatment	A filtering system often used in small water systems, individual homes and municipal water treatment plants to remove organics.
Groundwater	All subsurface water, especially that contained in the saturated zone below the water table.
Habitat	The part of the physical environment in which a plant or animal lives.
Hazardous Waste	A solid waste that meets the criteria listed in Title 40 of the *Code of Federal Regulations* (CFR) Section 261.3.
High Explosive	Any chemical compound or mechanical mixture which, when subjected to heat, impact, friction, shock, or other suitable initiation stimulus, undergoes a very rapid chemical change with the evolution of large volumes of highly heated gases that exert pressure in the surrounding medium.
In situ	In its original place; unmoved, unexcavated; remaining at the site or in the subsurface.
Inorganic Compound	A compound of mineral origin, not of basically carbon structure.
Landfill	A disposal facility or part of a facility where sanitary, solid, or hazardous waste is placed in or on land and which is not a land treatment facility, a surface impoundment, or an injection well.
Llano Estacado	Spanish for “staked plain,” used to refer to the Southern High Plains in Texas and New Mexico.
Migration	The natural travel of a material through the air, soil, or groundwater.
Monitored Natural Attenuation	Natural attenuation processes verified through ongoing sample collection and analysis.
National Ambient Air Quality Standards (NAAQS)	Air quality standards established by the Clean Air Act, as amended, that apply to outdoor air throughout the country. The primary NAAQS are intended to protect the public health with an adequate margin of safety, and the secondary NAAQS are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Environmental Policy Act	The National Environmental Policy Act was enacted to ensure that Federal decision-makers consider the effects of proposed actions on the human environment and to open their decision-making process to public scrutiny.
Offsite	Outside the Pantex site boundary.
Ogallala Aquifer	The principal aquifer and major source of water in the vicinity of Pantex Plant and the surrounding region. The depth to the Ogallala groundwater under Pantex Plant is approximately 430 feet (131 meters) below ground surface. The thickness of the Ogallala Aquifer under Pantex Plant is approximately 150 feet (46 meters).
Ogallala Formation	Tertiary formation consisting of silt, gravel, sand, and clay. The principal geologic unit in the High Plains aquifer, the Ogallala Formation comprises the Ogallala Aquifer in the Texas Panhandle, the primary source of groundwater in the region. The top of the Ogallala Formation in large areas of Texas and New Mexico consists of a resistant caliche layer. The Ogallala Formation at Pantex Plant overlies the Triassic Dockum Group strata and underlies the Quaternary Blackwater Draw Formation.
Onsite	Within the Pantex site boundary.
Organic Compound	Naturally-occurring (animal, plant-produced, or synthetic) substances containing mainly carbon, hydrogen, nitrogen, and oxygen.
Perched Groundwater	The perched groundwater at Pantex Plant can be described as three separate bodies of groundwater, one occurring beneath and surrounding Playa 1, one to the west of Pantex beneath the Wink Playa, and a smaller one occurring beneath Playa 3. Subsequent investigations have found that small areas of perched groundwater also occur in the vicinity of the Old Sewage Treatment Plant and Zone 6.
Permeability	The ability of rock or soil to transmit a fluid.
Playa	A term used in the southwestern United States for a dry, barren area in the lowest part of an undrained desert basin, underlain by clay, silt, or sand, and commonly by soluble salts; an ephemeral lake.
Polychlorinated Biphenyls (PCBs)	Any of the 209 compounds or isomers of the biphenyl molecule that have been chlorinated to various degrees.
Radioactive	The state of emitting radiation energy in forms of waves (rays) or particles.
Reduction	The addition of hydrogen, removal of oxygen, or addition of electrons to an element or a compound.
Resource Conservation and Recovery Act (RCRA) 1976, as amended	A comprehensive law that governs the aspects of hazardous waste management.
RCRA Facility Investigation	An investigation that determines the nature and extent of release of hazardous waste or constituents from regulated units, solid waste management units, and other source areas at the facility and to gather all necessary data to support a corrective measures study.

Region of Influence	The physical area that bounds the environmental, sociological, economic, or cultural feature of interest for the purpose of analysis.
Release	Spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing a hazardous waste or constituent.
Remedial Action	Actions consistent with a permanent remedy taken instead of, or in addition to, removal actions in the event of a release or threatened release of a hazardous waste into the environment. These actions are to prevent or minimize the release of hazardous wastes so that they do not migrate to cause an imminent and substantial danger to present or future public health and safety, or the environment.
Removal	Cleanup or removal of released hazardous wastes from the environment.
Risk Reduction Standard (RRS)	Three alternative levels of environmental remediation, designated RRS 1, RRS 2, and RRS 3, codified in the Texas Administrative Code (30 TAC) §335, Subchapters A and S, and known as the Risk Reduction Rule, issued by the Texas Natural Resources Conservation Commission, now the Texas Commission on Environmental Quality. RRS 1 is the most stringent level, where all waste and/or contaminated media must be remediated to background levels (concentrations). RRS 2 requires cleanup of affected media to health-based standards (concentrations) designated to be protective of human health. RRS 3 allows for partial remediation, i.e., levels of contaminants can be left in place as long as the risk posed by those contaminants falls beneath regulatory levels. In some cases, there are long-term site controls such as land-use restrictions.
Runoff	Any rainwater, leachate, or other liquid that drains over land from any part of a facility.
Scenario	A set of conditions presumed for the purpose of estimating doses by analysis.
Solid Waste	Any discarded regulated material, i.e. abandoned or considered inherently waste-like, as defined in 40 CFR 261.2.
Solid Waste Management Unit	An area identified through a RCRA Facility Assessment or formal notification to a regulatory agency that may have contained contaminants resulting from site activities.
Spill	Accidental leaking, pumping, emitting, emptying, or dumping of hazardous wastes or materials into or on any land or water.
Storage	The holding of a hazardous waste for a temporary period, at the end of which the hazardous waste is shipped offsite for treatment, processing, or disposal elsewhere.
Surface Water	A body of water that is directly exposed to the atmosphere.
Threatened Species	Any species likely to become an endangered species within the foreseeable future throughout all of a significant portion of its range. Requirements for declaring a species threatened are contained in the Endangered Species Act.

Treatment	Any method, technique, or process, including neutralization (except elementary neutralization), designed to change the physical, chemical, or biological character or composition of any hazardous waste. The result of the treatment is to neutralize the waste, to recover energy or material resources from it; or to render it non-hazardous, less hazardous, safest to transport, store or dispose of, amenable for recovery or storage, or reduced in volume.
Unsaturated Zone	A subsurface zone containing water below atmospheric pressure and air or gases at atmospheric pressure.
Upland	An extensive region of high land; the higher ground of a region, in contrast to a valley, plain or other low-lying land.
Volatile Organic Compound	Any compound containing hydrogen and carbon in combination with any other element that is characterized by being highly mobile in groundwater and is readily volatized (vaporized) into the atmosphere at a relatively low temperature.
Well	Any shaft or pit dug or bored into the earth, generally of a cylindrical form, and often walled with bricks or tubing to prevent the earth from caving in.
Wetland	Area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated solid conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

MEASUREMENTS AND CONVERSIONS

Rounding

Some numbers have been rounded; therefore, sums and products throughout the document may not be consistent. A number was rounded only after all calculations using that number had been made. Numbers that are actual measurements were not rounded.

Metric Conversion Chart

To Convert Into Metric			To Convert Out of Metric		
If You Know	**Multiply By**	**To Get**	**If You Know**	**Multiply By**	**To Get**
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	0.3048	meters	meters	3.281	feet
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
square feet	0.092903	square meters	square meters	10.7639	square feet
acres	0.40469	hectares	hectares	2.471	acres
square miles	2.58999	square kilometers	square kilometers	0.3861	square miles
Volume					
gal	3.7854	liters	liters	0.26417	gal
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight					
pounds	0.45360	kilograms	kilograms	2.2046	pounds

Units of Measure

°F	degrees Fahrenheit
cm	centimeter
dBA	decibels, A-weighted
ft	foot
ft^2	square foot
gal	gallon
gpd	gallon per day
gpm	gallon per minute
ha	hectare
in	inch
kg	kilogram
km	kilometer
kWh	kilowatt-hour
L	liters
lb	pound
Lpd	liter per day
Lpm	liter per minute
L/yr	liter per year
m	meter
m^2	square meter
m^3	cubic meter
MW	megawatt
MWh	megawatt-hour
MWh/yr	megawatt-hour per year
PM_{10}	particulate matter with an aerodynamic diameter less than or equal to 10 microns
yd	yard
yd^3	cubic yard

THIS PAGE INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY

The United States Department of Energy/National Nuclear Security Administration (USDOE/NNSA) is preparing to implement proposed corrective measures for perched groundwater, underlying and in the vicinity of Pantex. These corrective measures are required under the Resource Conservation and Recovery Act (RCRA), as implemented through the Texas Administrative Code (TAC) by the Texas Commission on Environmental Quality (TCEQ), and the Comprehensive Environmental Resource Compensation and Liability Act (CERCLA), administered by the U. S. Environmental Protection Agency (EPA).

The Pantex Plant is in the Texas Panhandle, 17 miles (27 km) northeast of Amarillo, Texas. The Plant was originally built for the United States Army during the early days of World War II, to produce conventional munitions, bombs, and artillery projectiles. In 1951, The Atomic Energy Commission (USDOE predecessor agency) began using the Plant for nuclear weapons assembly operations. Since that time, all nuclear weapons assembly and disassembly operations in the United States occur at Pantex.

Historical waste management practices have impacted perched groundwater underlying the Plant. These historical practices included disposal of spent solvents to unlined pits and sumps and disposal of high explosive wastewaters and industrial wastes to unlined ditches and playas. The perched groundwater is currently being treated to remove constituents of concern (COCs) under a Voluntary Interim Corrective Measures Program. Additional measures to improve removal of COCs, increase the efficiency and permanence of the cleanup, and prevent COCs from reaching the Ogallala Aquifer, are evaluated in the *Corrective Measures Study/Feasibility Study for the USDOE/NNSA Pantex Plant* (CMS/FS).

The *Corrective Measures Study* (CMS), a regulatory document required by the State of Texas Risk Reduction Rule (30 Texas Administrative Code §335, Subchapter S), identifies and evaluates potential remedial alternatives (i.e., corrective measures) for perched groundwater impacts associated with the Plant. Regulations require a corrective measure study to be submitted to regulators for review and selection of remedial actions. In a CMS, proposed corrective measure alternatives are evaluated against specific criteria to determine technological effectiveness, ability to be implemented, and cost, resulting in a corrective measure recommendation.

Since inclusion on the National Priorities List in 1994, Pantex has also been subject to CERCLA requirements. CERCLA contains a requirement to conduct a feasibility study (40 Code of Federal Regulations (CFR) 300.430 (e)), which is very similar to the CMS. Therefore, a CMS/FS was prepared for submittal to the TCEQ and EPA.

USDOE/NNSA submitted the Pantex CMS/FS to the TCEQ and the EPA in June 2006, and identified the recommended alternative for remediation of the perched groundwater. The final decision about which remedial actions should be implemented will be determined through regulatory review and approval processes, and public review and comment on the recommended action. This Environmental Assessment (EA) is a companion to the CMS/FS. Because the National Environmental Policy Act (NEPA) requires federal agencies to consider the environmental consequences of their proposed actions as part of the decision-making process, an evaluation of the alternatives proposed in the CMS/FS is required before deciding which should be implemented. This EA evaluates the potential environmental impacts of implementing the CMS/FS corrective measure alternatives to determine whether a finding of no significant impact is appropriate, or an environmental impact statement would be required before implementing any or all alternatives.

This EA evaluates two alternatives: the proposed action – implementing corrective measures at Pantex, and no action – not implementing corrective measures. The no action alternative describes how the groundwater would be managed in the absence of any remedial activities. This option would not meet the purpose and need for the proposed action, because remediation is required by TCEQ and EPA regulations. However, evaluation of the no action alternative is required under NEPA and provides a baseline from which to compare the potential impacts of the proposed action.

No Action. Under this alternative, no active measures would be implemented to reduce or contain the impacted perched groundwater. The current Pump and Treat System for perched groundwater would be turned off, and groundwater monitoring would be discontinued. Natural attenuation would be the only method for reduction of COCs in the perched groundwater. Use of perched groundwater without treatment, and drilling at the Plant without authorization, would continue as restrictions, but there would be no restrictions on offsite use or drilling.

Proposed Action. This alternative would implement corrective measures for the perched groundwater. Six possible corrective measure options have been proposed, five of which would discontinue injection of the treated groundwater back into the perched zone and instead use the water to irrigate agricultural land on or adjacent to the Plant. The other corrective measure option would discontinue all Perched Groundwater Pump and Treat System (PGPTS) activity but would continue to monitor natural attenuation in the perched groundwater. Institutional controls restricting offsite use of perched groundwater are also proposed under the six corrective measure options, as follows:

- Monitored Natural Attenuation (MNA)
- Existing Pump and Treat with MNA
- Enhanced Pump and Treat Using Horizontal Wells with MNA
- Enhanced Pump and Treat Using Vertical Wells with MNA
- Targeted Treatment with MNA
- Enhanced Pump and Treat with Targeted *In Situ* Treatment and MNA.

The last option is a combination of the best features of the first five corrective measure options. Potential environmental impacts associated with implementation are encompassed by evaluation of these options.

Corrective Measure Impacts. Corrective measure alternatives involve both short-term and long-term impacts, and could result in some minor offsite consequences. Short-term impacts primarily involve air quality and land use during well installation, and construction of conveyance lines, retention basins, and access roads. Long-term impacts on land use would result primarily from construction of the retention basins, and access roads. The size and number of the retention basins depends on which corrective measure option is selected. Between 50,000 ft^2 (4,600 m^2) and 230,000 ft^2 (21,400 m^2) (1.1 acre [0.45 ha] and 5.3 acres [2.1 ha]) of agricultural land near the eastern boundary of Pantex could be permanently displaced by the retention basins. One of the options would involve drilling and trenching to install extraction wells and piping in the 100-year floodplain of Playa 1. An assessment of the impacts determined that impacts associated with these activities would be minor, both individually and cumulatively.

There are no health risks to offsite receptors. Well drilling crews and construction workers would be subject to accidents typical of construction sites, and could also be exposed to COCs in soil from the saturated zone. These risks would be mitigated by use of appropriate personal protective equipment, training, and adherence to safe work practices.

There are potential long-term socioeconomic and offsite land use impacts associated with the groundwater alternatives. The value of affected properties could decrease through:

(1) Deed restrictions on offsite use of perched groundwater without treatment, and drilling without authorization

(2) Installation of monitoring, injection, and/or extraction wells.

The USDOE/NNSA is attempting to purchase the land comprising these affected properties, for a fair market value. If purchased by USDOE/NNSA, the potential socioeconomic and offsite land use impacts would be mitigated.

Except MNA, all proposed alternatives would provide some level of groundwater treatment and monitoring for 30 years. These corrective measure alternatives have been proposed to stabilize and/or prevent migration of perched groundwater COCs, with the intent of preventing contamination of the Ogallala Aquifer, a primary source of drinking and irrigation water for most of the High Plains. Although there would be some minor short-term adverse impacts, the long-term and cumulative impact of any of these actions would be an improvement in stabilization of perched groundwater migration and increased protection of the Ogallala Aquifer.

THIS PAGE INTENTIONALLY LEFT BLANK

1.0 INTRODUCTION

The USDOE/NNSA is preparing to implement proposed corrective measures for perched groundwater, underlying and in the vicinity of Pantex. These corrective measures are required under RCRA, as implemented through the TAC by TCEQ, and CERCLA, administered by EPA.

The *Corrective Measures Study/Feasibility Study for the Pantex Plant* (CMS/FS), a regulatory document required by the State of Texas Risk Reduction Rule (RRR) (30 Texas Administrative Code [TAC] §335, Subchapter S), presents and evaluates potential remedial alternatives (i.e., corrective measures) for perched groundwater at the Plant that have been identified through the prescribed RCRA and TCEQ evaluation process. Studies to determine areas that require corrective measure for closure have been documented in a number of reports described in Section 2.4.2 of this Environmental Assessment (EA). These studies have been conducted for all environmental media, ecological resources, and human health. Cross-media migration of some of the constituents released to some of the Solid Waste Management Units (SWMUs)/Areas of Concern (AOCs) closing to Risk Reduction Standard 3 (RRS 3) led to perched groundwater impacts. In a CMS/FS, proposed corrective measure alternatives are evaluated against specific criteria to determine technological effectiveness, ability to be implemented, and cost; and a corrective measure alternative is recommended. The CMS/FS is submitted to the TCEQ and EPA for review and selection of a remedial action.

USDOE/NNSA submitted the Pantex CMS/FS to TCEQ and EPA with the recommended alternative for remediation of the perched groundwater. TCEQ and EPA will consider the analyses in the CMS/FS along with other factors, and propose one of the options to USDOE/NNSA as the preferred alternative. After consideration of TCEQ and EPA feedback, USDOE/NNSA will propose one of the options as the preferred alternative to the public for review and comment.

This EA is a companion to the CMS/FS and is part of the USDOE/NNSA decision-making process for selection of a preferred alternative for groundwater corrective measures. This EA evaluates the potential environmental impacts of implementing the CMS/FS proposed corrective measures for impacted perched groundwater in accordance with requirements of the National Environmental Policy Act (NEPA).[1]

1.1 BACKGROUND

Pantex is in the Texas Panhandle 17 miles (27 km) northeast of Amarillo, Texas (see Figure 1-1). The Plant was originally built during the early days of World War II for the United States Army to produce conventional munitions, bombs, and artillery projectiles. After the war, the Plant was deactivated and remained vacant until 1949, when Texas Technological College (now Texas Tech University [TTU]) purchased the site for $1.00. In 1951, the main Plant and surrounding land were reclaimed under the recapture clause of the sales agreement for the Atomic Energy Commission (U.S. Department of Energy's [USDOE predecessor agency), and used for nuclear weapons assembly operations. Since that time, all nuclear weapons assembly and disassembly operations in the United States occur at the Plant. (USDOE, 1996)

[1] The Council on Environmental Quality (CEQ) is the government entity responsible for implementing NEPA. CEQ's NEPA regulations are found at Title 40 of the *Code of Federal Regulations* (CFR) Sections 1500 through 1508.

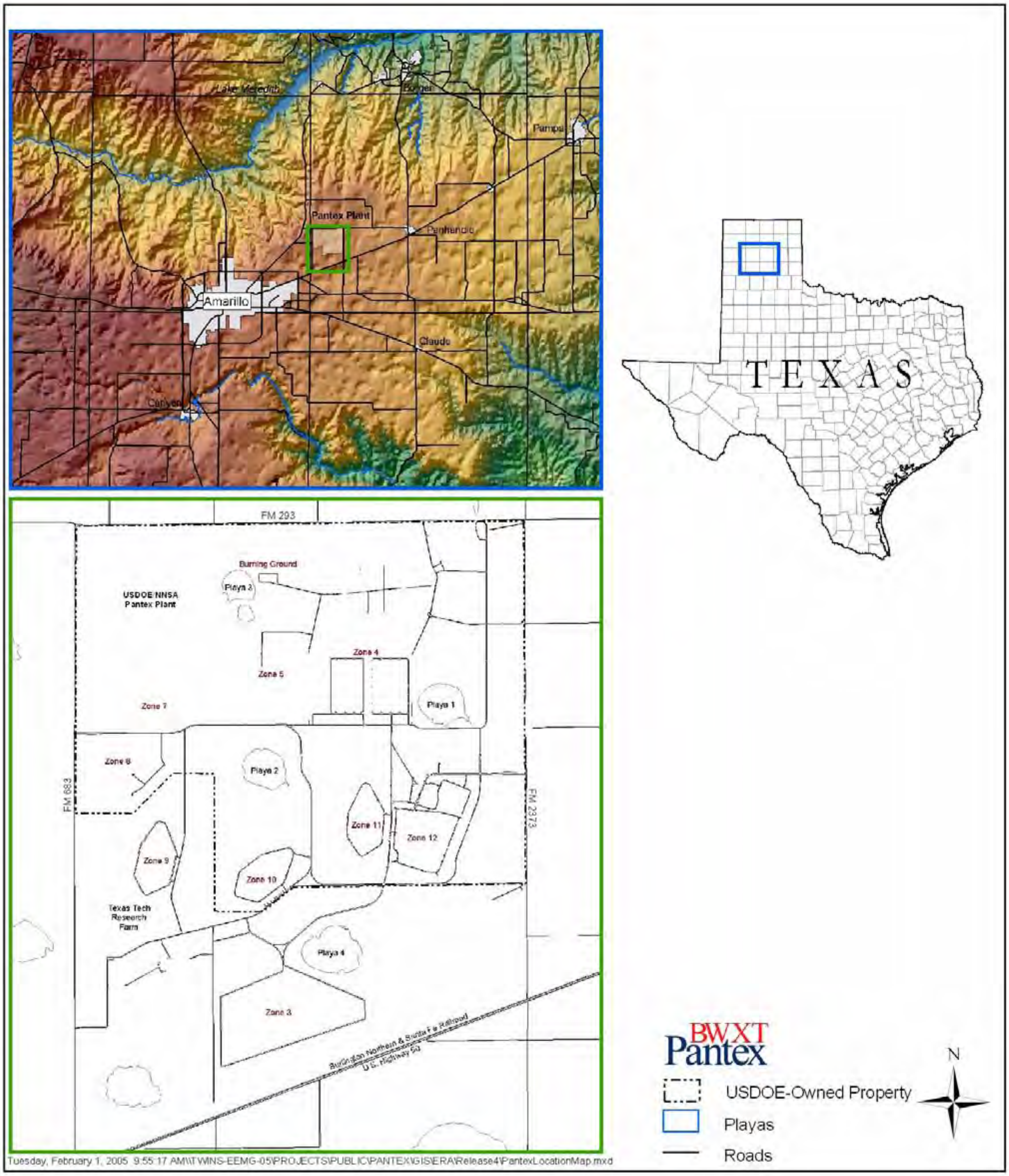

Figure 1-1. Location of Pantex and Key Areas

Historical waste management practices at the Plant have resulted in impacts to onsite soils and perched groundwater. These historical practices include disposal of spent solvents to unlined pits and sumps, and disposal of high explosive (HE) wastewater and industrial wastes to unlined ditches and playas. As a result, HE, solvents and metals may be found in the soils in the main operational areas and the Burning Ground at the Plant, and in the perched groundwater. The perched groundwater plume has migrated past the Plant boundaries and onto adjacent landowners' property to the southeast (USDOE/NNSA, 2003).

Pantex is an active, permitted, hazardous waste management facility subject to RCRA requirements. In 1991, Texas had partial authority to administer the RCRA Program, and the EPA and TCEQ jointly issued a Hazardous Waste Permit to Pantex that authorized storage and processing of hazardous waste.

In 1988, EPA conducted a preliminary review, followed by a visual site inspection in January 1989. Together, these activities formed the RCRA Facility Assessment (RFA) at Pantex that was used to identify SWMUs and AOCs requiring investigation, and possible corrective action, under the 1984 Hazardous and Solid Waste Amendments to RCRA. As a result of the RFA, several years of investigations, and negotiations between USDOE and EPA/TCEQ, SWMUs and other designated areas were sorted into 15 operable units, based on types of processes previously conducted at the units and the expected contaminants. RCRA Facility Investigations (RFIs) were subsequently initiated for the 15 operable units, but were finished according to geographical groupings referred to as Waste Management Groups. In May 1994, Pantex was added to the National Priorities List, thereby subjecting the Plant to the requirements of CERCLA in addition to RCRA.

The Hazardous Waste Permit was modified and replaced in 1996 by a Permit for Industrial Solid Waste Management Site issued by TCEQ. Previous requirements for performing interim corrective measures (ICMs), RFIs, CMSs, and corrective measure implementation were incorporated into the modified permit. In June 2003, TCEQ issued a *Compliance Plan for Industrial Solid Waste* (*Compliance Plan)* under the Hazardous Waste Permit, in conjunction with the Permit for Industrial Solid Waste Management Site. The *Compliance Plan* replaced the Hazardous Waste Permit corrective action and groundwater monitoring requirements, and included requirements for evaluating interim stabilization measures.

1.2 PURPOSE AND NEED FOR THE PROPOSED ACTION

The perched groundwater underlying Pantex is currently being treated to remove constituents of concern (COCs), as an interim stabilization measure. However, additional measures are being evaluated in the CMS/FS to determine a remedy that best achieves permanence, cost effectiveness, and cleanup requirements by minimizing the potential for COCs to reach the Ogallala Aquifer. The CMS/FS concludes with selection of a remedial alternative for groundwater that USDOE/NNSA recommends to TCEQ and EPA for implementation. The USDOE/NNSA now needs to implement corrective measures to fulfill the requirements of RCRA (as administered under the Texas Administrative Code) and CERCLA.

THIS PAGE INTENTIONALLY LEFT BLANK

2.0 DESCRIPTION OF THE PROPOSED ACTION

This EA evaluates the following alternatives:

- The "Proposed Action," implementing corrective measures to stabilize and reduce chemicals in perched groundwater, thereby increasing protection of the Ogallala Aquifer and its beneficial uses.

- "No Action," in which corrective measures for perched groundwater would not be implemented.

Under the proposed action, this EA considers the potential environmental impacts of implementing six corrective measure options evaluated in the CMS/FS to determine whether a finding of no significant impact is appropriate or an environmental impact statement (EIS) would be required before implementing any or all options.

The no action alternative would not meet the purpose and need for the proposed action because remediation is required at the Plant by RCRA and CERCLA regulations. However, evaluation of the no action alternative is required under NEPA and provides a baseline from which to compare the potential impacts of the Proposed Action.

2.1 NO ACTION

Under the no action alternative, no active measures would be implemented to reduce or contain the impacted perched groundwater. The perched groundwater pump and treat system (PGPTS) would be turned off and groundwater monitoring would be discontinued. Natural attenuation would be the only method for reduction and/or stabilization of COCs in the perched groundwater. Use of perched groundwater and drilling at the Plant would continue to be restricted, but no restrictions would be imposed on offsite use.

2.2 PROPOSED ACTION

The corrective measures proposed in the CMS/FS were selected for evaluation after considerable study of available conventional and innovative remedial technologies. A large number of remedial technologies were initially screened to eliminate those considered infeasible to implement, based on inherent limitations for site-specific COCs or conditions, or because remedial action objectives could not be achieved within a reasonable timeframe. After additional analysis of technologies that were still considered viable, a set of options were developed based on experience gained through treatability studies conducted at the Plant, ICMs, ongoing analyses of the existing PGPTS, groundwater modeling site knowledge, and application of professional engineering judgment.

The final selection of corrective measure options is based on computer modeling focused on flow and transport within the perched groundwater flow system. Five suites of modeling scenarios, totaling 38 separate simulations, were completed to evaluate the remedial potential of no action, and the corrective measure options evaluated under the proposed action. The scenarios providing the largest reduction in mass leaving the model boundaries, and greatest extraction of impacted perched groundwater, were developed into corrective measure options. These options have one characteristic in common: there is no injection of the treated groundwater back into the perched zone.

The six corrective measure options evaluated in the CMS/FS and this EA are:

- Monitored Natural Attenuation (MNA)
- Existing Pump and Treat with MNA
- Enhanced Pump and Treat Using Horizontal Wells with MNA
- Enhanced Pump and Treat Using Vertical Wells with MNA
- Targeted Treatment with MNA
- Enhanced Pump and Treat with Targeted Treatment and MNA.

2.2.1 Corrective Measure Options

Description of the Existing Perched Groundwater Pump and Treat System

The existing PGPTS extracts perched groundwater using vertical wells, processes the water above ground in the PGPTS Building, then injects the treated water into the perched zone for further cycling, or uses it for subsurface irrigation. The PGPTS Building houses two granulated activated carbon (GAC) units capable of extracting the organic contaminants from the groundwater and an ion exchange unit designed to extract chromium from the water. The ion exchange unit was installed in late 2005 to replace a chemical precipitation and microfiltration unit.

This system has evolved since its beginning in 1995 as a treatability study in response to the RFI for perched groundwater. The treatability study involved drilling a network of vertical extraction and injection wells and constructing a pilot groundwater treatment system designed to remove HEs, volatile organic compounds (VOCs), and metal (chromium) from the extracted groundwater. The system was subsequently expanded and ultimately resulted in a network of 17 extraction wells, two injection wells, and a treatment system with a capacity of 350 gpm (1,325 Lpm).

The system was then expanded in two phases as an Interim Corrective Measure (ICM). In 2000, the first phase was implemented and included installing an additional 30 extraction wells and seven injection wells, and connecting those wells to the existing treatability study system. Three new monitoring wells were also installed to the east (downgradient) of the extraction well field. Wells were installed in the perched groundwater to depths varying from 278 ft (85 m) to 294 ft (90 m) below ground surface. A supervisory control and data acquisition (SCADA) system was installed to allow an operator to review the real-time operational status of the extraction well system and send instant control commands to the well field from a personal computer workstation.

In 2001, the second phase was implemented. It involved removing the entire treatability study system, expanding and upgrading the PGPTS Building, constructing a control room inside the building, relocating the SCADA system to the new control room, and installing new ICM treatment system components. The GAC and chemical precipitation systems (the latter system recently replaced as previously discussed) were expanded to a capacity of 500 gpm (1,890 Lpm) and 120 gpm (450 Lpm), respectively.

The current treatment system well field consists of 63 wells: 11 injection wells (five of which are active) and 52 extraction wells. This includes all but two of the pre-existing treatability study injection and extraction wells (see Figure 2-1). The PGPTS consists of two separate processes for treatment of groundwater contaminant plumes. One plume contains only organic HEs and VOCs, and the other also contains chromium. Groundwater impacted with chromium above the regulatory limits for injection is passed through a 5-micron filter to remove fine particulates, then through one of two resin beds operating in parallel to remove the chromium. The treated groundwater is then transferred to the 500-gpm (1,890-Lpm) GAC system, where HEs and VOCs are removed before discharge. Groundwater derived from wells not impacted with chromium above regulatory limits is transferred directly to the GAC system for treatment (BWXT Pantex/SAIC, 2004). The PGPTS processes a combined total flow of 200 to 300 gpm (757 to 1,136 Lpm) from all extraction wells currently installed in the well field.

The average daily flow rate for a given month from the entire extraction system (using precipitation and microfiltration for chromium removal) has ranged from no flow to approximately 300,000 gpd (1.14 million Lpd), with an average daily flow rate of approximately 160,000 gpd (606,000 Lpd) (BWXT Pantex and SAIC, 2004). As of November 2006, the PGPTS had removed approximately 253 lb (115 kg) of hexavalent chromium, and 4,240 lb (1,925 kg) of research development explosive (RDX), 578 lb (262 kg) of high melting explosive, 289 lb (131 kg) of other HEs, summing to 5,107 lb (2,318 kg) of total HEs (Caldwell, 2006).

Operation of the PGPTS generates spent GAC and ion exchange resin. These systems are serviced by vendors who replace the spent GAC and resins with fresh materials and regenerate the spent GAC and resins offsite for reuse. Very small amounts of filters and other wastes are also generated as a result of these activities, and are disposed in accordance with the Plant procedures for each specific waste type.

Common Elements of Corrective Measure Options

Several new elements are common to all the corrective measure options:

- Implementation of institutional controls to restrict offsite use of perched groundwater on land bordering Pantex to the south and east and drilling without authorization
- Installation of 10 new monitoring wells
- Eliminating injection of treated water into the perched groundwater
- Decommissioning of wells installed or used under any of the proposed corrective measure options upon completion.

All proposed options except Corrective Measure Option 1, MNA, include installation of irrigation systems, such as center pivots. Each of these common elements is described in the following paragraphs. Under all six options, the existing injection wells would either be converted into monitoring wells or plugged and abandoned, and use of perched groundwater onsite without treatment would continue to be restricted. In addition, routine maintenance would be performed as required to keep the systems operational for an assumed 30-year operating period. It is expected that some of the pumps and other equipment would require repair or replacement during this time, and that not all of the wells would be operational at all times.

Institutional Controls. Perched groundwater use on USDOE/NNSA and TTU property is restricted. Other than treated perched groundwater from the PGPTS used for irrigation, no perched groundwater is used on either the Plant site or TTU property. There are no offsite domestic or production wells completed in the perched groundwater in the vicinity of the Plant to the south and east. Restrictions would remain in place to ensure that no wells would be completed in the perched groundwater on the Plant site or TTU property in the future. In addition, deed restrictions precluding use of perched groundwater without treatment and drilling without authorization would be imposed on private land overlying the current extent of the impacted perched groundwater and the expected extent of future migration. These restrictions would affect private land to the south and east of the Plant. The USDOE/NNSA is attempting to purchase the land that comprises the affected properties east of Pantex Plant. Therefore, a change of ownership is possible, but the use of the land would remain substantially the same, as some of it could be used for irrigation of crops with the treated perched groundwater.

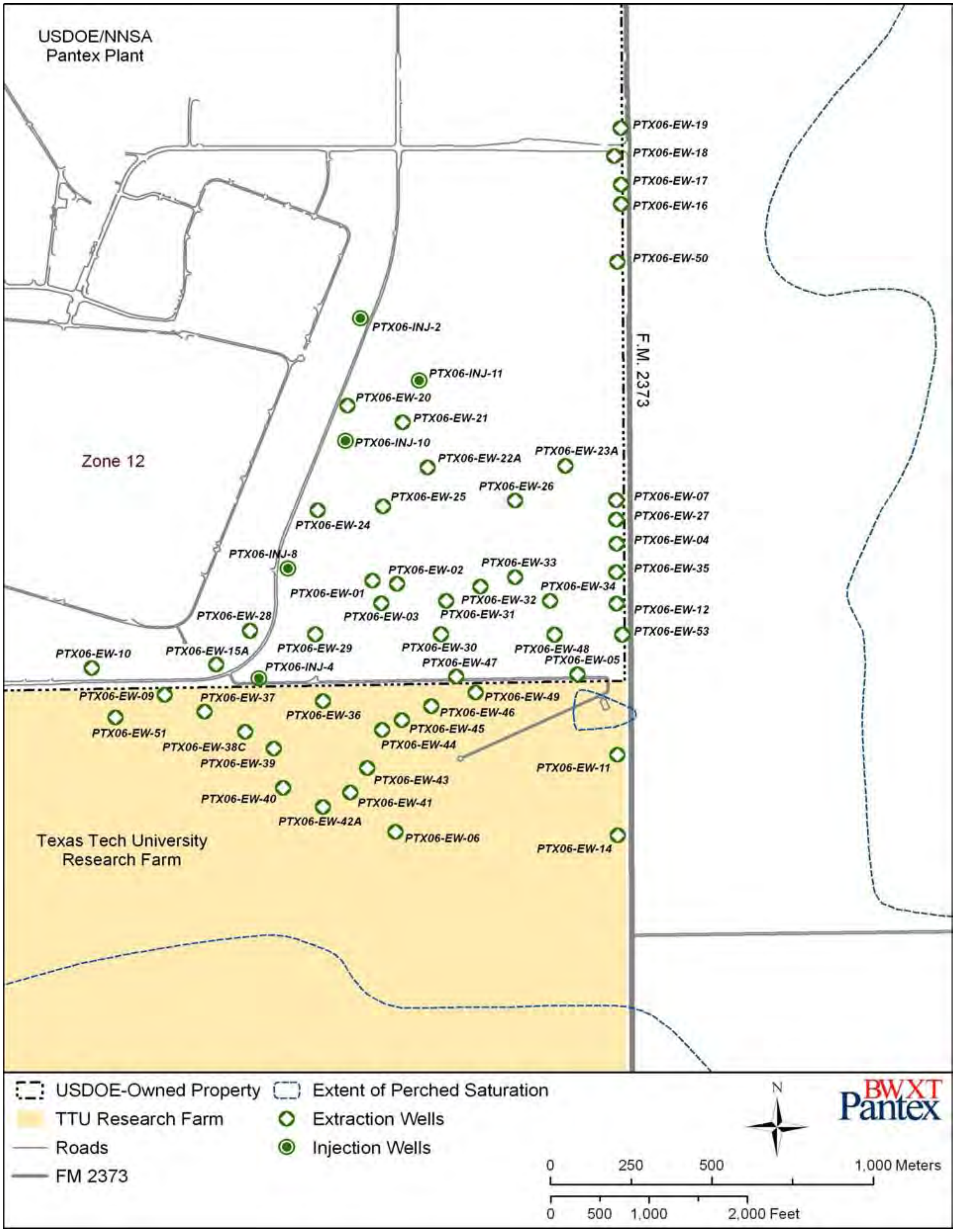

Figure 2-1. Existing Groundwater Pump and Treat System

Groundwater Monitoring. The existing Pantex Plant groundwater-monitoring network comprises more than 100 monitoring wells, 75 of which are completed in the perched groundwater. These wells are sampled on an established schedule that is, quarterly, semiannually, or annually, depending on the analyte, using an EPA-approved low-flow sampling method. Analytical results are compared to TCEQ RRS 1 guidelines representing calculated backgrounds for naturally occurring compounds and the practical quantitation limit (PQL) for non-naturally occurring compounds and RRS 2 residential cleanup values calculated specifically for the Plant (BWXT Pantex, 2005). As shown in Figure 2-2, 10 new wells would be added to the existing groundwater monitoring network. Approximately two 4-in (10-cm) polyvinyl chloride (PVC)-cased monitoring wells would be completed in the perched groundwater and eight 5-in (13-cm) stainless steel-cased monitoring wells would be completed in the Ogallala Aquifer. The additional wells would expand the groundwater-monitoring network to better characterize the concentration and migration of contaminants in the perched groundwater and to monitor the Ogallala Aquifer. Three of the Ogallala Aquifer wells and one perched groundwater well would be east of the Plant on private agricultural land. One perched groundwater well would be in the southwest corner of the site, one Ogallala Aquifer well would be on TTU property, and four Ogallala Aquifer wells would be in the north and north central parts of the Plant site (two on the northern site boundary.)

The perched groundwater wells would be completed to a depth of approximately 300 ft (91 m) while the Ogallala Aquifer wells would be completed to a depth of approximately 450 ft (137 m). These new perched monitoring wells would be expected to be installed using Air Rotary Casing Hammer (ARCH) drilling techniques, the method used to install the wells in the existing PGPTS. For the Ogallala Aquifer monitoring wells, the ARCH method would be used to drill approximately the first 300 ft (91 m); the remaining 150 ft (46 m) would be completed using standard mud rotary drilling.

Estimated resource requirements for construction of these additional monitoring wells are presented in Table 2-1. Drill cuttings from unaffected zones would be spread around the well installation and mixed with soil to even the grade in accordance with standard well installation practice. Drill cuttings from the perched groundwater and drilling mud from installation of Ogallala wells are regulated and would be treated as waste. Cuttings would be containerized in 55-gal (208-L) drums, and drilling mud would be containerized in 4,000-gal (15,140-L) sludge boxes. Both waste forms would then be characterized to determine the appropriate waste classification, with final disposal occurring at a suitable offsite facility. Perched groundwater and Ogallala development water would be containerized in tanks and treated through the PGPTS. Installation of these new wells and two-track access roads would temporarily disturb as much as 2.2 acres (0.9 ha) of land, of which approximately 1.1 acres (0.45 ha) would be offsite on private agricultural land. Approximately 80 workdays (about 4 months) would be required to install these 10 wells using two drill rigs, each with a crew of three persons. In total, the completed monitoring wells, pads, and access roads would occupy approximately 1.1 acres (0.4 ha), of which approximately 0.55 acres (0.22 ha) would be private agricultural land.

Irrigation System. Groundwater modeling indicates that eliminating injection of the treated groundwater would substantially improve the performance of the existing PGPTS in stabilizing the potential for migration of the perched groundwater, and reducing recharge to the perched groundwater altogether could result in a reduction of the long-term potential for vertical migration to the Ogallala Aquifer (BWXT Pantex/SAIC, 2006a). Therefore, injection of groundwater has been eliminated from the proposed corrective measure options. Instead, the treated groundwater would be beneficially reused for irrigation in onsite and offsite locations that would be designed and managed in a way that would not contribute to future recharge of the perched groundwater. The land proposed for irrigation is agricultural land that is either currently cultivated or that could be made available for cultivation.

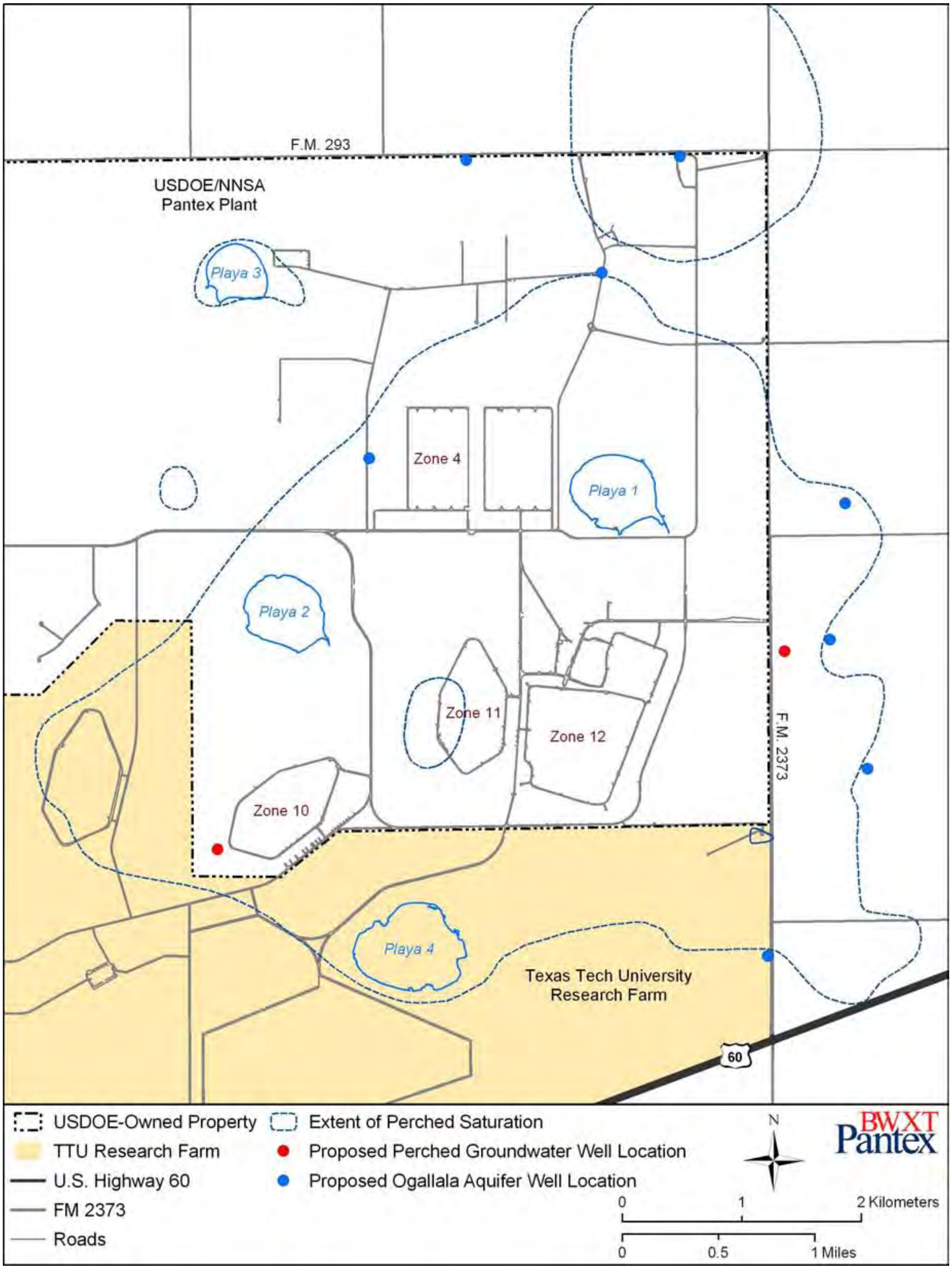

Figure 2-2. Location of Proposed Monitoring Wells

Table 2-1. Estimated Resource Requirements for Installation of Additional Perched and Ogallala Monitoring Wells

Material/Resource	Two Perched Groundwater Wells	Eight Ogallala Aquifer Wells	Total [a]
Steel/PVC casing, ft (m) [b]	600 (180)	3,600 (1,100)	4,200 (1,280)
Wire-wrapped screen, ft (m)	20 (6.1)	80 (24)	100 (30)
Steel intermediate casing, ft (m)	0	2,400 (730)	2,400 (730)
Concrete, yd^3 (m^3) [c]	1.8 (1.4)	7.2 (5.5)	9.0 (6.9)
Sand (well packing), yd^3 (m^3)	0.3 (0.2)	1.1 (0.9)	1.4 (1.1)
Bentonite, yd^3 (m^3)	0.08 (0.06)	0.3 (0.2)	0.4 (0.3)
Grout, yd^3 (m^3)	5.6 (4.3)	50 (39)	56 (43)
Diesel fuel, gal (L) [d]	750 (2,840)	6,000 (22,700)	6,800 (25,600)
Water (drilling and development), gal (L)	2,000 (7,600)	63,000 (238,500)	65,000 (246,000)

Key: PVC, polyvinyl chloride
[a] Totals may not equal the sum of the contributions due to rounding.
[b] Assumes total well depth of 300 ft (91 m) for perched groundwater wells using 4-in (10-cm) PVC casing and 450 ft (137 m) for Ogallala Aquifer wells using 5-in (13-cm) stainless steel casing.
[c] Calculated assuming construction of a 5-ft (1.7-m) by 7-ft (2.1-m) by 8-in (20-cm) thick pad per well requiring 0.90 yd^3 (0.69 m^3) concrete per pad.
[d] Reflects drill rig consumption of 75 gal (284 L) of diesel fuel per workday.

Irrigation systems, such as center pivots, would be installed to disperse the treated groundwater for all corrective measure options evaluated under the Proposed Action except MNA (Corrective Measure Option 1). Earthen retention basins large enough to hold at least 30 days of treated water would be constructed to accommodate an irrigation system malfunction or a long period of inclement weather when irrigation would not be possible or practicable. Figure 2-3 shows one possible arrangement of the retention basins. The exact location may vary, but the retention basins would be near the eastern Plant boundary. The size and number of retention basins would be based on the maximum volume of water to be stored, so would differ by corrective measure option. The basins would be constructed by digging the basin area to a depth of 6 ft (1.8 m) and compacting the excavated soil around the perimeter to form 9-ft (2.7 m) high above-grade berms for a total basin depth of 15 ft (4.6 m). Basin dimensions could change based on Pantex operational needs and they would probably be deeper with shorter berms. The basins would be lined with 6 in (15 cm) of sand and a 40-mil high-density polyethylene (HDPE) liner. The liner would be kept in place by a 3-in (8-cm) pea gravel ballast. Unauthorized access to the basins would be prevented by construction of chain link fences. The amount of fencing for each basin would include a buffer of 20 feet on all sides. The retention basins would be connected to both the PGPTS Building and the irrigation systems by underground piping. Water would be moved through the system by electrically driven pumps.

The amount of land proposed to be irrigated would also depend on the amount of water to be dispersed, and is conservatively estimated as six times the minimum acreage needed to utilize the water resulting from each option. This EA identifies many of the areas that could potentially be used for irrigation with treated perched groundwater. A combination of subsurface and center pivot irrigation systems is possible. The method of irrigation and location will be determined during design of the system. Also, enough area could be identified to manage the water on existing Pantex property, if necessary.

To ensure that all the water could be used for irrigation, a cycle consisting of three plots each large enough to utilize the entire output of water from the PGPTS would be used. At any one time, one plot would be under cultivation, hence irrigation; another in transition (in other words, being planted or harvested); and another fallow. This minimum acreage has been doubled to ensure enough land would be available to expand if more water needs to be dispersed than expected. Figure 2-3 also shows onsite areas currently used for subsurface irrigation, and proposed locations on and to the east of the Plant that would be suitable for this use. Onsite areas would be the first to be irrigated. Additional plots of privately owned land to the east across Farm-to-Market Road (FM) 2373 would be used as needed, according to future agreements to be reached with adjacent landowners. It is anticipated that one irrigation system would be installed for approximately every 100 acres (40 ha). Approximately 240 acres (100 ha) of land onsite and 2020 acres (820 ha) off the Plant site have been identified as available for potential future irrigation.

A subsurface irrigation system was installed at Pantex to reuse treated wastewater from the sewage treatment plant beneficially. This system irrigates approximately 300 acres (121 ha) north of Playa 1 (See Figure 2-3). The PGPTS has been connected to this subsurface irrigation system to allow flexibility so at least a portion of the treated groundwater could be used for irrigation. However, effluent discharged for irrigation must first be treated to reduce the boron concentration to levels acceptable for agricultural use. Boron is removed using an ion exchange module with a capacity of 150 gpm (568 Lpm). This module is in the PGPTS Building, but is not part of the PGPTS. Only water destined for the irrigation system passes through the boron removal module. This module is serviced by a vendor who replaces the spent ion exchange resin with fresh material and regenerates the spent resin offsite. Connection to the existing subsurface irrigation system would be maintained to provide flexibility for dispersing the treated groundwater. Because the entire output of the PGPTS would be directed to irrigation systems under all the proposed corrective measure options except MNA, treated groundwater would be routed for boron removal, as needed, to meet the requirements of the crops being irrigated.

Well Decommissioning. Under each option, after completing the necessary operations, the systems would be decommissioned. Wells would be capped or plugged in accordance with applicable TCEQ standards.

2.2.1.1 Corrective Measure Option 1: Monitored Natural Attenuation (MNA)

Corrective Measure Option 1 is similar to the No Action alternative in that the PGPTS would be turned off and no other active measures would be implemented to reduce or contain the impacted perched groundwater. Onsite use of perched groundwater and drilling would continue to be restricted. Unlike the No Action alternative, the current groundwater-monitoring program would remain in place to monitor natural attenuation for 30 years, and as described in Section 2.2.1, 10 new monitoring wells would be added to the groundwater-monitoring network. Approximately 80 workdays (4 months) would be required to install the monitoring wells using two drill rigs, each with a crew of three persons. Estimated resource requirements for installation of the new monitoring wells are presented in Table 2-1. Institutional controls restricting offsite use of perched groundwater and drilling without authorization would also be implemented under this option for land south and east of the Plant boundaries.

2.2.1.2 Corrective Measure Option 2: Existing Pump and Treat with MNA

Under Corrective Measure Option 2, the existing PGPTS would continue to be operated and maintained for 30 years, but without injection of extracted groundwater following its treatment. Ten new monitoring wells would be installed and institutional controls restricting perched groundwater use would be implemented as described in Section 2.2.1. The irrigation system would be capable of dispersing 160,000 gpd (606,000 Lpd) using two irrigation subsystems with as many as 200 acres (81 ha) available for irrigation. A 200 ft (61 m) wide by 250 ft (76 m) long by 15 ft (4.6 m) deep retention basin would be constructed to accommodate up to 4.8 million gal (18 million L), or 30 days of treated groundwater.

Figure 2-3. Location of Proposed Retention Basins and Irrigation Systems

The existing PGPTS and boron removal module would be able to treat this additional volume of water without upgrading the size of the units.

Estimated resource requirements for construction of the retention basin and installation of new monitoring wells are presented in Table 2-2, operational resource requirements in Table 2-3. Installation of the retention basin, associated irrigation system piping, new monitoring wells, and access roads would temporarily disturb as much as 6.5 acres (2.6 ha), of which approximately 1.1 acres (0.45 ha) would be offsite on private agricultural land. Approximately 80 workdays (4 months) would be required to install the monitoring wells using two drill rigs, each with a crew of three persons. Construction of the retention basin would require approximately 8 days using three heavy-equipment crews, each with three persons; and three additional laborers. In total, the completed monitoring wells and pads, new retention basin, and access roads would occupy approximately 2.7 acres (1.1 ha), of which approximately 0.5 acres (0.2 ha) would be private agricultural land.

Table 2-2. Estimated Construction Resource Requirements for Corrective Measure Option 2

Material/Resource	Requirement
Ten Monitoring Wells	
Steel casing, ft (m) [a]	4,200 (1,280)
Wire-wrapped screen, ft (m)	100 (30)
Steel intermediate casing, ft (m)	2,400 (730)
Concrete, yd^3 (m^3) [b]	9.0 (6.9)
Sand (well packing), yd^3 (m^3)	1.4 (1.1)
Bentonite, yd^3 (m^3)	0.4 (0.3)
Grout, yd^3 (m^3)	56 (43)
Diesel fuel, gal (L) [c]	6,800 (25,600)
Water (drilling and development), gal (L)	65,000 (246,000)
Retention Basin	
Excavation (earthwork), yd^3 (m^3)	11,100 (8,490)
Pea gravel (3-in [8-cm] layer), yd^3 (m^3)	490 (375)
Sand (6-in [15-cm] layer), yd^3 (m^3)	1,160 (887)
Water pipe (4-in [10-cm]), ft (m)	3,000 (900)
HDPE liner, ft^2 (m^2)	69,600 (6,470)
Diesel fuel, gal (L)	1,390 (5,280)
Water, gal (L)	2,470 (9,340)
Chain link Fence, ft (m)	1,060 (323)

Key: HDPE, high-density polyethylene.
[a] Assumes total well depth of 300 ft (91 m) for perched groundwater wells and 450 ft (137 m) for Ogallala Aquifer wells.
[b] Calculated assuming construction of a 5-ft (1.7-m) by 7-ft (2.1-m) by 8-in (20-cm) thick pad per well requiring 0.90 yd^3 (0.69 m^3) concrete per pad.
[c] Reflects drill rig consumption of 75 gal (284 L) of diesel fuel per workday.

Table 2-3. Estimated Annual Operational Resource Requirements for Corrective Measure Option 2

Material/Resource	Retention Basin and Irrigation System[a]
Electricity, (MWh)	200

[a] Reflects electrical power demand to pump and irrigate an average of 160,000 gpd (606,000 Lpd) of treated water from the PGPTS.

2.2.1.3 Corrective Measure Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA

Under Corrective Measure Option 3, the existing PGPTS would continue to be operated and maintained for 30 years, but without injection of extracted groundwater following its treatment. Six horizontal extraction wells would be added to the existing 52-well vertical extraction system to increase the extraction rate of perched groundwater to 590,000 gpd (2.2 million Lpd). Ten new monitoring wells would be installed and institutional controls restricting perched groundwater use would be implemented as described in Section 2.2.1. The irrigation system would be capable of dispersing 590,000 gpd (2.2 million Lpd) using six irrigation subsystems, with as many as 700 acres (280 ha) available for irrigation. Two retention basins would be constructed to accommodate up to 18 million gal (68 million L), or 30 days of treated groundwater. One basin would be 400 ft (122 m) by 310 ft (94 m) by 15 ft (4.6 m) deep. The second basin would be 200 ft (61 m) by 250 ft (76 m) by 15 ft (4.6 m) deep. The GAC system would be adequate to treat the additional volume of groundwater, but both the chromium and boron removal ion exchange modules in the PGPTS Building would need to be tripled in size.

Horizontal wells would be installed in selected areas of the perched groundwater shown in Figure 2-4. Well locations would be based on a combination of higher saturated thickness, a high concentration of RDX in the groundwater, or both. All wells would be outside the delineated floodplain for Playa 1. As many as 102 two-inch (5-cm) diameter boreholes would be completed along the proposed path of each horizontal well to more accurately place each well within the fine-grained zone. The boreholes would be completed using air rotary drilling techniques and would be plugged after use. After determining the well locations, the 6-in (15-cm) diameter steel-cased wells would be installed to a depth of about 280 ft (85 m); screen length would range from 1,000 ft (300 m) to 1,400 ft (430 m). The wells would be installed using directional drilling techniques involving the use of special drill bits to advance curved boreholes underground. A pilot hole would first be drilled at an angle, and then leveled out at a specific depth. Once that depth was reached, the pilot hole would be advanced horizontally the desired distance.

Estimated resource requirements to implement this option are presented in Table 2-4, operational resource requirements in Table 2-5. Installation of the new monitoring and horizontal extraction wells, piping, retention basins, and access roads would temporarily disturb as much as 21.7 acres (8.8 ha), of which approximately 1.4 acres (0.6 ha) would be private agricultural land east of the Plant. Approximately 110 workdays (6 months) would be required to install the boreholes, and new monitoring and extraction wells using five drill rigs, each with a crew of three persons. Construction of the retention basins would require approximately 22 workdays (1 month) using three heavy-equipment crews each with three persons; and three additional laborers. In total, the completed monitoring and extraction well pad locations, extraction pipeline corridor, retention basins, and access roads would occupy approximately 9.0 acres (3.6 ha), of which approximately 0.7 acres (0.3 ha) would be offsite on private agricultural land.

Figure 2-4. Location of Proposed Horizontal Wells for Option 3

Table 2-4. Estimated Construction Resource Requirements for Corrective Measure Option 3

Material/Resource	Requirement		
	10 Monitoring Wells [a]	6 Horizontal Wells [b]	Total [c]
Steel casing, ft (m)	4,200 (1,280)	1,700 (520)	5,900 (1,800)
Wire-wrapped screen, ft (m)	100 (30)	6,600 (2,012)[b]	6,700 (2,040)
Steel intermediate casing, ft (m)	2,400 (730)	0	2,400 (730)
Concrete, yd^3 (m^3) [d]	9.0 (6.9)	5.4 (4.1)	14 (11)
Sand (well packing), yd^3 (m^3)	1.4 (1.1)	2.9 (2.2)	4.3 (3.3)
Bentonite, yd^3 (m^3)	0.4 (0.3)	0.48 (0.37)	0.9 (0.7)
Grout, yd^3 (m^3)	56 (43)	34 (26)	90 (69)
Diesel fuel, gal (L)[e]	6,800 (25,600)	4,500 (17,000) [wells] 7,600 (29,000) [boreholes]	19,000 (72,000)
Water (drilling and development), gal (L)	65,000 (246,000)	21,000 (79,700)	86,000 (326,000)
Steel extraction piping, ft (m)	0	17,000 (5,180)	17,000 (5,180)
Retention Basins			
Excavation (earthwork), yd^3 (m^3)			38,700 (29,600)
Pea gravel (3-in [8-cm] layer), yd^3 (m^3)			1,690 (1,290)
Sand (6-in [15-cm] layer), yd^3 (m^3)			4,000 (3,060)
Water pipe (4-in [10-cm]), ft (m)			18,100 (5,520)
HDPE liner, ft^2 (m^2)			223,600 (20,800)
Diesel fuel, gal (L)			3,870 (14,600)
Water, gal (L)			23,800 (90,200)
Chain link Fence, ft (m)			2,640 (805)

Key: HDPE, high-density polyethylene.
[a] From Table 2–1.
[b] Assumes total well depth of 280 ft (85 m) using 6-in (15-cm) steel casing with 1,100 ft (335 m) screen length for each horizontal well.
[c] Totals may not equal the sum of the contributions due to rounding.
[d] Calculated assuming construction of a 5-ft (1.7-m) by 7-ft (2.1-m) by 8-in (20-cm) thick pad per well requiring 0.90 yd^3 (0.69 m^3) concrete per pad.
[e] Reflects drill rig consumption of 75 gal (284 L) of diesel fuel per workday.

Table 2-5. Estimated Annual Operational Resource Requirements for Corrective Measure Option 3

Material/Resource	Extraction Well System[a]	Retention Basins and Irrigation System[b]
Electricity, (MWh)	200	250

[a] Reflects electrical power demand to operate six horizontal extraction well pumps at a rate of 50 gpm (189 Lpm) or 430,000 gpd (1.6 million Lpd).
[b] Reflects electrical power demand to pump and irrigate an average of 590,000 gpd (2.2 million Lpd) of treated water.

2.2.1.4 Corrective Measure Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA

Under Corrective Measure Option 4, the existing PGPTS would continue to be operated and maintained for 30 years, but without injection of extracted groundwater. Eighty-seven new vertical wells would be added to the existing 52-well vertical extraction system as shown in Figure 2-5 to increase the extraction rate of perched groundwater to 360,000 gpd (1.4 million Lpd). Ten new monitoring wells would be installed and institutional controls restricting perched groundwater use and drilling would be implemented as described in Section 2.2.1. The irrigation system would be capable of dispersing 360,000 gpd (1.4 million Lpd) using four irrigation subsystems, with as many as 400 acres (162 ha) available for irrigation. Two retention basins would be constructed to accommodate up to 11 million gal (41 million L), or 30 days of treated groundwater. One basin would be 200 ft (61 m) by 290 ft (88 m) by 15 ft (4.6 m) deep. The second basin would be 200 ft (61 m) by 250 ft (76 m) by 15 ft (4.6 m) deep. The GAC system would be adequate to treat the additional volume of groundwater, but both the chromium and boron removal ion exchange modules in the PGPTS Building would need to be doubled in size to accommodate the additional groundwater.

Estimated resource requirements for construction of the 87 extraction wells and 10 monitoring wells are presented in Table 2-6, operational resource requirements in Table 2-7. New extraction wells would be installed using the same technique described in Section 2.2.1 for perched groundwater wells. Installation of the new monitoring and extraction wells, conveyance piping, retention basins, and access roads would temporarily disturb as much as 14.5 acres (6.0 ha), of which approximately 1.5 acres (0.6 ha) would be offsite on private agricultural land east and southeast of the Plant. Approximately 200 workdays, about 10 months, would be required to complete installation of the two well systems using four drill rigs, each with a crew of three persons. Construction of the retention basins would require about 15 workdays using three heavy-equipment crews, each with three persons; and three additional laborers. Another 80 workdays would be required to install the 10 new monitoring wells. In total, the completed well systems, associated piping corridors, retention basins, and access roads would occupy approximately 5.9 acres (2.4 ha), with approximately 0.7 acres (0.3 ha) of this area being private agricultural land.

2.2.1.5 Corrective Measure Option 5: Targeted Treatment with MNA

Corrective Measure Option 5 would use enhanced anaerobic biodegradation to provide targeted *in situ* treatment for 30 years along the south and east fringes of the perched groundwater at Pantex. Under this option, the existing PGPTS would be turned off. In its place, 203 vertical injection wells and 178 vertical extraction wells would be installed in the general area shown in Figure 2-6. Six injection and five extraction well lines would be spaced on average 100 ft (30 m) apart. The 4-in (10-cm) PVC injection wells and 6-in (15-cm) PVC extraction wells would be installed to an approximate depth of 280 ft (85 m) using the techniques described in Section 2.2.1 for perched groundwater wells. Exploratory boreholes placed approximately 50 ft (15 m) apart would be used to determine the depth of the fine-grained zone in order to install the well screens at the correct depths. Approximately 766 4-in (10-cm) boreholes could be needed to place the injection and extraction wells, half of which would be expected to be completed as wells. Ten new monitoring wells would be installed and institutional controls restricting perched groundwater use would be implemented as described in Section 2.2.1.

An amendment consisting of food-grade soybean oil, sodium lactate, sodium bicarbonate, and proprietary non-ionic surfactants would be injected into the subsurface and would ferment to provide an anaerobic environment for reductive biodegradation of COCs. Similar amendments may be considered to achieve substantially equivalent conditions and results. Amendments would be injected every 6 months (over a 2- to 3-day period) into all six lines of injection wells until the RDX in this zone is remediated. It is anticipated that after 10 years of injection, the groundwater south of lines 1 and 5 would be effectively treated, so for years 11 through 30, only lines 1 and 5, consisting of a total of 69 wells, would continue to receive amendments.

An average of 30,000 gal (113,600 L) of amendments would be injected into each well during each injection cycle, for an estimated 12 million gal (45 million L) of amendments each year for the first 10 years. The amount of amendment required after the tenth year would be expected to drop to 2.1 million gal (7.9 million L) per year.

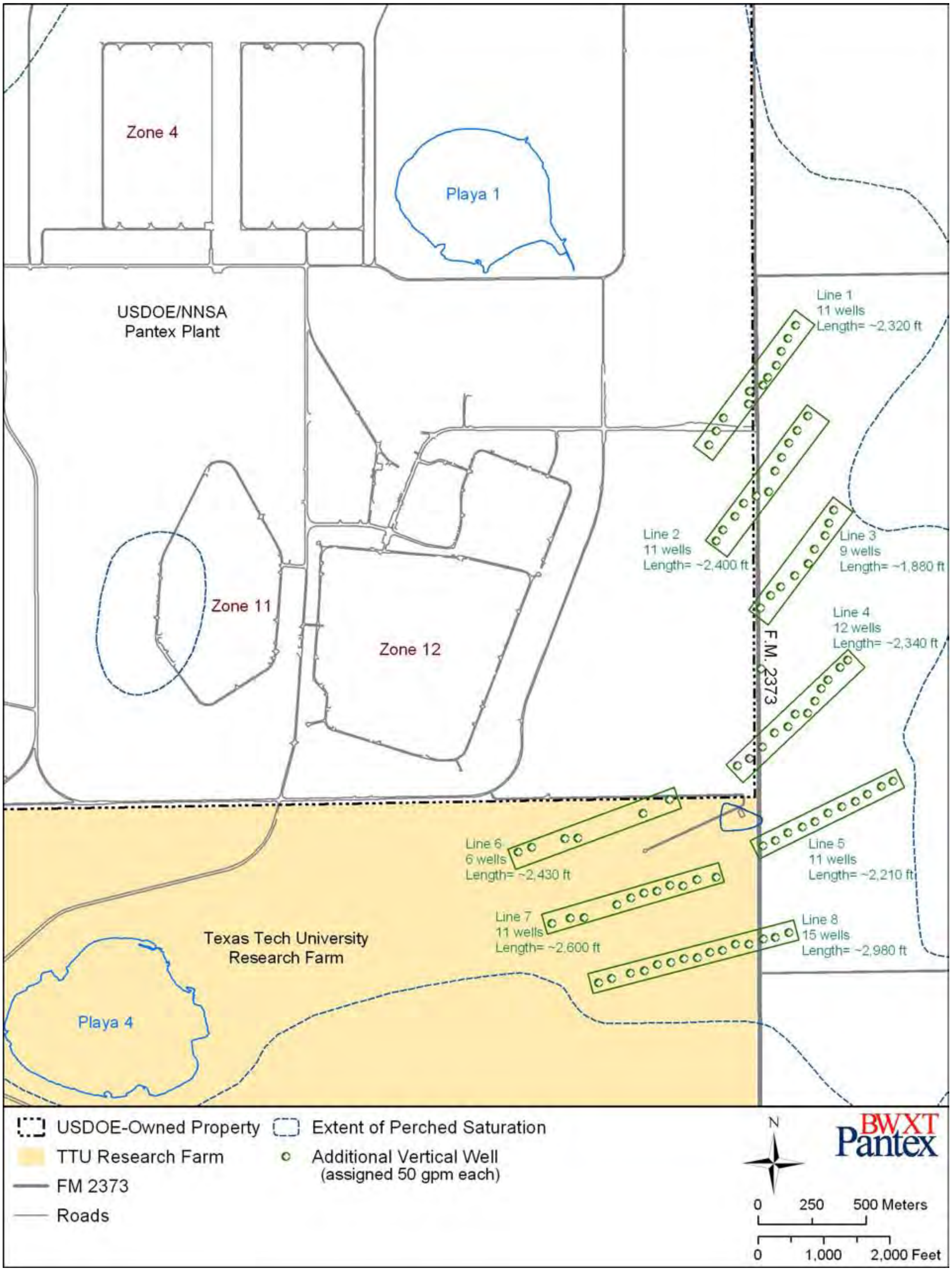

Figure 2-5. Location of Proposed Vertical Wells for Corrective Measure Option 4

Amendment use is estimated based on an on-going treatability study at Pantex. Extracted groundwater would be treated to remove HE and chromium, and then routed, as needed, through the boron removal module before use for irrigation.

Table 2-6. Estimated Construction Resource Requirements for Corrective Measure Option 4

Material/Resource	10 Monitoring Wells [a]	87 Vertical Extraction Wells [b]	Total [c]
PVC/Steel casing, ft (m)	4,200 (1,300)	24,400 (7,420)	28,600 (8,720)
Wire-wrapped screen, ft (m)	100 (30)	0	100 (30)
Stainless Steel Screen	0	1,740 (530)	1,740 (530)
Steel intermediate casing, ft (m)	2,400 (730)	0	2,400 (730)
Concrete, yd^3 (m^3) [d]	9.0 (6.9)	78 (60)	87 (67)
Sand (well packing), yd^3 (m^3)	1.4 (1.1)	18 (14)	19 (15)
Bentonite, yd^3 (m^3)	0.4 (0.3)	5.2 (4)	5.6 (4.3)
Grout, yd^3 (m^3)	56 (43)	364 (278)	420 (321)
Diesel fuel, gal (L) [e]	6,800 (25,600)	65,000 (247,000)	72,000 (273,000)
Water (drilling and development), gal (L)	65,000 (246,000)	131,000 (495,000)	196,000 (741,000)
Steel extraction piping, ft (m)	0	11,165 (3,400)	11,165 (3,400)
Retention Basins			
Excavation (earthwork), yd^3 (m^3)			24,000 (18,300)
Pea gravel (3-in [8-cm] layer), yd^3 (m^3)			1,050 (803)
Sand (6-in [15-cm] layer), yd^3 (m^3)			2,500 (1,910)
Water pipe (4-in [10-cm]), ft (m)			15,000 (4,600)
HDPE liner, ft^2 (m^2)			148,000 (13,800)
Diesel fuel, gal (L)			2,590 (9,820)
Water, gal (L)			9,920 (37,600)
Chain link Fence, ft (m)			2,200 (671)

Key: HDPE, high-density polyethylene; PVC, polyvinyl chloride.
[a] From Table 2–1.
[b] Assumes total well depth of 280 ft (85 m) using 6-in (15-cm) steel casing with each well having a 10-ft (3-m) screen.
[c] Totals may not equal the sum of the contributions due to rounding.
[d] Calculated assuming construction of a 5-ft (1.7-m) by 7-ft (2.1-m) by 8-in (20-cm) thick pad per well requiring 0.90 yd^3 (0.69 m^3) concrete per pad.
[e] Reflects drill rig consumption of 75 gal (284 L) of diesel fuel per workday.

Table 2-7. Estimated Annual Operational Resource Requirements for Corrective Measure Option 4

Material/Resource	Extraction Well System[a]	Retention Basin and Irrigation System[b]
Electricity, (MWh)	95	145

[a] Reflects electrical power demand to operate 87 vertical extraction well pumps at a rate of 1.5 gpm (5.7 Lpm) or 200,000 gpd (757,000 Lpd).
[b] Reflects electrical power demand to pump and irrigate an average of 360,000 gpd (1.4 million Lpd) of treated water.

The amount of groundwater extracted to maintain proper conditions in the treatment area of the perched groundwater would be adjusted as needed based on field conditions. Since more water is being extracted than injected under the treatability study, the same irrigation system proposed under Corrective Measure Option 2, capable of dispersing 160,000 gpd (606,000 Lpd) with as many as 200 acres (81 ha) used for irrigation and a retention basin that can accommodate up to 4.8 million gal (18 million L), is proposed for this option. Proposing an irrigation system of this size is a conservative approach that provides flexibility to extract larger volumes of water if the conditions are found to support it.

A small (240 ft^2 [22 m^2]) prefabricated storage building would be constructed to support injection activities. This building would house mixing equipment for preparation of the amendments, including two 10,000 gal (38,000 L) stainless steel tanks, mixers, pumps and connections. The building would have electricity, water, sewer connections, and heating and air conditioning. The wells would be connected along their respective well lines, and piping manifolds would be installed to accomplish the injections.

Estimated operational resource requirements for the 203 injection wells, 178 extraction wells, boreholes, 10 monitoring wells, retention basin and service building are presented in Table 2-8, resource requirements for construction/installation are in Table 2-9. Implementing this option would temporarily disturb as much as 19.4 acres (7.4 ha), of which approximately 5.5 acres (2.2 ha) would be offsite on private agricultural land. Approximately 800 workdays (3 years) would be required to install the new monitoring, injection and extraction wells using 14 drill rigs, each with a crew of three persons. However, this effort would likely be completed in less time because the estimated 800 workdays includes time to drill all the boreholes and all the wells, when in fact about half the boreholes would become wells, thus reducing the amount of time required to drill the wells. Construction of the retention basins would require approximately 8 days using three heavy-equipment crews, each with three persons; and three additional laborers. In total, the completed injection and extraction well pad locations, injection and extraction piping corridors, retention basin, storage building and access roads would occupy approximately 8.4 acres (3.4 ha), approximately 2.0 acres (0.8 ha) of which would be offsite on private agricultural land.

Additional study is being performed to assist in determining whether these *in situ* technologies could be applied practically in reducing the potential migration of contaminants to the Ogallala Aquifer. Should any be determined to be promising and proposed for use at Pantex, they would be implemented within the bounds of the corrective measure options evaluated in this EA.

Table 2-8. Estimated Annual Operational Resource Requirements for Corrective Measure Option 5

Material/Resource	Injection/Extraction Well System	Retention Basin and Irrigation System
Electricity, (MWh)	60 [a]	80 [b]
Amendments, gal (L)	12 million (45 million) [c]	Not applicable

[a] Reflects electrical power demand to operate 203 injection and 178 extraction well pumps at a rate of 33,000 gpd (38 Lpd) each for a total of 12 million gal (45 million L) injected and extracted annually.
[b] Reflects electrical power demand to pump and irrigate an average of 190,000 gpd (719,000 Lpd) of treated water.
[c] Maximum amount of amendments used each year during the first 10 years.

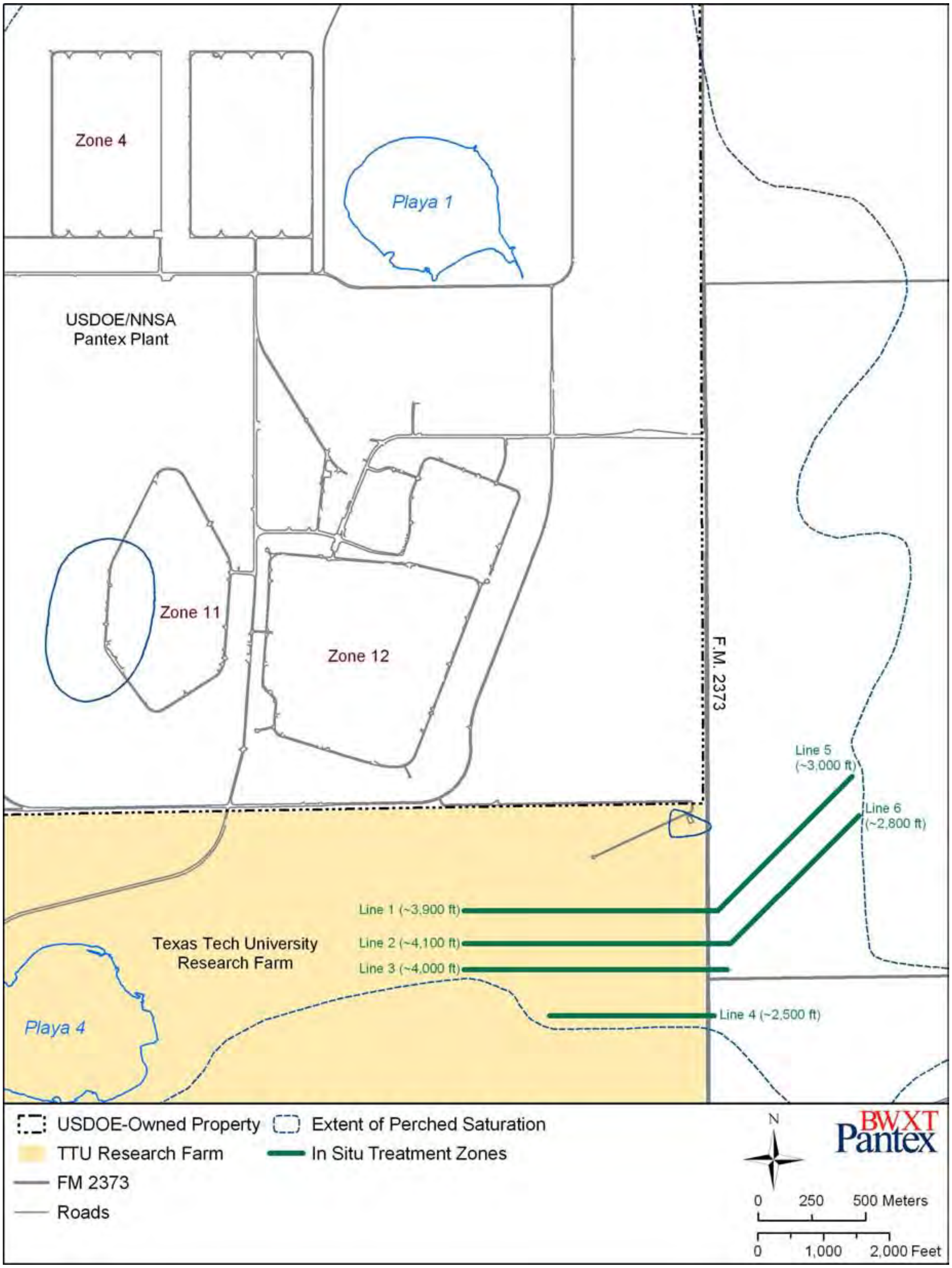

Figure 2-6. Location of Proposed Treatment Zone for Corrective Measure Option 5

Table 2-9. Estimated Construction Resource Requirements for Corrective Measure Option 5

Material/Resource	Requirement				
	10 Monitoring Wells[a]	**766 Boreholes[b]**	**203 Injection Wells[c]**	**178 Extraction Wells[d]**	**Total[e]**
PVC/Steel casing, ft (m)	4,200 (1,280)	0	56,840 (17,300)	49,840 (15,200)	110,880 (33,800)
Wire-wrapped screen, ft (m)	100 (30)	0	0	0	100 (30)
Stainless steel screen, ft (m)	0	0	4,060 (1,240)	3,560 (1,090)	7,620 (2,330)
Steel intermediate casing, ft (m)	2,400 (730)	0	0	0	2,400 (730)
Concrete, yd^3 (m^3) [f]	9.0 (6.9)	0	183 (140)	160 (122)	352 (269)
Sand (well packing), yd^3 (m^3)	1.4 (1.1)	0	28 (22)	37 (29)	66 (52)
Bentonite, yd^3 (m^3)	0.4 (0.3)	0	8.1 (6.2)	11 (8.2)	20 (15)
Grout, yd^3 (m^3)	56 (43)	0	566 (433)	745 (570)	1,367 (1,050))
Diesel fuel, gal (L)[g]	6,800 (25,600)	114,900 (435,000)	60,900 (231,000)	66,750 (253,000)	249,350 (945,000)
Water (drilling and development), gal (L)	65,000 (246,000)	0	203,000 (770,000)	268,000 (1,013,000)	536,000 (2,030,000)
Steel injection well piping, ft (m)	0	0	27,190 (8,290)	0	27,190 (8,290)
Steel extraction well piping, ft (m)	0	0	0	22,330 (6,810)	22,330 (6,810)
Retention Basins					
Excavation (earthwork), yd^3 (m^3)					11,100 (8,490)
Pea gravel (3-in [8-cm] layer), yd^3 (m^3)					490 (375)
Sand (6-in [15-cm] layer), yd^3 (m^3)					1,160 (887)
Water pipe (4-in [10-cm]), ft (m)					3,000 (900)
HDPE liner, ft^2 (m^2)					69,600 (6,470)
Diesel fuel, gal (L)					1,390 (5,280)
Water, gal (L)					2,470 (9,340)
Chain link Fence, ft (m)					1,060 (323)
Service Building[h]					
Excavation (earthwork), yd^3 (m^3)					200 (150)
Concrete, yd^3 (m^3)					89 (68)

Key: HDPE, high-density polyethylene; PVC, polyvinyl chloride.

[a] From Table 2–1.

[b] Assumes each 4-in (10 cm) borehole is drilled to a depth of 280 ft (85 m).

[c] Assumes total well depth of 280 ft (85 m) using 4-in (10 cm) PVC casing with a 20-ft (6-m) stainless steel screen.

[d] Assumes total well depth of 280 ft (85 m) using 6-in (15 cm) PVC casing with a 20-ft (6-m) stainless steel screen.

[e] Totals may not equal the sum of the contributions due to rounding.

[f] Calculated assuming construction of a 5-ft (1.7-m) by 7-ft (2.1-m) by 8-in (20-cm) thick pad per well requiring 0.90 yd^3 (0.69 m^3) concrete per pad.

[g] Reflects drill rig consumption of 75 gal (284 L) of diesel fuel per workday.

[h] Earthwork and resource requirements calculated based on a pre-engineered structure having the dimensions of 60 ft (18 m) by 40 ft (12 m) with a 12-in (30-cm) thick concrete pad.

2.2.1.6 Corrective Measure Option 6: Enhanced Pump and Treat with Targeted *In Situ* Treatment and MNA

The CMS/FS presents a hybrid of corrective measures Options 2 through 5 as its recommended corrective measure, represented in this EA as Corrective Measure Option 6. Specifically, this hybrid presents the "base" action of enhancing the extraction capabilities of the existing PGPTS, with three additional components that could be added at any time: an increase in the size of the PGPTS and two *in situ* treatment enhancements. This option should be considered conceptual at this time because it is subject to refinement resulting from decisions regarding which additional components should be implemented, if at all, and when each component should be added. Decisions to implement any or all of the additional components could be made anytime during the assumed 30-year treatment period. The components selected for implementation would be those that would be expected to result in the most effective treatment of the perched groundwater considering cleanup goals, implementation capability, and cost of the effort. Consideration would be given to the results of the comprehensive groundwater modeling and treatability studies performed for the Plant.

After evaluating the proposed corrective measure options against the RCRA and CERCLA criteria in the CMS/FS and completing additional single layer modeling, USDOE/NNSA determined that the best solution might be a combination of vertical extraction wells added to the existing PGPTS and targeted *in situ* treatment. As proposed, 25 new vertical wells would be installed using the well locations that account for the highest volume of groundwater removal from modeling runs for Corrective Measure Options 3 and 4. Retention basins and irrigation systems would be the same as those proposed for Corrective Measure Option 3. As in all the corrective measure options that include groundwater extraction, injection of treated groundwater into the perched zone would be eliminated. The extracted groundwater would be treated and used for irrigation, and the 10 new monitoring wells would be added to the existing groundwater monitoring network.

Upgrades and enhancements have been proposed for potential implementation contingent on additional computer modeling, field-testing, and system operation. Figure 2-7 shows the proposed configuration of Corrective Measure Option 6, including the enhancements. These upgrades and enhancements are described in the following paragraphs.

PGPTS upgrade. It is possible that for the first 5 years of system operation, the cumulative groundwater extraction rate could average as much as 796,000 gpd (3 million Lpd), which would exceed the 720,000-gpd (2.7-million Lpd) treatment capacity of the existing PGPTS. For this to occur, all the extraction wells would have to begin operation at the same time and produce the maximum predicted amount of water. Corrective Measure Options 3 and 4 would exceed the averaged capacity of the existing chromium and boron ion exchange units, but not the GAC that removes HEs and organics; and therefore, implementation includes adding more ion exchange units within the existing PGPTS Building. However, modifications to accommodate this higher volume and flow rate of groundwater to be treated during the first 5-years of operation would require additional GAC units. As a result, augmenting the existing PGPTS, by either adding skid-mounted units in the field or increasing the capacity of the system through addition to the PGPTS Building, is considered.

Because there is uncertainty in the actual well extraction rates, extensive expansion of the PGPTS is not included in Corrective Measure Option 6. In addition, wells would begin producing at different times, and lower yielding wells could be brought into production first, thereby avoiding the situation where the capacity of the PGPTS is exceeded in the short term. However, as a contingency should actual production greatly exceed PGPTS capacity, expansion of the PGPTS or addition of a skid-mounted treatment deployed near the Playa 1 extraction wells would be considered to handle the extra groundwater, and is evaluated in this EA.

***In situ* treatment enhancements.** Possible implementation of a targeted *in situ* treatment is being considered should additional detailed modeling, field data (i.e., from exploratory boreholes), or data from operating the proposed system indicate either or both enhancements could be beneficial to contaminant stabilization/removal. These *in situ* treatment enhancements include bioremediation and use of a permeable reactive barrier. Permeable reactive barriers, also known as passive/reactive treatment walls, allow the passage of water while causing degradation or removal of COCs. These barriers are installed across the flow path of a contaminant plume, allowing the water portion of the plume to move passively through the wall, while using zero-valent metals, chelators, sorbents, or microbes to inhibit movement of COCs or enhance COC degradation. These technologies would be deployed in the southeast portion of the impacted perched groundwater, on TTU property and possibly on adjacent privately-owned property.

If included as part of Corrective Measure Option 6, *in situ* bioremediation would be implemented as described for Corrective Measure Option 5, but on a much smaller scale. Corrective Measure Option 5 comprises more wells (203 injection and 178 extraction wells) installed over a larger area that includes the area identified for *in situ* treatment under this option. (See Section 2.2.1.5.) Under this option, a total of 56 injection wells in two lines, one 3,200 ft (975 m) long and the other 2,400 ft (732 m) long, and one line of 25 extraction wells, would be installed in an area of about 40 acres (16 ha) southeast of the Plant.

If implemented, the permeable reactive barrier would be installed in lieu of the nine vertical extraction wells southeast of the Plant. The barrier would consist of 40 injection wells along the 2,400-ft (732-m) line shown in Figure 2-7. A one-time injection of calcium polysulfide would be used to form the barrier. Four monitoring wells would be installed downgradient of the barrier to monitor its effectiveness.

Computer modeling and simulations have identified the most effective methods for protecting the Ogallala Aquifer from impacted perched groundwater, i.e., reducing or eliminating recharge, along with continued dewatering of the perched groundwater. However, computer modeling and simulations are now being used to identify and refine the best way to implement these methods to maximize their effectiveness. Field-testing at Pantex also continues to provide additional data about how to implement the technologies in the best way. Numbers, types, and locations of wells; increased efficacy of treatment using enhancements; and predictions of flow rates, are important elements of the overall plan to remedy the impacted perched groundwater. These elements continue to be refined by on-going computer modeling and field-testing. Because of this continuing effort, this option should be considered a conceptual design that is still in the planning stages. As such, this EA is evaluating the “base” corrective measure of enhancing extractions capabilities, with the additional upgrades and enhancements as modules that can be individually added. Even the “base” corrective measure should be considered dynamic as the total number, type, and locations of wells could vary depending on modeling results and field conditions. Nevertheless, this option describes the proposed system that could be deployed, and provides a reasonable basis for analysis in this EA. As demonstrated in Section 4.2, the potential variability in implementing this action would not measurably affect its potential impacts.

2.2.1.6.1 <u>*Resource Requirements*</u>

This section describes the resource requirements needed to implement Corrective Measure Option 6, including upgrades and enhancements. The “base” corrective measure is the addition of 25 vertical wells to the existing PGPTS along with the common elements described in Section 2.2.1, elimination of injection of treated groundwater with reuse as irrigation instead, addition of 10 new monitoring wells, and implementation of deed restrictions to restrict offsite use of untreated perched groundwater. Additional components are evaluated and discussed individually to independently present the potential impacts of each component and to be able to evaluate the potential impacts of any combination of components.

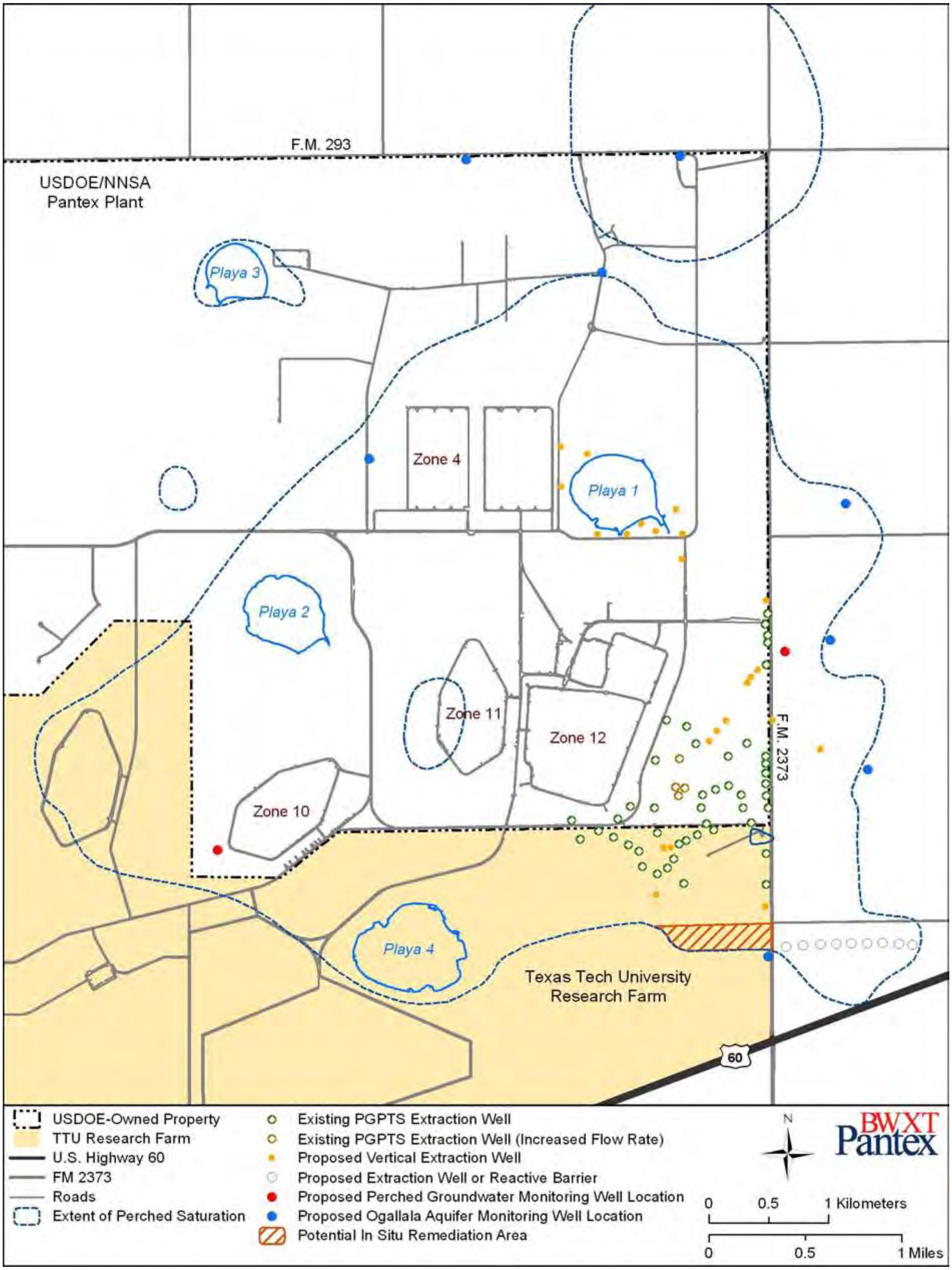

Figure 2-7. Location of Proposed Vertical Extraction Wells, Treatment Areas, and Monitoring Wells for Corrective Measure Option 6

Enhanced Pump and Treat

Under the base option, 25 vertical extraction wells would be installed along with 10 new monitoring wells. As many as 30 boreholes would be completed to place more accurately the wells relative to the fine-grained zone. Two retention basins and six irrigation systems would be required as described for Corrective Measure Option 3. The irrigation system would be capable of dispersing 590,000 gpd (2.2 million Lpd) using six subsystems, with as many as 700 acres (280 ha) available for irrigation. Two retention basins would be constructed to accommodate up to 18 million gal (68 million L), 30 days of treated groundwater. One basin would be 400 ft (122 m) by 310 ft (94 m) by 15 ft (4.6 m) deep. The second basin would be 200 ft (61 m) by 250 ft (76 m) by 15 ft (4.6 m) deep. The GAC system would be adequate to treat the additional volume of groundwater, but both the chromium and boron removal ion exchange modules in the PGPTS Building would need to be tripled in size.

Estimated resource requirements to implement this action are presented in Table 2-10, operational resource requirements in Table 2-11. Installation of the new monitoring wells, vertical extraction wells, piping, retention basins, and access roads would temporarily disturb as much as 21.5 acres (8.7 ha), of which approximately 2.6 acres (1.1 ha) would be private agricultural land east of the Plant. Of this total, 12 acres (4.8 ha) would be associated with the retention basins. Approximately 180 workdays (6 months) would be required to install the boreholes, new monitoring wells, and extraction wells using three drill rigs, each with a crew of three persons. Construction of the retention basins would require approximately 22 workdays (about 1 month) using three heavy-equipment crews each with three persons; and three additional laborers. In total, the completed monitoring and extraction well pad, extraction pipeline corridor, retention basins, and access roads would occupy approximately 9.2 acres (3.7 ha), of which approximately 2.8 acres (1.1 ha) would be offsite on private agricultural land. Of the total land commitment, about 4 acres (1.6 ha) would be associated with the retention basins.

Upgraded PGPTS

If after implementation, the actual sustained extraction rate is considerably greater than the capacity of the PGPTS, the PGPTS could be enlarged to handle the additional flow, or skid-mounted treatment units could be installed in the field to treat the additional extracted groundwater. Whichever method would be selected, the system would be expanded to treat an additional 250 gpm (950 Lpm), for a total of 750 gpm (2,800 Lpm). This would require the equivalent of five chromium and boron removal modules and expansion of the GAC by 50 percent.

Skid-mounted units would be installed approximately 800 to 1,000 ft (244 to 303 m) south or 1,200 ft (364 m) east of Playa 1, approximately 2,000 to 3,000 ft (607 to 910 m) from the extraction well to treat the groundwater extracted from that well. The proposed treatment units would be outside the delineated floodplain for Playa 1. They would be protected from the weather, most likely inside a prefabricated building. There would be up to two units on four skids that would occupy an area approximately 100 ft (30 m) long by 40 ft (12 m) wide. One unit would contain the GAC system and the other, the ion exchange modules. Each unit would have the required pumps, prefilters, piping, sample ports, and freeze protection. This system would be able to treat up to 250 gpm (959 Lpm). Treated water would be pumped from the units to the retention basins on the eastern boundary of the Plant site. The irrigation system would be capable of dispersing 1.1 million gpd (4.2 million Lpd) using 13 subsystems, with as many as 1,300 acres (530 ha) available for irrigation. Two retention basins would be constructed to accommodate up to 24 million gal (91 million L), 30 days of treated groundwater. One basin would be 400 ft (122 m) by 310 ft (94 m) by 15 ft (4.6 m) deep, the size of the larger basin proposed under Corrective Measure Option 3. The second basin would be 340 ft (104 m) by 300 ft (91 m) by 15 ft (4.6 m) deep.

Table 2-10. Estimated Construction Resource Requirements for Enhanced Pump and Treat

Material/Resource	Requirement			
	10 Monitoring Wells[a]	25 Vertical Extraction Wells [b]	30 Exploratory Boreholes[c]	Total [d]
PVC/Steel casing, ft (m)	4,200 (1,280)	7,000 (2,134)	0	11,200 (3,414)
Wire-wrapped screen, ft (m)	100 (30)	0	0	100 (30)
Stainless steel screen, ft (m)	0	500 (152)	0	500 (152)
Steel intermediate casing, ft (m)	2,400 (730)	0	0	2,400 (730)
Concrete, yd^3 (m^3) [e]	9.0 (6.9)	23 (17)	0	32 (24)
Sand (well packing), yd^3 (m^3)	1.4 (1.1)	5.3 (4.0)	0	6.7 (5.1)
Bentonite, yd^3 (m^3)	0.4 (0.3)	1.5 (1.1)	0	1.9 (1.4)
Grout, yd^3 (m^3)	56 (43)	105 (80)	27 (21)	188 (144)
Diesel fuel, gal (L)[f]	6,800 (25,600)	9,400 (35,500)	4,500 (17,400)	20,700 (78,500)
Water (drilling and development), gal (L)	65,000 (246,000)	37,600 (142,300)	0	102,600 (386,000)
Steel injection well piping, ft (m)	0	0	0	0
Steel extraction well piping, ft (m)	0	18,800 (5,700)	0	18,800 (5,700)
Retention Basins				
Excavation (earthwork), yd^3 (m^3)				38,700 (29,600)
Pea gravel (3-in [8-cm] layer), yd^3 (m^3)				1,690 (1,290)
Sand (6-in [15-cm] layer), yd^3 (m^3)				4,000 (3,060)
Water pipe (4-in [10-cm]), ft (m)				18,100 (5,520)
HDPE liner, ft^2 (m^2)				223,600 (20,800)
Diesel fuel, gal (L)				3,870 (14,600)
Water, gal (L)				23,800 (90,200)
Chain link Fence, ft (m)				2,640 (805)

Key: HDPE, High-density polyethylene; PVC, polyvinyl chloride.
[a] From Table 2–1.
[b] Assumes total well depth of 280 ft (85 m) using 6-in (15 cm) PVC casing with a 20-ft (6-m) stainless steel screen.
[c] Assumes total borehole depth of 280 ft (85 m) with a diameter of 4 inches.
[d] Totals may not equal the sum of the contributions due to rounding.
[e] Calculated assuming construction of a 5-ft (1.7-m) by 7-ft (2.1-m) by 8-in (20-cm) thick pad per well requiring 0.90 yd^3 (0.69 m^3) concrete per pad.
[f] Reflects drill rig consumption of 75 gal (284 L) of diesel fuel per workday.

Table 2-11. Estimated Annual Operational Resource Requirements for Enhanced Pump and Treat

Material/Resource	Extraction Well System[a]	Retention Basins and Irrigation Systems[b]
Electricity, (MWh)	160	250

[a] Reflects electrical power demand to operate 25 vertical extraction well pumps at a rate of 12 gpm (45 Lpm) or 430,000 gpd (1.6 million Lpd).
[b] Reflects electrical power demand to pump and irrigate an average of 590,000 gpd (2.2 million Lpd) of treated water.

If the existing PGPTS were expanded, an addition to the PGPTS Building of approximately 100 ft (30 m) long by 40 ft (12 m) wide would be needed to house the additional equipment. Essentially the same equipment and treatment modules described for the skid-mounted units would be added to the PGPTS Building. Additional or larger pumps would be added to pump the increased volume of water from the PGPTS Building to the retention basins.

Estimated resource requirements to implement this action are presented in Table 2-12, operational resource requirements in Table 2-13. As presented in Table 2–12, additional resources would be required for construction of one larger retention basin and for construction of an addition to the PGPTS Building. Construction of the larger retention basins and PGPTS Building addition would temporarily disturb a total of 22.7 acres (8.4 ha) onsite, 3.8 acres (1.6 ha) more than the base option. Construction of the retention basins would require approximately 29 workdays (about 1 month) using three heavy-equipment crews each with three persons; and three additional laborers. In total, the retention basins and PGPTS Building addition would occupy approximately 5.3 acres (2.1 ha), an increase of 1.2 acres (0.5 ha) over the "base" corrective measure.

Table 2-12. Estimated Construction Resource Requirements for the Upgraded PGPTS

Retention Basins		
Material/Resource		**Requirement**
Excavation (earthwork), yd^3 (m^3)		50,200 (38,400)
Pea gravel (3-in [8-cm] layer), yd^3 (m^3)		2,250 (1,720)
Sand (6-in [15-cm] layer), yd^3 (m^3)		5,100 (3,900)
Water pipe (4-in [10-cm]), ft (m)		18,100 (5,520)
HDPE liner, ft^2 (m^2)		313,000 (29,000)
Diesel fuel, gal (L)		5,000 (19,100)
Water, gal (L)		40,400 (153,000)
Chain link Fence, ft (m)		3,020 (920)
Addition to PGPTS Building		
Excavation (earthwork), yd^3 (m^3)		300 (229)
Concrete, yd^3 (m^3)		148 (113)

Key: HDPE, high-density polyethylene; PGPTS, Perched Groundwater Pump and Treat System.

Table 2-13. Estimated Annual Operational Resource Requirements for the Upgraded PGPTS

Material/Resource	Extraction Well System[a]	Retention Basins and Irrigation Systems [b]
Electricity, (MWh)	120	410

[a] Reflects electrical power demand to operate 25 vertical extraction well pumps at an increased pumping demand of 10 gpm (38 Lpm) or 366,000 gpd (1.4 million Lpd).

[b] Reflects electrical power demand to pump and irrigate an average of 1,100,000 gpd (4.2million Lpd) of treated water.

In situ Bioremediation

Enhanced anaerobic biodegradation could be added to provide targeted *in situ* treatment of COCs in the perched groundwater. The system would be as described in Section 2.2.1.5 for Corrective Measure Option 5, except much smaller. A total of 56 injection wells in two lines, one 3,200 ft (975 m) long and the other 2,400 ft (732 m) long to deliver amendments; and one line of 25 extraction wells, would be installed in an area of about 40 acres (16 ha) southeast of the Plant. As in Corrective Measure Option 5, up to 30,000 gal (113,600 L) of amendments would be injected into each well every 6 months. The extracted groundwater would be treated in the PGPTS and used for irrigation. The additional groundwater extracted by these wells is not expected to require expansion of either the PGPTS or irrigation system, including the retention basins.

Estimated resource requirements to implement this enhancement are presented in Table 2-14, operational resource requirements in Table 2-15. Installation of the new wells and appurtenances for *in situ* bioremediation would temporarily disturb as much as 2 acres (0.8 ha). Approximately 180 workdays (9 months) would be required to install the *in situ* wells using four drill rigs, each with a crew of three persons. In total, the *in situ* wells would occupy approximately 1.0 acre (0.4 ha) on USDOE/NNSA-leased TTU property.

Table 2-14. Estimated Construction Resource Requirements for *In Situ* Bioremediation

Material/Resource	Requirement		
	56 Vertical Injection Wells [a]	25 Vertical Extraction Wells [b]	Total [c]
PVC/Steel casing, ft (m)	15,680 (4,780)	7,000 (2,134)	22,700 (6,900)
Wire-wrapped screen, ft (m)	0	0	0
Stainless steel screen, ft (m)	1,120 (341)	500 (152)	1,620 (493)
Steel intermediate casing, ft (m)	0	0	0
Concrete, yd^3 (m^3) [d]	50 (39)	23 (17)	73 (56)
Sand (well packing), yd^3 (m^3)	7.8 (6.0)	5.3 (4.0)	13 (10)
Bentonite, yd^3 (m^3)	2.2 (1.7)	1.5 (1.1)	3.7 (2.9)
Grout, yd^3 (m^3)	156 (119)	105 (80)	261 (199)
Diesel fuel, gal (L) [e]	16,800 (63,600)	9,380 (35,500)	26,200 (99,000)
Water (drilling and development), gal (L)	56,100 (212,000)	37,600 (142,000)	93,700 (354,000)
Steel injection well piping, ft (m)	5,600 (1,707)	0	5,600 (1,707)
Steel extraction well piping, ft (m)	0	3,300 (1,006)	3,300 (1,006)

Key: PVC, polyvinyl chloride.
[a] Assumes total well depth of 280 ft (85 m) using 4-in (15 cm) PVC casing with a 20-ft (6-m) stainless steel screen.
[b] Assumes total well depth of 280 ft (85 m) using 6-in (20 cm) PVC casing with a 20-ft (6-m) stainless steel screen.
[c] Totals may not equal the sum of the contributions due to rounding.
[d] Calculated assuming construction of a 5-ft (1.7-m) by 7-ft (2.1-m) by 8-in (20-cm) thick pad per well requiring 0.90 yd^3 (0.69 m^3) concrete per pad.
[e] Reflects drill rig consumption of 75 gal (284 L) of diesel fuel per workday.

Table 2-15. Estimated Annual Operational Resource Requirements for *In Situ* Bioremediation

Material/Resource	Extraction and Injection Wells [a]	Retention Basins and Irrigation Systems [b]
Electricity, (MWh)	50	250
Amendments, gal (L)/yr	3.4 million (12.8 million)	Not applicable

[a] Reflects electrical power demand to operate 56 injection and 25 extraction wells at a rate of 9,300 gpd (35,300 Lpd) for a total of 3.4 million gal (12.8 million L) injected and extracted annually.
[b] Reflects electrical power demand to pump and irrigate an average of about 600,000 gpd (2.3 million Lpd) of treated water.

Permeable Reactive Barrier

The proposed permeable reactive barrier would replace the nine vertical extraction wells southeast of the Plant. The barrier would consist of 40 injection wells along the 2,400-ft (732-m) line shown in Figure 2-7. A one-time injection of calcium polysulfide would be used to form the barrier. Up to 40,000 gal (150,000 L) of amendment would be injected into each well, for a total of 1.6 million gal (6 million L). Four monitoring wells would be installed downgradient of the barrier to monitor its effectiveness over time. This enhancement would not affect either the PGPTS or irrigation system.

Estimated resource requirements to implement this enhancement are presented in Table 2-16, operational resource requirements in Table 2-17. Installation of the permeable reactive barrier system in lieu of the nine vertical extraction wells under the "base" corrective measure would temporarily disturb approximately 0.44 acres (0.18 ha) of private agricultural land east of the Plant. Approximately 140 workdays (7 months) would be required to install all permeable reactive barrier wells using four drill rigs, each with a crew of three persons. In total, the completed permeable reactive barrier wells would occupy approximately 0.2 acres (0.08 ha) of private agricultural land.

Table 2-16. Estimated Construction Resource Requirements for the Permeable Reactive Barrier

Material/Resource	Requirement		
	40 Vertical Injection Wells [a]	**4 Monitoring Wells [b]**	**Total [c]**
PVC/Steel casing, ft (m)	11,200 (3,400)	1,120 (341)	12,370 (3,742)
Wire-wrapped screen, ft (m)	0	0	0
Stainless steel screen, ft (m)	800 (244)	80 (24)	880 (268)
Steel intermediate casing, ft (m)	0	0	0
Concrete, yd^3 (m^3) [d]	36 (28)	3.6 (2.8)	40 (30)
Sand (well packing), yd^3 (m^3)	8.4 (6.4)	0.6 (0.4)	9 (6.9)
Bentonite, yd^3 (m^3)	2.4 (1.8)	0.2 (0.1)	2.6 (2.0)
Grout, yd^3 (m^3)	167 (128)	11 (9)	179 (137)
Diesel fuel, gal (L)[e]	15,000 (56,800)	1,200 (4,650)	16,200 (61,300)
Water (drilling and development), gal (L)	60,100 (228,000)	4,010 (15,540)	64,110 (243,000)
Steel injection well piping, ft (m)	2,400 (732)	0	2,400 (732)
Steel extraction well piping, ft (m)	0	0	0

Key: PVC, polyvinyl chloride
[a] Assumes total well depth of 280 ft (85 m) using 4-in (15 cm) PVC casing with a 20-ft (6-m) stainless steel screen.
[b] Assumes total well depth of 280 ft (85 m) using 4-in (15 cm) PVC casing with a 20-ft (6-m) stainless steel screen.
[c] Totals may not equal the sum of the contributions due to rounding.
[d] Calculated assuming construction of a 5-ft (1.7-m) by 7-ft (2.1-m) by 8-in (20-cm) thick pad per well requiring 0.90 yd^3 (0.69 m^3) concrete per pad.
[e] Reflects drill rig consumption of 75 gal (284 L) of diesel fuel per workday.

Table 2-17. Estimated Annual Operational Resource Requirements for the Permeable Reactive Barrier

Material/Resource	Injection Well System [a]	Retention Basins and Irrigation Systems [b]
Electricity, (MWh)	Negligible	250
Amendments, gal (L)/yr	1.6 million (6 million)	Not applicable

[a] Negligible operational increase for one-time injection of 40 wells.
[b] Reflects electrical power demand to pump and irrigate an average of 590,000 gpd (2.2 million Lpd) of treated water.

2.2.2 Summary of Construction Elements for the Corrective Measure Options

The corrective measure options described in Section 2.2.1 consist of varying types and quantities of new construction activities that would be placed within approximately 2,500 acres of land, as shown on Figure 2-8. For ease of comparison, Table 2-18 presents the new construction elements that comprise each of the corrective measure options.

Table 2-18. Summary of Construction Elements for Each Corrective Measure Option

Corrective Measure Option	New Wells[a]	New Boreholes	New Retention Basins	Acres Permanently Displaced by Retention Basins	Acres Permanently Displaced by All Components of Option
Option 1: MNA	10	0	0	0	1.1
Option 2: Existing Pump and Treat with MNA	10	0	1	1.2	2.7
Option 3: Enhanced Pump and Treat using Horizontal Wells with MNA	16	0	2	4.0	9.0
Option 4: Enhance Pump and Treat using Vertical Wells with MNA	97	0	2	2.5	5.9
Option 5: Targeted Treatment with MNA	391	766	1	1.2	8.4
Option 6: Enhanced Pump and Treat with Targeted *In Situ* Treatment and MNA[b]	160	30	2	5.2	9.3

[a] All totals include ten new monitoring wells
[b] Includes upgrade of the existing perched groundwater pump and treat system, targeted *in situ* biodegradation treatment over an area of 40 acres, and a 2,400-ft permeable reactive barrier

2.3 TECHNOLOGIES CONSIDERED BUT DISMISSED FROM FURTHER CONSIDERATION

Groundwater remediation technologies and options[2] were extensively researched and screened against a set of criteria before selecting candidate options and technologies as viable options for further evaluation. Prior to the development of remedial options, the potentially applicable remedial technologies were screened to eliminate those that were thought to be infeasible to implement due to inherent limitations for the site-specific COCs and conditions, or would not achieve the remedial action objectives within a reasonable timeframe. The impact of site, waste, and technology characteristics on the effectiveness, implementation, and cost of each technology established the basis for consideration in corrective measure options in the CMS/FS.

Table 2-19 presents the technologies considered for groundwater remediation and the reasons for their elimination from further consideration.

[2] The term "remedial technology" refers to general categories of technologies (e.g., biological treatment and chemical/physical treatment). The term "process options" refers to specific processes within each remedial technology type (e.g., bioventing, bioremediation, and phytoremediation are process options for biological treatment.

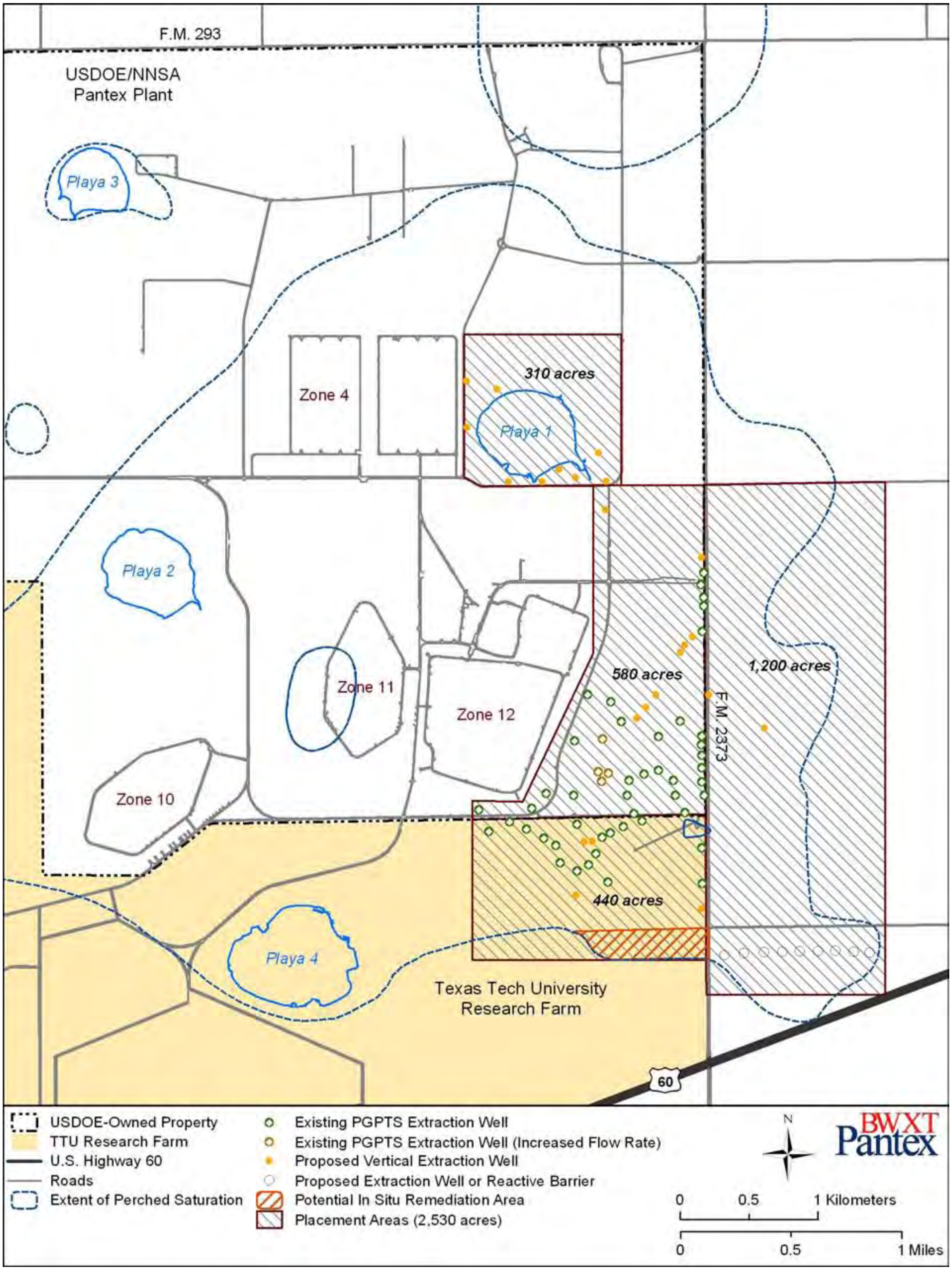

Figure 2-8. Approximate Area for Placement of Corrective Measures under the Proposed Action

Table 2-19. Initial Screening of Groundwater Technologies

Technology	Primary Rationale for Dismissing
Vertical engineered barriers: Deep soil mixing Jet grouting Geosynthetic membrane Sheet pile Slurry walls Soil freezing	Eliminated based on limitations associated with application depth.
Collection trenches	Eliminated based on limitations associated with application depth.
Phytoremediation	Eliminated based on limitations associated with application depth.
In situ physical/chemical treatment technologies: Air sparging Bioslurping In-well air stripping	Eliminated based on inability to treat HEs and dissolved organics.
In situ thermal treatment	Eliminated based on hazards associated with thermal treatment of HEs.
Ex situ separation by distillation	Eliminated based on hazards associated with thermal treatment of HEs.
Ex situ separation techniques: Filtration/ultrafiltration/microfiltration Membrane pervaporation Freeze crystallization Reverse Osmosis	Eliminated based on waste characteristics.
Deep well injection	Eliminated based on difficulty of implementation and limited availability of injection facilities.

Key: HEs, high explosives
Source: BWXT Pantex/SAIC, 2006a

2.4 RELATED ACTIONS

This section discusses the NEPA documents relevant to the proposed action and the documentation of extensive investigations and risk assessments completed in accordance with RCRA and CERCLA requirements.

2.4.1 NEPA Documentation

The *Final Environmental Impact Statement for Continued Operation of Pantex Plant and Associated Storage of Nuclear Weapons Components* (DOE/EIS-0225), or Site-Wide Environmental Impact Statement (SWEIS) (USDOE, 1996) was issued in November 1996. The Record of Decision (ROD) was issued in the *Federal Register* on January 27, 1997 (62 FR 3880). The SWEIS assessed potential environmental impacts of Plant operations on all areas of the human and natural environment, and outlined the environmental restoration process at Pantex as being conducted under RCRA and CERCLA guidelines.

The *Supplement Analysis to the Pantex Site-Wide EIS* (DOE/EIS-0225/SA-03) was issued in February 2003. This document fulfills the USDOE/NNSA requirement to review site-wide EISs at least every 5 years to determine the adequacy of the assessment. A Supplement Analysis (SA) must contain sufficient information for USDOE/NNSA to determine whether an existing EIS should be supplemented, a new EIS should be prepared, or no further NEPA documentation is required. An SA fulfilling the 5-year site-wide EIS review requirement evaluates potential impacts associated with new information, new and proposed projects, and modifications to existing projects since the site-wide EIS was issued.

Evaluations in the Pantex SA support the USDOE/NNSA determination that continued operation of the Plant does not constitute a substantial change to the SWEIS or ROD, or result in any environmental concerns requiring additional NEPA documentation. The SWEIS is expected to be evaluated again by preparation of another SA in the 2006-2008 timeframe.

2.4.2 RCRA/CERCLA Documentation

The RCRA documents discussed in this section provide the preliminary investigations and evaluations that have resulted in SWMUs and AOCs (collectively referred to as corrective action units) evaluated in the CMS/FS.

The *Environmental Management Performance Management Plan for Accelerating Cleanup of the Pantex Plant* (USDOE/NNSA, 2003) describes the USDOE/NNSA approach to accelerate the reduction of environmental risk at Pantex by completing its cleanup responsibility faster and more efficiently. The plan describes cleanup strategies and business practices at the Plant that allow for integration of work processes that will emphasize risk reduction without compromising protection of the environment, site workers, or the public. The accelerated cleanup is managed by a Core Team composed of representatives from USDOE/NNSA, TCEQ, EPA Region 6, and BWXT Pantex. This document represents a commitment on the part of these responsible parties to complete remediation activities by 2008, 6 years earlier than previously estimated.

A CMS/FS is required by the State of Texas RRR and EPA to identify and evaluate alternative technologies (corrective measures) for remediating releases of COCs. The CMS/FS prepared for Pantex is the culmination of an investigative process that began with the RFA, and progressed with the RFIs and the human health risk assessments (HHRAs) discussed in this section. This EA evaluates the potential impacts of implementing the corrective measures identified in the CMS/FS.

EPA conducted a preliminary review of the Plant in 1988 and a Visual Site Inspection in January 1989 to identify corrective action units that would require investigation and possible remedy. Together, these actions formed the RFA (EPA, 1989). In December 1990, an Administrative Order on Consent was signed by EPA and USDOE that outlined the requirements for ICMs, RFIs, CMSs, and corrective measure implementation at Pantex. The following studies and documents have been prepared to meet those requirements.

RCRA Facility Investigations. RFIs were conducted for various zones/waste management groups/corrective action units at Pantex. These RCRA Facility Investigation Reports (RFIRs) summarized site characterization activities, defined sources, described the nature of contamination, and presented the extent of each constituent of potential concern (COPC). The RFIRs identified chemical COPCs to be evaluated in Pantex risk assessments.

The following RFIRs have been approved by TCEQ and EPA:

- **Fire Training Area:** Final RCRA Facility Investigation Report for the Fire Training Area (2002)
- **Burning Ground:** Burning Ground Waste Management Group Final RCRA Facility Investigation Report (2002)
- **Zone 10:** Final RCRA Facility Investigation Report, Zone 10 at DOE Pantex Plant (2003)
- **Zone 11:** Final RCRA Facility Investigation Report, Zone 11 at DOE Pantex Plant (2003)
- **Zone 12:** Final RCRA Facility Investigation Report, Zone 12 at DOE Pantex Plant (2003)

- **Ditches and Playas:** Final RCRA Facility Investigation Report, Ditches and Playas at USDOE Pantex Plant (2003)
- **Groundwater:** Pantex Plant Final RCRA Facility Investigation Report, Groundwater, USDOE Pantex Plant (2004)
- **Independent Sites:** Final RCRA Facility Investigation Report for Independent Sites at USDOE Pantex Plant (2004)

***Final Pantex Plant Radiological Investigation Report* (*RI Report*) (BWXT Pantex, 2004a).** The *RI Report* presents a comprehensive assessment of radiological issues and releases at Pantex and facilitates site radiological closure. There are no radiological issues or releases associated with the areas evaluated in this EA.

Pantex Plant Baseline Risk Assessments: A series of risk assessments were conducted to help identify the specific areas requiring corrective measures for closure:

- *Draft Final Risk Assessment, Firing Site 5 (FS-5)* (Battelle Memorial Institute, 1999) evaluates the risk from depleted uranium at this firing site under current and future land use scenarios.

- *Baseline Human Health Risk Assessment* (HHRA) *Report for Zones 10, 11, and 12, Fire Training Area, Ditches and Playas, Independent Sites, and Groundwater* (*Baseline HHRA*) (BWXT Pantex/SAIC, 2006b) evaluates potential risks to onsite and offsite human receptors that may be exposed to impacted media at Pantex. The purpose of the *Baseline HHRA* is to identify COCs for evaluation in the CMS/FS. Pantex units closing to RRS 3 were evaluated in the *Baseline HHRA*.

- *Burning Ground Human Health Risk Assessment Report* (BWXT Pantex/SAIC, 2006c) evaluates potential risks to onsite and offsite human receptors that may be exposed to impacted media at the Burning Ground.

- *Nuclear Weapon Accident Residue Storage Unit Human Health Risk Assessment Report* (BWXT Pantex/SAIC, 2006d) documents the results of additional investigations completed to define the nature and extent of residual contaminants following completion of waste removal actions and an ICM and documents the results of the Human Health Risk Assessment for residual contaminants at the former Nuclear Weapons Accident Residue (NWAR) Storage Unit.

- *Site-Wide Ecological Risk Assessment Report* (BWXT Pantex/SAIC, 2005) presents the results of the Site-Wide Ecological Risk Assessment conducted at Pantex to evaluate potential impacts on ecological receptors. The report focuses on Playas 1, 2, 3, and 4, Pantex Lake, and associated ditches as the playas represent the most significant habitat for ecological receptors and serve as final repositories for surface water drainage from corrective action units at the Plant.

3.0 AFFECTED ENVIRONMENT

Pantex, in Carson County of the Texas Panhandle, is approximately 17 miles (27 km) northeast of downtown Amarillo (see Figure 1-1). The Plant is bound to the north by FM 293, on the east by FM 2373, and on the west by FM 683. To the south, USDOE/NNSA-owned property extends to within 1 mile of United States Highway (U.S. Highway) 60. TTU owns the land south of, and contiguous to, the USDOE/NNSA-owned lands.

The site consists of 10,177 acres (4,118 ha) owned by USDOE/NNSA for Plant operations and 5,856 acres (2,370 ha) leased from TTU as a safety and security buffer. This buffer area is managed by Texas Tech Research Farm (TTRF) and is used as rangeland and farmland. Part of the land is in the Conservation Reserve Program. TTRF also uses approximately 6,400 acres (2,590 ha) of USDOE/NNSA-owned land for agricultural purposes. Industrial operations occur in the central portion of the Plant and encompass approximately 2,000 acres (809 ha) of USDOE/NNSA property.

Pantex is on the Llano Estacado (staked plains) portion of the Great Plains, at an elevation of approximately 3,500 ft (1,067 m). Plant topography is relatively flat, characterized by rolling grassy plains and numerous natural playa basins. The region is a semi-arid farming and ranching area. The Plant is surrounded by agricultural land, but several industrial facilities are also nearby.

The climate in the area is classified as semi-arid and characterized by hot summers and relatively cold winters. The skies are clear to partly cloudy 70 percent of the time. The mean daily minimum temperature in January is 21.8°F, and the mean daily maximum temperature in July is 91.1°F. The Southern High Plains is subject to rapid temperature changes, especially in winter, when cold fronts pass through the area.

The average annual rainfall is 19.56 in (49.7 cm), with 75 percent of the total annual precipitation falling between April and September. Severe storms occur seasonally, with damaging hail, lightning, and wind. The average annual snowfall is 16.9 in (42.9 cm), but it usually melts in a few days. Heavy snowfalls of 10 in (25.4 cm) or more, usually with near-blizzard conditions, occur an average of once every 5 years and last about 2 days. The region is classified as windy, with wind speeds above 7 miles (11.3 km) per hour more than 95 percent of the year. The wind blows predominately from the south and southwest. (USDOE/NNSA, 2004)

3.1 REGULATORY INITIATIVES

3.1.1 National Environmental Policy Act

As discussed in Section 1.2 of this EA, NEPA requires Federal agencies to consider the environmental consequences of their proposed actions before decisions are made. USDOE/NNSA follows Council on Environmental Quality (CEQ) regulations at Title 40 of the CFR Sections 1500 through 1508 (40 CFR 1500 through 1508) and the USDOE NEPA implementing regulations at 10 CFR 1021. These regulations provide for several levels of environmental review. An EA is used to determine whether to prepare an EIS or a finding of no significant impact for a proposed action.

RCRA and CERCLA also require preparation of documents to assist decision makers in selecting remedies. USDOE has issued guidance on incorporating NEPA values into documents prepared pursuant to CERCLA and RCRA. Guidance issued in 1997 provides information to determine the appropriate environmental review process for corrective actions taken under RCRA. This EA is being prepared to evaluate implementation of the corrective measures proposed and evaluated in the CMS/FS, in accordance with NEPA, CERCLA, and USDOE requirements.

3.1.2 Resource Conservation and Recovery Act

Pantex is a permitted hazardous waste management facility regulated under RCRA. Section 3006 of RCRA authorizes states to assume responsibility for carrying out the RCRA program. Therefore, the State of Texas has been delegated authority for the RCRA program. TCEQ administers the Texas Solid Waste Disposal Act, and facilities that store, treat, and/or dispose hazardous waste must comply with regulations of both TCEQ and EPA. Pantex Plant Hazardous Waste Permit No. 50284, jointly issued by EPA and TCEQ in 1991 and renewed by TCEQ most recently in 2003, authorizes storage and processing of hazardous waste. Section 1.1 of this EA describes the on-going RCRA process to address impacts to soil and perched groundwater resulting from past activities at Pantex.

3.1.3 Comprehensive Environmental Response, Compensation, and Liability Act

In 1994, Pantex was added to the National Priorities List for chemical constituents, requiring compliance with CERCLA through interactions with the EPA (Region 6). Achieving closure under both CERCLA and RCRA requires development of an integrated process to ensure objectives mandated by CERCLA are considered with those for RCRA. In this integrated approach, TCEQ has primary responsibility for RCRA chemical contaminants, and EPA has primary responsibility for radiological contaminants. Both TCEQ and EPA share the responsibility for contaminants associated with perched groundwater and monitoring of the Ogallala Aquifer.

3.1.4 State of Texas Risk Reduction Rule

In Texas, the investigation, cleanup, and closure of corrective action units for chemical contaminants are completed under the Texas RRR found in 30 TAC §335, Subchapter S. Although the RRR has been replaced by the Texas Risk Reduction Program, which can be applied to remediation projects subsequent to the applicability date of May 1, 2000, Pantex remains grandfathered under the RRR. The RRR provides three Risk Reduction Standards (RRS 1, RRS 2, and RRS 3) for closure. Subchapter S contains the regulations to determine and apply the RRSs. The TCEQ *Consistency Document for Implementation of the Existing Risk Reduction Rule* (TNRCC, 1998) provides further detailed information for implementing the RRR. The three RRSs are defined as follows:

RRS 1: Closure/remediation to background or PQL. Under RRS 1, the most stringent level, all waste and/or contaminated environmental media must be remediated to background concentrations unaffected by waste management or industrial activities, as specified in 30 TAC §335.554. PQLs are defined in 30 TAC §335.552 as the lowest concentration of an analyte that can be reliably quantified within specified limits of precision and accuracy during routine laboratory operating conditions for non-naturally-occurring constituents or naturally-occurring constituents with background concentrations lower than the PQL.

RRS 2: Closure/remediation to health-based standards and criteria following the procedures specified in 30 TAC §335.555 to provide appropriate protection for human health or the environment. RRS 2 values are based on promulgated standards (e.g., maximum contaminant levels) or cleanup values established in 30 TAC §335.556 through §335.559. The calculations used to establish the RRS 2 cleanup values are the same for all corrective action units and are based on exposure to one constituent in one exposure medium. Thus, the RRS 2 cleanup values do not account for site-specific factors or the presence of more than one COPC. Closure under RRS 2 also requires an ecological evaluation, starting with the initial ecological screening detailed in TCEQ guidance.

RRS 3: Closure/remediation with controls. RRS 3 compliance requires the remedy to achieve the highest degree of long-term effectiveness possible, considering cleanup objectives and costs, and the remedy must achieve media cleanup requirements specified in 30 TAC §335.563. Under RRS 3, cleanup values can be derived using site-specific information for land use and associated potential receptors, but these cleanup values must consider multiple COPCs within the medium and exposure to multiple contaminated media, when necessary. Furthermore, COPCs can be left in place as long as the risk posed by those COPCs is not greater than the target risk values provided in 30 TAC §335.563. Media cleanup requirements under RRS 3 also allow the use of long-term site controls (e.g., institutional or engineering controls) to attain regulatory compliance.

Unlike RRS 2 closure, RRS 3 closure requires a Baseline Risk Assessment to evaluate potential adverse effects under both current and future conditions from COPCs at a site in the absence of any action to control or mitigate the release. When a permanent COPC removal technology (e.g., soil composting or soil removal) has been implemented, current site conditions will serve as the baseline for calculating risks. RRS 3 also requires a CMS to evaluate the abilities and effectiveness of remedial actions and to recommend the remedial action that best achieves the requirement of RRS 3.

3.2 GENERAL PLANT DESCRIPTION AND REGIONAL SETTING

3.2.1 Land Use

The predominant land use within both 50- (80-km) and 10-mile (16-km) radii of the Plant is agricultural. Grazing is the predominant land use to the west and northwest of the Plant. Cultivated land with scattered patches of grazing predominates the areas immediately surrounding the Plant and to the north, northeast, east, southeast, south and southwest. Some industrial areas are south and southwest of the Plant. The urban centers in this area are Highland Park Village to the southwest (on the outskirts of Amarillo), the town of Panhandle to the east, and the town of Washburn to the south. Highland Park School is directly northeast of Highland Park Village. Offsite land use within 10 miles (16 km) of the Plant is shown in Figure 3-1.

Pantex comprises several functional areas, commonly referred to as numbered zones (see Figure 1-1). These functional areas include a weapons assembly and disassembly area, a weapons staging area, an area for explosives development, a potable water treatment plant, a sanitary wastewater treatment facility, photography shops, vehicle maintenance areas, and administrative areas. Other functional areas include a utilities area for steam and compressed air, an explosives test-firing facility, a burning ground for thermally processing (burning or flashing) explosive materials, and landfills; a portion is currently used only for storage. Overall, there are more than 400 buildings at Pantex. (BWXT Pantex/SAIC, 2006b)

As shown in Figure 3-2, operations, cultivation, wetlands, and grassland are the four distinct types of land use found at Pantex. Operational areas include active and inactive industrial areas. Active operational areas contain a medium-to-high density of buildings, roadways, storage facilities, parking areas, actively disturbed land (landfills and borrow pits), and heavier human utilization. Zones 4, 11, and 12 are enclosed by high security fencing and are therefore subject to restricted access. Support facilities are in Zones 10, 11, 12, the Burning Ground, firing ranges and Firing Sites. The active operational areas are mowed and maintained in shortgrass prairie. Shrubs, trees, and watered lawns are present around some administrative buildings in the operational areas. Denuded areas are also maintained as a safety and security buffer for portions of the operational areas. Inactive operational areas contain mowed and maintained areas around the active operational areas, and are designed primarily to serve as safety and security buffers.

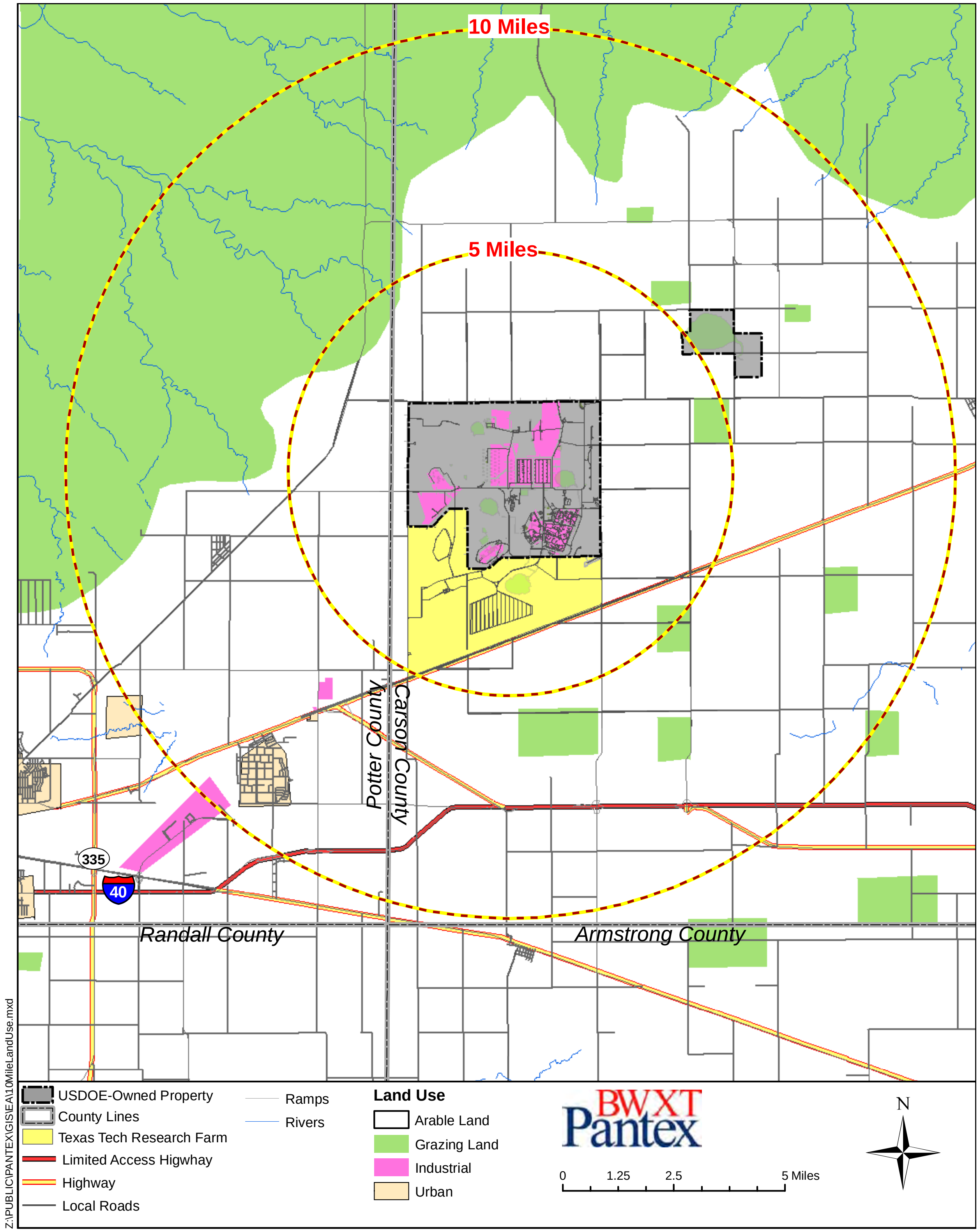

Figure 3-1. Land Use within a 10-Mile Radius of Pantex

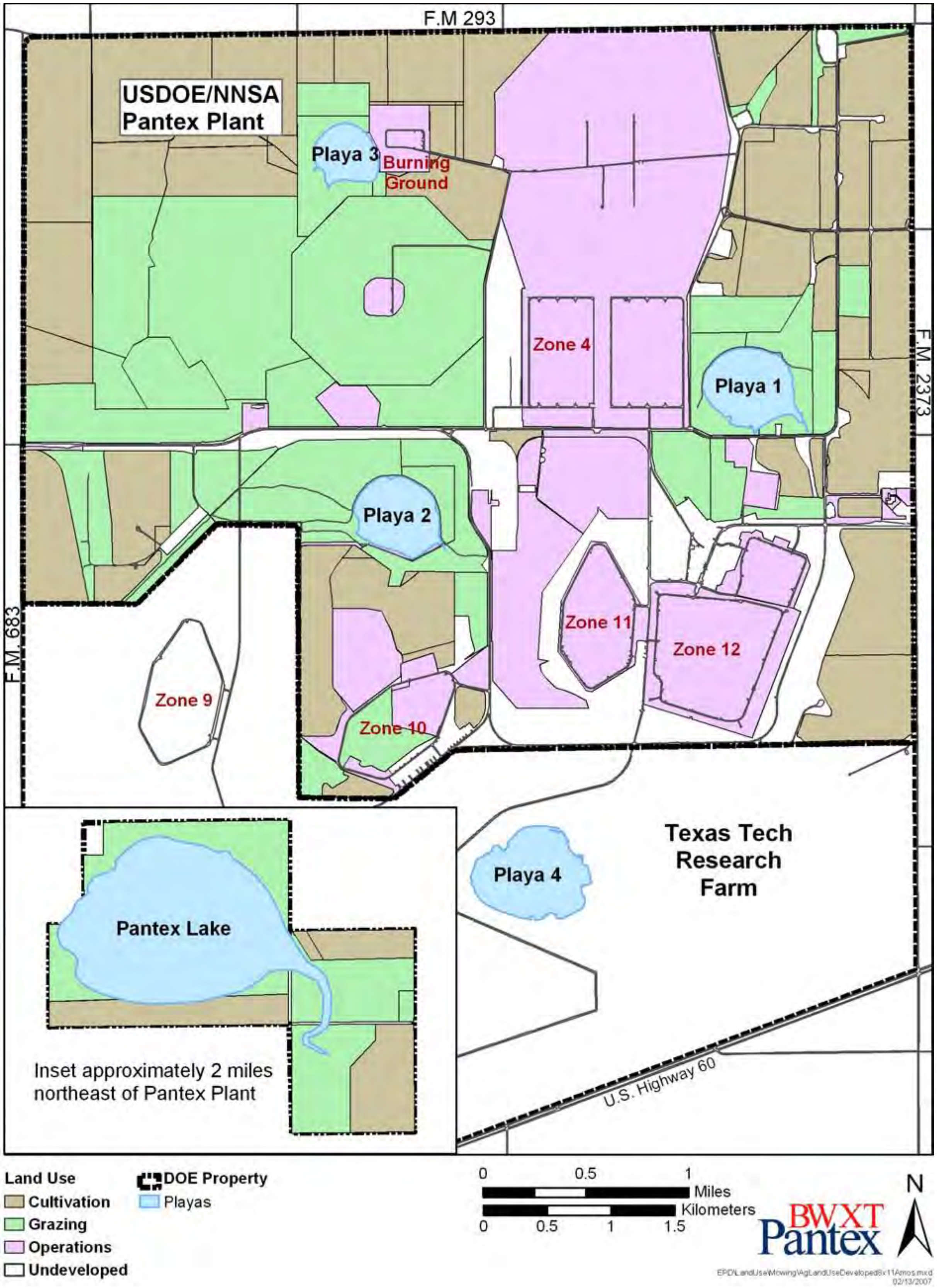

Figure 3-2. Onsite Land Use at Pantex

Agricultural lands owned by USDOE/NNSA at the Plant and Pantex Lake (i.e., not including the TTU property) are managed by TTRF through a Service Agreement that allows TTU to use the land for farming and ranching. Approximately 3,817 acres (1,545 ha) are available for cultivation and approximately 1,945 acres (791 ha) are available for grazing. These areas are required to be managed in accordance with the Plant mission, including protection of the environment, safety, and health of the employees and the public and national security. Areas available for grazing and farming under the Service Agreement with TTU are designated as "cultivation" in Figure 3-2. Most agricultural land at Pantex is classified as prime farmland.

In addition to the agricultural land owned by USDOE/NNSA, most of the buffer zone leased from TTU is used for agriculture. The approximate 5,800-acre (2,347-ha) buffer zone includes rangeland used for grazing cattle (including playas), a small portion of farmland, and land set aside as part of the Conservation Reserve Program. Under the terms of the Service Agreement, Pantex provides potable water from the Ogallala Aquifer to TTRF for watering livestock and human consumption.

3.2.2 Geology and Soils

The primary surface deposits at Pantex are the Pullman and Randall soil series, which grade downward to the Blackwater Draw Formation. This formation consists of approximately 50 ft (15 m) of interbedded silty clays with caliche and very fine sands with caliche. Underlying the Blackwater Draw Formation, the Ogallala Formation consists of interbedded sands, silts, clays, and gravels. The base of the Ogallala Formation is an irregular surface that represents the pre-Ogallala topography. As a result, depths to the base of the Ogallala vary. At Pantex, the vertical distance to the base of the Ogallala varies from 300 ft (90 m) at the southwest corner to 720 ft (220 m) at the northeast corner of the Plant. Underlying the Ogallala Formation is sedimentary rock of the Dockum Group, consisting of shale, clayey siltstone, and sandstone (BWXT Pantex/SAIC, 2004b).

3.2.3 Water Resources

The major surface water source near Pantex is the Canadian River, approximately 25 miles (40 km) northwest of the Plant. The river flows in a generally northeasterly direction into manmade Lake Meredith. A few smaller streams are south and east of Pantex along the High Plains Escarpment. These streams are tributaries of the Red River and include 1) the Salt Fork of the Red River, approximately 20 miles (32 km) southeast of Pantex; 2) the Prairie Dog Town Fork of the Red River, 25 miles (40 km) southwest of Pantex; and 3) Sweetwater Creek, approximately 50 miles (80 km) east of Pantex. During flood events at Pantex, surface water may flow to offsite playas but runoff from the Plant does not flow into the Canadian River, Lake Meredith, or any of the smaller streams (BWXT Pantex/SAIC, 2004b).

Most of the surface drainage on the USDOE-owned and -leased lands flows through manmade ditches, natural drainage channels, or by sheet-flow to onsite playa basins. Playa basins consist of the playa lakes themselves and their corresponding watersheds. Industrial effluents from Plant operations are treated and, along with some non-contact industrial discharges and domestic wastewater, directed into an onsite wastewater treatment facility. Until January 2005, effluent from the wastewater treatment facility discharged through ditches to Playa 1. This effluent is now used for subsurface irrigation on the Plant site under the Texas Land Application Permit.

Perched groundwater is found below Pantex in the Ogallala Formation. This groundwater is approximately 200 to 300 ft (61 to 91 m) below ground surface and rests upon a relatively low permeability zone referred to as the fine-grained zone, which consists of silt and clay. Perched groundwater is associated with natural recharge from several playas and historic releases to the ditches draining Zones 11 and 12. Initially the groundwater flows outward in a radial manner away from the playa lakes, then it is quickly influenced by the regional south to southeast gradient. The perched groundwater ranges in saturated thickness from less than a foot to approximately 70 ft (21 m).

The second water-bearing zone below the fine-grained zone is the Ogallala Aquifer. The groundwater surface beneath the Plant is approximately 400 ft (122 m) below ground surface and is approximately 1 to 100 ft (less than 1 to 30 m) thick in the southern regions of the Plant and approximately 250 to 400 ft (76 to 122 m) thick in the northern regions. In the vicinity of the Plant, the primary flow direction of the Ogallala Aquifer is north to northeast due to the influence of the City of Amarillo's well field north of the Plant.

The Ogallala Aquifer is the major source of domestic water for a number of municipalities and industries in the High Plains. The City of Amarillo, the largest user of water from the aquifer in the area, pumps water for public use from the Carson County Well Field north and northeast of the Plant. Pantex obtains its water from wells in the northeast corner of the site. Historical groundwater withdrawals, and long-term pumping from the Ogallala in Carson County and the surrounding eight-county area, have exceeded the natural recharge rate to the Ogallala. These overdrafts have removed large volumes of groundwater from recoverable storage, and have caused substantial water-level declines. (BWXT Pantex/SAIC, 2004b)

3.2.4 Floodplains and Wetlands

The Tulsa District of the United States Army Corps of Engineers delineated floodplains on the Plant site. Floodplain boundaries were delineated for Playas 1, 2, 3, and 4, Pantex Lake, and Pratt Lake (north of Pantex). Within the main Plant site, the only major facility lying within delineated floodplain boundaries is the old wastewater treatment facility (now the Lower Irrigation Storage Pond), which is within the 100-year floodplain of Playa 1 (USDOE, 1996). The Lower Irrigation Pond has been constructed with an earthen berm to protect it from a 100-year flood event.

Playas are ephemeral water bodies. Figure 1-1 shows the locations and relative sizes of Playas 1, 2, 3, and 4. Playas 1, 2, and 3 are on the Plant site; Playa 4 is on TTU Property; and Pantex Lake is on detached property owned by USDOE/NNSA approximately 2.5 miles (4 km) northeast of the main Plant site.

3.2.5 Biological Resources

Biological resources at Pantex include terrestrial and aquatic resources, and threatened and endangered species. This section describes these resources for the site and adjacent areas potentially affected by groundwater monitoring and treatment options. Wetlands are addressed in Section 3.2.4. A detailed description of biological resources is presented in Appendix A.

Pantex is situated on the Southern High Plains of the Texas Panhandle. The Southern High Plains is an area of shortgrass prairie that has few natural trees. It is dominated by two grasses, blue grama (*Bouteloua gracilis*) and buffalo grass (*Buchloe dactyloides*) (USDOE, 1996). However, much of the native shortgrass prairie has been converted to agricultural uses for crops and livestock grazing. Additionally, some agricultural land has been placed in the Conservation Reserve Program. Pantex is principally relatively flat upland punctuated by six playas, including Pantex Lake, and supports grazed, shortgrass prairie (BWXT Pantex, 2002).

Terrestrial Resources. While most of the land leased from the TTRF is in agriculture use, those portions of the Plant owned by USDOE include industrial areas, agricultural land, grasslands, and natural wetlands. Grasslands and natural wetlands are important to site wildlife. Most of the area adjacent to the

Plant is in agricultural production. At Pantex, the shortgrass prairie is dominated by blue grama and buffalo grass; however other typical, although less abundant grass species are present. The SWEIS identified 40 plant species (BWXT Pantex, 2002). A detailed description of the vegetation is presented in Appendix A.

Wildlife recorded at Pantex includes 40 species of mammals, 180 species of birds, 12 species of reptiles, and 10 species of amphibians (Ray, 2005). The majority of these species are associated with the playas and surrounding upland areas. Management initiatives have been instituted to maintain biodiversity, including revegetation of formally cultivated areas, especially around playas, and to manage prairie dogs as part of the short-grass prairie ecosystem. A detailed analysis of the vegetation and wildlife species is presented in Appendix A of this EA. Detailed listings of wildlife are presented in Appendix A.

While Zone 12 is an industrial area that supports little natural vegetation and few species of wildlife, portions of the Burning Ground are grass covered. Cultivated land on the Plant, TTU property to the south, and private land to the east and southeast provides little habitat for most wildlife found in the area.

Aquatic Resources. Aquatic resources of the Southern High Plains are very limited, consisting primarily of the biota associated with the playas (see Section 3.2.4). Playa 1 is the only playa on the Plant that has ever held water permanently; however, no fish have been recorded. The only location found to have fish is a small catchment area impounded to retain water for cattle at the southeast corner of Pantex Lake. Minnows of the genus *Notropis,* along with several individuals of an unidentified species of crayfish and upland chorus frog tadpoles, were observed in this catchment (BWXT Pantex, 2002).

Threatened and Endangered Species. Table 3-1 identifies endangered, threatened, and candidate species and species of concern for Pantex. There are two federally endangered, one threatened, and 11 species of concern that have been found on or near the Plant. Additionally, two state-endangered and three threatened species may occur on or near the site. Offsite areas potentially affected by groundwater monitoring and treatment options are unlikely to support special status species since these areas are in agricultural production.

The bald eagle has been observed on the Plant, foraging among the prairie dog towns. Ferruginous hawk numbers have been found to increase at the site during the winter due to the availability of the prairie dog. A flock of 13 mountain plovers (shore birds) was observed in a wheat field on the Plant site in 2002. The western burrowing owl is a common summer resident on the Plant and is often observed in the proximity of prairie dog towns. The whooping crane migrates to the Pantex area in the spring and fall, and has been observed flying over the Plant. The cave myotis generally roosts in caves in large colonies; however, the one individual found on the Plant was identified in a building. The swift fox was sighted in 1996; however, trapping and other efforts have failed to substantiate its continued presence. The Texas horned lizard resides in grassland areas of the Plant, especially around playas (BWXT Pantex, 2002; BWXT Pantex, 2005). The Texas horned lizard has also been observed in Zone 12 North and South and in the Burning Ground (Ray, 2005).

Table 3-1. Endangered, Threatened, and Candidate Species and Species of Concern Known to Appear on or Near Pantex

Common Name	Scientific Name	Federal Status	State Status
Birds			
Arctic peregrine falcon [a]	*Falco peregrinus tundrius*	Concern	Threatened
Baird's sparrow	*Ammodramus bairdii*	Concern	Not listed
Bald Eagle [b]	*Haliaeetus leucocephalus*	Threatened	Threatened
Ferruginous hawk [b]	*Buteo regalis*	Concern	Not listed
Interior least tern	*Sterna antillarum athalassos*	Endangered	Endangered
Mountain plover	*Charadrius montanus*	Concern	Not listed
Snowy plover	*Charadrius alexandrinus*	Concern	Not listed
Western burrowing owl [b]	*Athene cunicularia hypugea*	Concern	Not listed
Whooping crane [b]	*Grus Americana*	Endangered	Endangered
Mammals			
Black-tailed prairie dog [b]	*Cynomys ludivivianus*	Concern	Not listed
Cave myotis [b]	*Myotis velifer*	Concern	Not listed
Plains spotted skunk	*Spilogale putorius interrupta*	Concern	Not listed
Swift fox	*Vulpes velox*	Concern	Not listed
Reptiles			
Texas horned lizard [b]	*Phrynosoma cornutum*	Concern	Threatened

[a] Presence of Arctic or American peregrine species documented at Pantex
[b] Known to occur at Pantex.
Source: BWXT Pantex, 2002

3.2.6 Air Quality

State monitoring data for the Amarillo region includes ambient monitoring data for particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}). Concentrations of PM_{10} in the Amarillo region were within the National Ambient Air Quality Standards (NAAQS). For the purpose of environmental surveillance at Pantex, the State of Texas established ambient air monitors at strategic locations around the Plant. These monitors were originally established for total suspended particulate, PM_{10}, hydrogen fluoride, and various VOCs. The monitoring data have shown no concentrations of VOCs expected to result in long-term health effects and confirm past air monitoring and modeling results obtained by Pantex. Most organic compounds have been below their respective Effects Screening Levels (ESLs), and hydrogen fluoride concentrations and PM_{10} concentrations have been below their respective standards. Modeling results of concentrations for criteria and toxic pollutants, using Plant emissions for ongoing operations, indicate that none of the NAAQS would be exceeded at the Pantex boundary. All of the toxic air pollutants were estimated to be below their respective ESLs at the Plant boundary (BWXT Pantex, 2002). Modeling performed during the period 1996 through 2001 indicated that no NAAQS or Effects Screening Level (ESL) was exceeded during that time. Similarly, based on projected emissions for continued operations during the period 2002 through 2006, concentrations at the Pantex boundary are estimated to continue to remain within all NAAQSs and ESLs. Criteria pollutant emissions from continued operations at the Plant would contribute approximately 1 percent or less to the overall pollution burden in Carson and Potter counties, the two closest counties, and can be expected to have negligible impact on the regional air quality.

Ongoing construction and demolition projects result in some temporary fugitive dust emissions and equipment exhaust emissions. Construction emissions from new facilities and facility upgrades during the period 1996 through 2006 were estimated to increase Pantex emissions by 8 to 13 percent during the peak construction year. Air quality impacts resulting from construction of the new facilities would be negligible. Emissions from operating some of the proposed facilities evaluated in the SWEIS would be essentially unchanged from the existing facilities (USDOE, 1996). However, TCEQ authorization would need to be obtained if an emission contains organic compounds that would be emitted to the atmosphere.

Under the Federal Operating Permit, Pantex qualifies as a minor source with the establishment of federally enforceable emission limits. Plant emissions are presently and would be expected in the future to remain substantially below levels that would cause ambient air quality standards or ESLs for toxic pollutants to be exceeded (BWXT Pantex, 2002).

3.2.7 Visual Resources

The topography of the Plant site is relatively flat, composed of agricultural land, Conservation Reserve Program land, and rangeland. In the course of a year, both Pantex workers and some landowners can see different types of crops in various stages of growth, exotic and native grasses, and wildflowers. Occasionally, cattle can be seen grazing on rangeland. The office and production buildings at the Plant are visible to some landowners and traffic along U.S. Highway 60 and FM 2373, FM 683, and FM 293. Some of the four playas and the wastewater treatment facility, which attract birds and other wildlife, can also be seen by some of the landowners and traffic along these roads. Shortgrass prairie, including one onsite and one offsite prairie dog colony and agricultural fields, provides habitat for wildlife that is visible to workers and some landowners. (USDOE/NNSA and BWXT Pantex, 2005)

From the most sensitive vantage point for Plant facilities at the intersection of FM 2373 and U.S. Route 60, the Plant appears as a low cluster of buildings on the flat landscape. The most visible structures include a water tower (148 ft [45 m]) and the twin boiler house stacks (65 ft [20 m]). The tallest structures are a meteorological tower in the northeast corner of the site that is 197 ft (60 m) and a communication tower northeast of Zone 11 that is 200 ft (61m). At a distance, these towers would appear as pencil-thin structures. Security lighting in operations areas is visible at night. (USDOE, 2003)

3.2.8 Cultural Resources

Cultural resources at Pantex have been identified under three separate contexts: prehistoric and historic archaeology, World War II, and the Cold War. These resources include 69 archeological sites indicating prehistoric Aboriginal and historic Euroamerican occupation and use of Plant land; standing structures, foundations, and other extant features that were once part of the Pantex Ordnance Plant (1942 to 1945), the World War II predecessor of Pantex; and structures and features associated with Cold War Era (1951 to 1991) operations. The Plant also has valuable historic documents, records, and artifacts pertinent to interpretation of the prehistoric and historic human activities conducted on the Plant site. A number of these resources are eligible for inclusion on the National Register of Historic Places, and warrant protection and preservation under the nation's cultural resource management laws and regulations.

Key cultural resource management requirements at the Federal level are the National Historic Preservation Act (NHPA) of 1966, as amended (Public Law [PL] 89-655), American Indian Religious Freedom Act of 1978 (PL 95-341), Archaeological Resources Protection Act of 1979 (PL 96-95), Native American Graves Protection and Repatriation Act of 1990 (PL 101-601), and Executive Order 13287 Preserve America.

In October 2004, the USDOE/NNSA Pantex Site Office, BWXT Pantex, the Texas State Historic Preservation Office, and the Advisory Council on Historic Preservation executed a new Programmatic Agreement and Cultural Resource Management Plan (PA/CRMP), with concurrence from the DOE Chief

Historian. This PA/CRMP ensures compliance with Section 106 of the NHPA, providing for more efficient and effective review of Plant projects having the potential to impact cultural resources. In addition, the PA/CRMP outlines a range of preservation activities planned for the Plant's Section 110 compliance program and provides for the systematic management of all archeological and historic resources at Pantex.

The PA/CRMP describes development of a prehistoric archaeological site location model based on extensive surveys and testing. This site location model holds that prehistoric archaeological sites at Pantex and likely throughout the Llano Estacado would be within approximately 0.25 mile (400 m) of playas or their major drainages, and conversely would not be likely to occur in interplaya upland areas. This model is incorporated into the PA/CRMP, and is the basis for not requiring additional archaeological surveys for projects not within these identified areas. No culturally sensitive areas have been found and, based on the model, would not be expected in any of the areas for which corrective measure implementation is being evaluated.

Plant standards and procedures have been implemented providing for early cultural resource management staff notification and coordination of any projects requiring ground-disturbing activities with the potential to uncover new prehistoric archeological sites. These procedures and the PA/CRMP require that any previously undiscovered sites found during the course of the Plant operations be protected as though they were eligible for the *National Register of Historic Places*, until formal eligibility determinations can be made.

3.2.9 Utility Infrastructure

Electricity. Pantex receives electrical energy from Xcel Energy Company (formerly Southwestern Public Service [SPS] Company). Xcel Energy Company serves most of the Texas Panhandle as well as much of eastern and southeastern New Mexico, the Oklahoma Panhandle, and a small area of southwestern Kansas. The eight principal operating power plants, along with two small standby plants, can produce a net electric output of 4,379 MW. Peak Power usage for SPS from 1990 to 1997 averaged 3,787 MW or approximately 86.5 percent of capability. Peak electrical usage tends to coincide with high summertime temperatures and subsequent increases in air-cooling demands. Electrical usage at Pantex has varied over the past years, but after peaking in 1998, has decreased. Consumption for fiscal year 2004 was 76,213 MWh (Nester, 2005a).

Water Use. Water for Pantex is pumped from the Ogallala Aquifer by five production wells in the northeast portion of the site. Water storage reservoirs are integrated into the water distribution system, with total storage capacity exceeding 5.2 million gal (20 million L).

Total water pumped from the system has ranged from 172 to 315 million gal (651 million to 1.2 billion L) annually from 1990 to 2001. The volume used by Pantex during this time period ranged from 162 to 224 million gal (613 million to 848 million L). Water sold to TTU ranged from 9 to 91 million gal (34.1 to 344.4 million L) annually during the same years. In general, water usage by the Plant has decreased (Nester, 2005a).

The SWEIS projected that Pantex would consume 90,800 MWh of electricity by 2006, and 267 million gal (1,011 million L) of water per year. Table 3-2 shows that at the rates of consumption projected in the SWEIS, the Plant would consume 45 percent of the electrical utility capacity of the region and 53 percent of the water capacity.

Table 3-2. Site-Wide Environmental Impact Statement Projected Utility Consumption and Capacities, 1996 through 2006

Utility	Total Projected Consumption: 2006	System Capacity	Percentage of Capacity
Electricity, MWh/yr	90,800	201,480	45
Water, million gal/yr (million L/yr)	267 (1,011)	500 (1,893)	53

Source: USDOE, 2003.

3.2.10 Noise

Major noise emission sources on the Plant site include various industrial facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, construction and materials-handling equipment, and vehicles), as well as small-arms firing, alarms, and explosives detonation. Most facilities are at a far enough distance that noise levels from these sources are barely distinguishable from background noise at the site boundary. However, some noise from explosives detonation can be heard at residences north of the site, and small arms weapon firing can be heard at residences to the west (BWXT Pantex, 2002; USDOE, 1998).

The acoustic environment along the Pantex boundary and at nearby residences away from traffic noise is typical of rural locations. The day-night average sound levels are in the range of 35 to 50 decibels A-weighted (dBA) that is typical of rural areas. The results of noise surveys in areas adjacent to the Plant indicate that ambient sound levels are generally low, with natural sounds and distant traffic being the primary sources. Traffic, aircraft, trains, and agricultural activities result in higher short-term levels. Traffic is the primary source of noise at the site boundary and at residences near roads. Traffic noise is expected to dominate sound levels along major roads in the area such as U.S. Highway 60. The residents most likely to be affected by noise from traffic along Pantex access routes are those living along FM 2373 and FM 683 (BWXT Pantex, 2002; USDOE, 1998).

Except for prohibition of nuisance noise, neither the State of Texas nor local governments have established any regulations that specify acceptable community noise levels applicable to Pantex. EPA guidelines for environmental noise protection recommend an average day-night sound level of 55 dBA as sufficient to protect the public from the effects of broadband environmental noise in typically quiet outdoor and residential areas. Land-use compatibility guidelines adopted by the Federal Aviation Administration and the Federal Interagency Committee on Urban Noise indicate that yearly day-night average sound levels less than 65 dBA are compatible with residential land uses, and levels up to 75 dBA are compatible with residential uses if suitable noise reduction features are incorporated into structures. It is expected that for most residences near Pantex, the day-night average sound level is less than 65 dBA and is compatible with the residential land use (USDOE, 1996).

3.2.11 Human Health

The *Baseline HHRA Report* (BWXT Pantex/SAIC, 2006b) and *Burning Ground HHRA Report* (BWXT Pantex/SAIC, 2006c) evaluate potential risks to onsite and offsite human receptors that may be exposed to contaminated media at Pantex. Risks for each receptor/exposure pathway were identified in the RFIRs and the RI Report for soil, soil gas, and perched groundwater. The *Baseline HHRA Report* quantifies and evaluates potential risks from COPCs in environmental media to the following receptors:

- Onsite industrial worker under current and future exposure conditions
- Onsite construction/excavation worker under current and future exposure conditions
- Offsite resident farmer under future exposure conditions.

The subset of COPCs requiring closure to RRS 3 are trinitrotoluene (TNT) and RDX for the maintenance worker and construction worker in Zone 12 and for the industrial worker and construction/excavation worker in the Burning Ground.

BWXT Pantex is committed to employee safety, and has implemented programs and initiatives to reduce workplace accidents, striving toward a goal of zero accidents. This philosophy applies equally to employees and contractors. Pantex procedures require proper training and adherence to strict safety requirements when operating heavy equipment or working in potentially hazardous locations to reduce the risk of injury. In addition, because the proposed corrective measure options would involve remediation of contaminated media in accordance with RCRA requirements, workers would be required to complete Hazardous Waste Operations and Emergency Response (HAZWOPER) training.

3.2.12 Waste Management

Hazardous waste; non-hazardous waste; low-level radioactive waste; mixed low-level radioactive waste; Toxic Substances Control Act-regulated (i.e., polychlorinated biphenyls), sanitary, and medical wastes are routinely generated at the Plant. These wastes are primarily generated from ongoing assembly/ dismantlement operations of nuclear weapons and HE production, and also from support operations such as medical services, vehicle maintenance activities, general office work, construction activities, environmental monitoring, laboratory activities, and environmental remediation activities (BWXT Pantex, 2005; USDOE, 2003). Pantex is permitted to manage its hazardous waste under Hazardous Waste Permit No. HW-50284, issued by TCEQ. Procedures are in place to ensure compliance with permit requirements and applicable USDOE orders.

Table 3-3 shows the volumes of non-hazardous waste generated at Pantex between 2000 and 2004. The increases in waste generated in 2002 and 2003 have been attributed to the generation of Class 1 and Class 2 non-hazardous wastes from deactivation and decommissioning of excess facilities and construction projects. However, there was a major reduction in generation of non-hazardous waste in 2004.

Table 3-3. Non-Hazardous Waste Volumes Generated at Pantex

Waste Type	2000	2001	2002	2003	2004
Non-hazardous Waste, yd^3 (m^3)	9,194 (7,029)	2,638 (2,017)	5,891 (4,504)	14,209 (10,863)	6,050 (4,626)

Sources: BWXT Pantex, 2003; BWXT Pantex, 2005.

Non-hazardous waste is accumulated and stored onsite and managed and treated both onsite and offsite. Construction debris is disposed in an onsite landfill. All other non-hazardous waste is disposed offsite by commercial contractors. Waste minimization and recycling are used at Pantex to reduce waste generation

3.2.13 Transportation

Regional and site transportation routes are the primary carriers of traffic generated by Plant activities. There are 47 miles (76 km) of roads within the Plant boundaries. Onsite inter-zonal transfers between Zones 4, 11, and 12 are carried out on paved roads. Transportation between buildings in Zones 11 and 12 is frequently carried out by way of enclosed ramps. Track roads are sometimes used for production and monitoring well and utility access (BWXT Pantex/SAIC, 2006a; USDOE, 2003).

Access to the Plant is provided to the site by Texas FM roads, which bound the site on the north, east, and west, and by U.S. Highway 60, 1 mile (1.6 km) to the south, see Figure 1-1. Interstate highways 40 and 27 provide access to the traffic highway system. A railroad spur from the Burlington Northern and Santa

Fe railroad along the southern boundary of the TTU property also provides access to the site (USDOE, 2003).

3.2.14 Socioeconomics

As of 2005, Pantex employs 3,730 persons, including management and operating contractors, USDOE and National Laboratory staff, consultants, and oversight agency personnel (Nester, 2005b). This employment figure has remained relatively constant over the past 10 years.

Pantex is the major employer in Carson County, and is one of the largest employers within the four county regions of influence that includes Carson, Armstrong, Potter and Randall counties, and in the Amarillo metropolitan area. In 2001, Pantex was ranked the third largest employer in the Amarillo metropolitan area (BWXT Pantex, 2002).

In 2000, Pantex represented 3.3 percent of the entire 111,491-person civilian labor force in the region of influence (ROI). The annual unemployment average in the ROI was 5.5 percent during this period, less than the State of Texas average of 6.1 percent (DOC, 2005a).

The population of the ROI grew by 13.4 percent from 1990 to 2000. The two counties, Potter and Randall, that comprise the Amarillo Standard Metropolitan Area, had the largest population increases, 13.8 percent, and 14.0 percent, respectively. The more rural counties, Armstrong (5.9 percent) and Carson (-0.9 percent), had a lower if not negative growth rate (DOC, 2005b).

In 2001, based on estimates prepared by BWXT Pantex, the Plant generated $177.5 million in salaries, $6.8 million in direct expenditures, $7.2 million in construction dollars, and $297,000 in consultant fees, for a total of $191.9 million in direct expenditures. By using direct expenditures and employment figures associated with the Plant, it is possible to estimate the indirect effect these expenditures have on the Amarillo region. In the case of Pantex, indirect effects enhance development of local economic sectors such as office and industrial supplies, computer hardware and software, construction services and other items. Other economic impacts result from payrolls generated by the direct and indirect activity, which are partly spent in the local economy for items such as food, clothing, housing, and gasoline. The overall multiplier effect is estimated to be $274 million dollars in expenditures and almost an additional 5,000 jobs in the local economy (BWXT Pantex, 2002).

3.2.15 Environmental Justice

Executive Order 12898, Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations, directs Federal agencies to address the environmental justice impacts of their actions on minority and low-income populations. Every Federal agency is required to analyze environmental effects, including human health, economic, and social effects of Federal actions, including effects on minority populations (all people of color, exclusive of white non-Hispanics) and low-income families (households with incomes of less than $15,000 per year) when such analysis is required by NEPA. The ROI for the SWEIS environmental justice analysis is a 50-mile (80-km) radius centered in the southwest corner of the site (BWXT Pantex, 2002). Although the ROI for environmental justice extends beyond the four-county socioeconomic ROI, the four-county socioeconomic area of Armstrong, Carson, Potter, and Randall counties is used for this analysis, and more specifically, the census blocks that abut the southeast portion of the Pantex site in Carson County where the proposed activities would take place.

Based on 2000 census data, approximately one-fifth of all residents living within the ROI are minority. The two ROI urban counties within the Amarillo Standard Metropolitan Area have the largest percentage of minority residents, Potter with 31.4 percent and Randall with 9.6 percent. Of the two more rural counties, 4.6 percent of Armstrong County and 6.2 percent of Carson County are considered minority. Persons of Hispanic heritage comprise 20.4 percent of the ROI population. The urban counties have the greatest percentage of Hispanic residents, Potter with 28.1 percent, and Randall with 10.3 percent. Of all residents living in the rural ROI counties, 5.4 percent in Armstrong County and 7.0 percent in Carson County self-designated themselves as Hispanic (DOC, 2005b).

The 2000 census indicated that of all families within the ROI, 10.2 percent are living below the poverty line. Potter County has the largest concentration of families living below the poverty line at 15.4 percent; followed by Armstrong County with 8.2 percent; Randall with 5.7 percent; and Carson with 5.4 percent (DOC, 2005b).

Portions of the proposed corrective measures could take place outside the Plant boundaries, on private property adjacent to the southeast portion of the site. All groundwater corrective measures activities proposed outside of the Plant boundaries would take place in Carson County, within Census Tract 9502, Block Group 1. The individual blocks that abut the southeast portion of the Plant include blocks 1122, 1129, 1132, 1137, and 1138. The *Environmental Information Document* indicates that 41 people reside within a 3-mile (5-km) radius of the center of the Plant and 130 people reside within a 5-mile (8-km) radius (BWXT Pantex, 2002). Based on 2000 census data, only 12 people live within census blocks 1122, 1129, 1132, 1137, and 1138. None of these 12 residents is either minority or has a Hispanic heritage (DOC, 2005c). Household income is only available at the block group level in the 2000 census. The median household income for Census Tract 9502, Block Group 1, is $46,154, and of all 1,258 households living within this block group, 6.8 percent are below the poverty line (DOC, 2005d).

THIS PAGE INTENTIONALLY LEFT BLANK

4.0 POTENTIAL ENVIRONMENTAL ISSUES AND EFFECTS DISCUSSION

The potential environmental impacts of implementing the proposed corrective measure options are evaluated using the USDOE/NNSA "sliding scale" approach, in which resource areas are evaluated commensurate with the potential level of impact. Impacts of taking no action are presented in Section 4.1, to establish a baseline for comparison to the proposed action. Impacts of the proposed action are evaluated by corrective measure option, according to the environmental factors discussed under section 4.2, below.

4.1 NO ACTION IMPACTS ANALYSIS

Under the No Action alternative, the existing PGPTS would be turned off and the system abandoned in place. There would be no impacts on any resource areas associated with the No Action alternative because no new activities would be undertaken to remove contaminants from the perched groundwater; in fact, there would be less activity were the No Action alternative implemented. However, the COCs would remain in the perched groundwater; the plumes of impacted perched groundwater would continue to migrate unabated except for natural attenuation, and could eventually reach the Ogallala Aquifer. Except for Pantex and TTU property, where USDOE/NNSA and TTU currently restrict use of perched groundwater and would continue to do so, there would be no restrictions on the use of this water. Although there are no domestic or production wells completed in perched groundwater at this time, there would be no way to prevent use of this water. Further, selecting the No Action alternative would not meet TCEQ requirements, particularly with respect to addressing the potential for future impacts to human health.

4.2 PROPOSED ACTION IMPACTS ANALYSIS

4.2.1 Land Use

Corrective Measure Option 1: Monitored Natural Attenuation (MNA)

This option would be similar to the No Action alternative in that the PGPTS would be turned off and use of onsite perched groundwater would continue to be restricted. However, 10 new monitoring wells would be added to the groundwater monitoring network and offsite use of perched groundwater and drilling would be restricted. The 10 new monitoring wells would include five onsite wells (one on agricultural land and four within operations areas) and five offsite (all on agricultural land, either on private or TTU property) as shown in Figure 2-2. Two-track roads constructed of crushed concrete, rock or gravel would be installed to ensure access to the monitoring wells during periods of inclement weather. In total, the new monitoring wells and access roads would temporarily disturb 2.2 acres (0.9 ha) and permanently disturb 1.1 acres (0.45 ha). Placement of the corrective measure options under the proposed action would occur in an area of approximately 2,500 acres, as shown on Figure 2-8. Although some wells would be on agricultural land, as described above, impacts would be negligible due to the minimal acreage disturbed.

Instituting deed restrictions on offsite use of perched groundwater would not affect current or future land use because there are no domestic or production wells completed in the perched groundwater on land contiguous to the south and east boundaries of the Plant. Although instituting deed restrictions on offsite drilling for this same land could affect future use, the impacts would be negligible because placement and construction controls could be instituted to allow installation of wells into the Ogallala Aquifer. Such preventative controls and planning actions would mitigate the potential for creating cross-contamination and preferential pathways for migration of perched groundwater to the Ogallala Aquifer.

Corrective Measure Option 2: Existing Pump and Treat with MNA

Construction activities proposed under this option would temporarily disturb about 6.5 acres (2.6 ha) of land, 2.7 acres (1.1 ha) of which would be permanently disturbed, primarily by the retention basin and access roads. Placement of any of the corrective measure options under the proposed action would occur in an area of approximately 2,500 acres, as shown on Figure 2-8. Because most wells and the retention basin would be on cultivated land, this option would result in the loss of some production. However, due to the very small acreage involved compared to the area of agricultural land in the region, impacts would be negligible.

Instituting deed restrictions on offsite use of perched groundwater would not affect current or future land use because there are no domestic or production wells completed in the perched groundwater on land contiguous to the south and east boundaries of the Plant. Although instituting deed restrictions on offsite drilling for this same land could affect future use, the impacts would be negligible because placement and construction controls could be instituted to allow installation of wells into the Ogallala Aquifer. Such preventative controls and planning actions would mitigate the potential for creating cross-contamination and preferential pathways for migration of perched groundwater to the Ogallala Aquifer.

The Natural Resources Conservation Service (NRCS) would probably categorize most of the offsite land identified for potential irrigation with treated perched groundwater, shown on Figure 2-3, as prime farmland. Impacts associated with irrigation of the offsite lands would be positive, as the availability of the water would result in more productive cultivation than on farmland that is not irrigated.

Approximately half of the offsite agricultural land identified for potential irrigation with treated perched groundwater is presently in the Conservation Reserve Program (CRP). Removing some of this land from the CRP would reduce the total acreage in the program, but its impact would be insignificant as 60,000 acres of land in Carson County are part of the program. Also, cultivation of these lands would result in improved control of exotic vegetation within the immediate area, since old world bluestem is colonizing CRP land.

As many as 200 acres (81 ha) would be used for irrigation under this option. The additional irrigation applied to agricultural land currently under or available for cultivation would not be expected to affect land use. Different crops (but consistent with those grown in the area), higher yield, and more land in service could result from the additional irrigation, but these potential impacts would be consistent with land use and local agricultural practices.

Corrective Measure Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA

Construction activities proposed under this option would temporarily disturb approximately 21.7 acres (8.8 ha), including 3.0 acres (1.2 ha) of CRP land on TTU property. About 6.2 acres (2.6 ha) of land in Plant operations, 1.5 acres (0.6 ha) of CRP land, and 0.7 acres (0.3 ha) of offsite agricultural land would be permanently disturbed by the retention basins, wells, access roads and appurtenances. Placement of any of the corrective measure options under the proposed action would occur in an area of approximately 2,500 acres, as shown on Figure 2-8. Any temporarily disturbed agricultural land would be returned to grade, and non-cultivated areas would be reseeded with native species. Therefore, impacts on land use from implementing this corrective measure option would be minor.

Instituting deed restrictions on offsite use of perched groundwater would not affect current or future land use because there are no domestic or production wells completed in the perched groundwater on land contiguous to the south and east boundaries of the Plant. Although instituting deed restrictions on offsite drilling for this same land could affect future use, the impacts would be negligible because placement and construction controls could be instituted to allow installation of wells into the Ogallala Aquifer. Such preventative controls and planning actions would mitigate the potential for creating cross-contamination and preferential pathways for migration of perched groundwater to the Ogallala Aquifer.

The Natural Resources Conservation Service (NRCS) would probably categorize most of the offsite land identified for potential irrigation with treated perched groundwater, shown on Figure 2-3, as prime farmland. Impacts associated with irrigation of the offsite lands would be positive, as the availability of the water would result in more productive cultivation than on farmland that is not irrigated.

Approximately half of the offsite agricultural land identified for potential irrigation with treated perched groundwater is presently in the Conservation Reserve Program (CRP). Removing some of this land from the CRP would reduce the total acreage in the program, but its impact would be insignificant as 60,000 acres of land in Carson County are part of the program. Also, cultivation of these lands would result in improved control of exotic vegetation in the immediate area, since old world bluestem is colonizing CRP land.

As many as 700 acres (283 ha) would be used for irrigation under this option. The additional irrigation applied to agricultural land currently under or available for cultivation would not be expected to affect land use. Different crops (but consistent with those grown in the area), higher yield, and more land in service could result from the additional irrigation, but all of these potential impacts would be consistent with land use and local agricultural practices.

Corrective Measure Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA

Construction activities proposed under this option would temporarily disturb about 14.5 acres (5.9 ha) of land and would permanently disturb about 5.9 acres (2.4 ha). Placement of any of the corrective measure options under the proposed action would occur in an area of approximately 2,500 acres, as shown on Figure 2-8. Land disturbed by this option includes areas on TTU property that are in the CRP, private agricultural land to the east and southeast, and both agricultural and operations areas on Pantex property. Well placement would disturb some agricultural land; however, due to the very small acreage involved compared to the area of agricultural land in the region, impacts on production would be negligible. Any disturbed agricultural land would be returned to grade, and non-cultivated areas would be reseeded with native species. Wells placed in operations areas of the Plant would not impact land use within those areas because they are in industrial use. Therefore, impacts on land use from implementing this corrective measure option would be minor.

Instituting deed restrictions on offsite use of perched groundwater would not affect current or future land use because there are no domestic or production wells completed in the perched groundwater on land contiguous to the south and east boundaries of the Plant. Although instituting deed restrictions on offsite drilling for this same land could affect future use, the impacts would be negligible because placement and construction controls could be instituted to allow installation of wells into the Ogallala Aquifer. Such preventative controls and planning actions would mitigate the potential for creating cross-contamination and preferential pathways for migration of perched groundwater to the Ogallala Aquifer.

The Natural Resources Conservation Service (NRCS) would probably categorize most of the offsite land identified for potential irrigation with treated perched groundwater, shown on Figure 2-3, as prime farmland. Impacts associated with irrigation of the offsite lands would be positive, as the availability of the water would result in more productive cultivation than on farmland that is not irrigated.

Approximately half of the offsite agricultural land identified for potential irrigation with treated perched groundwater is presently in the Conservation Reserve Program (CRP). Removing some of this land from the CRP would reduce the total acreage in the program, but its impact would be insignificant as more than 60,000 acres of land in Carson County are part of the program. Also, cultivation of these lands would result in improved control of exotic vegetation within the immediate area.

As many as 400 acres (162 ha) would be used for irrigation under this option. The additional irrigation applied to agricultural land currently under or available for cultivation would not be expected to affect land use. Different crops (but consistent with those grown in the area), higher yield, and more land in service could result from the additional irrigation, but all of these potential impacts would be consistent with land use and local agricultural practices.

Corrective Measure Option 5: Targeted Treatment with MNA

Construction activities proposed under this option would temporarily disturb about 19.4 acres (7.9 ha) of land, of which about 8.4 acres (3.4 ha) would be permanently disturbed. Placement of any of the corrective measure options under the proposed action would occur in an area of approximately 2,500 acres, as shown on Figure 2-8. Land disturbed by this option would include areas on TTU property, private agricultural land to the east and southeast, and both agricultural and operations areas on Pantex property. Borehole and well placement would disturb some agricultural land; however, due to the very small acreage involved compared to the area of agricultural land in the region, impacts on production would be negligible. Any disturbed agricultural land would be returned to grade, and non-cultivated areas would be reseeded with native species. Those wells placed in operations areas of the Plant would not impact land use within those areas because they are in industrial use. Therefore, impacts on land use from implementing this corrective measure option would be minor.

Instituting deed restrictions on offsite use of perched groundwater would not affect current or future land use because there are no domestic or production wells completed in the perched groundwater on land contiguous to the south and east boundaries of the Plant. Although instituting deed restrictions on offsite drilling for this same land could affect future use, the impacts would be negligible because placement and construction controls could be instituted to allow installation of wells into the Ogallala Aquifer. Such preventative controls and planning actions would mitigate the potential for creating cross-contamination and preferential pathways for migration of perched groundwater to the Ogallala Aquifer.

The Natural Resources Conservation Service (NRCS) would probably categorize most of the offsite land identified for potential irrigation with treated perched groundwater, shown on Figure 2-3, as prime farmland. Impacts associated with irrigation of the offsite lands would be positive, as the availability of the water would result in more productive cultivation than on farmland that is not irrigated.

Approximately half of the offsite agricultural land identified for potential irrigation with treated perched groundwater is presently in the Conservation Reserve Program (CRP). Removing some of this land from the CRP would reduce the total acreage in the program, but its impact would be insignificant as more than 60,000 acres of land in Carson County are part of the program. Also, cultivation of these lands would result in improved control of exotic vegetation within the immediate area.

As many as 200 acres (81 ha) would be used for irrigation under this option. The additional irrigation applied to agricultural land currently under or available for cultivation would not be expected to affect land use. Different crops (but consistent with those grown in the area), higher yield, and more land in service could result from the additional irrigation, but all of these potential impacts would be consistent with land use and local agricultural practices.

Corrective Measure Option 6: Enhanced Pump and Treat with Targeted In Situ Treatment and MNA

Installation of new monitoring wells, vertical extraction wells, boreholes, and associated piping and retention basins would temporarily disturb 21.5 acres (8.7 ha). This includes about 18.9 acres (7.6 ha) of onsite land presently designated as operations and agricultural areas and 2.6 acres (1.1 ha) of offsite agricultural land. Placement of any of the corrective measure options under the proposed action would occur in an area of approximately 2,500 acres, as shown on Figure 2-8. Any temporarily disturbed agricultural land would be returned to grade, and non-cultivated areas would be reseeded with native species. Approximately 6.5 acres (2.6 ha) onsite and 2.8 acres (1.1 ha) offsite would be permanently disturbed.

Instituting deed restrictions on offsite use of perched groundwater would not affect current or future land use because there are no domestic or production wells completed in the perched groundwater on land contiguous to the south and east boundaries of the Plant. Although instituting deed restrictions on offsite drilling for this same land could affect future use, the impacts would be negligible because placement and construction controls could be instituted to allow installation of wells into the Ogallala Aquifer. Such preventative controls and planning actions would mitigate the potential for creating cross-contamination and preferential pathways for migration of perched groundwater to the Ogallala Aquifer. Therefore, impacts on land use from construction associated with enhancing the capability for extraction of perched groundwater would be minor.

The Natural Resources Conservation Service (NRCS) would probably categorize most of the offsite land identified for potential irrigation with treated perched groundwater, shown on Figure 2-3, as prime farmland. Impacts associated with irrigation of the offsite lands would be positive, as the availability of the water would result in more productive cultivation than on farmland that is not irrigated.

Approximately half of the offsite agricultural land identified for potential irrigation with treated perched groundwater is presently in the Conservation Reserve Program (CRP). Removing some of this land from the CRP would reduce the total acreage in the program, but its impact would be insignificant as more than 60,000 acres of land in Carson County are part of the program. Also, cultivation of these lands would result in improved control of exotic vegetation within the immediate area.

Up to 700 acres (283 ha) would be used for irrigation under this option. The additional irrigation applied to agricultural land currently under or available for cultivation would not be expected to affect land use. Different crops (but consistent with those grown in the area), higher yield, and more land in service could result from the additional irrigation, but all of these potential impacts would be consistent with land use and local agricultural practices.

Upgraded PGPTS - Upgrading the PGPTS would involve either expanding the existing facility by about 4,000 ft^2 (372 m^2) or installing skid-mounted units in the field, and enlarging one of the retention basins to contain the larger volume of extracted groundwater. The existing PGPTS Building is in an operations area, so increasing the facility size would not affect land use. There is sufficient vacant land surrounding the PGPTS Building to accommodate the additional building footprint

Skid-mounted units would be either south or east of Playa 1, outside the delineated floodplain, on land designated for operations or cultivation, respectively. If placed south of Playa 1 on land designated for operations there would be no impact on land use. If placed east of Playa 1, impacts on onsite agricultural land would be negligible due to the small area affected.

Increasing the size of one of the retention basins from about 1.1 acres (0.45 ha) to 2.3 acres (0.9 ha) under this additional component would increase the amount of onsite agricultural land disturbed. However, this would not appreciably alter impacts on onsite agricultural land use as described for the construction activities that would be needed to enhance capabilities for extraction of perched groundwater. Regardless of where the new units were placed, this additional component would result in an increase in temporary disturbance over the activities needed to enhance extraction capabilities of 9.1 acres (3.7 ha) and a permanent disturbance of 1.2 acres (0.5 ha).

It would also be necessary to increase the land used for irrigation to 1,300 acres (530 ha). However, more than 2,000 acres (800 ha) offsite and 240 acres (97 ha) have been identified as available and suitable for irrigation, so there would be adequate land available to manage this additional volume of treated groundwater.

In situ Bioremediation - The use of *in situ* bioremediation would involve installation of 56 injection wells and 25 extraction wells, as well as associated piping, pumps, and service building. This component would temporarily disturb 2 acres (0.8 ha) and permanently disturb 1.0 acre (0.4 ha) more of either operations or agricultural land than affected by just enhancing the extraction capabilities.

Permeable Reactive Barrier - Forty injection wells would be installed in place of the nine vertical extraction wells southeast of the Plant. This action would not result in a change in permanent disturbance of onsite lands relative to enhancing extraction capabilities, but would result in a small increase in permanent disturbance to offsite agricultural land.

4.2.2 Geology and Soils

Corrective Measure Option 1: Monitored Natural Attenuation

Under Corrective Measure Option 1, the only ground-disturbing activities would be to add 10 monitoring wells to the existing groundwater-monitoring network and install two-track roads for improved access using crushed concrete, gravel, or rock. Installation of these new wells and two-track access roads would temporarily disturb approximately 2.2 acres (0.9 ha) of land, with the completed monitoring wells, pads, and two-track roads occupying approximately 1.1 acres (0.45 ha). Geologic resources required would include approximately 9.0 yd^3 (6.9 m^3) of concrete, 1.4 yd^3 (1.1 m^3) of sand, 0.4 yd^3 (0.3 m^3) of bentonite, and 56 yd^3 (43 m^3) of grout (typically a mixture of bentonite and Portland cement for well applications). Approximately 260 yd^3 (198.8 m^3) of rock or gravel would be needed for the two-track roads, if crushed concrete is not available. The wells would be installed in accordance with good engineering practice, and best management practices would be used for soil erosion and sediment control (e.g., watering, use of temporary covers, sediment fencing). The overall impact of these activities on site geology and geologic resources would be negligible.

Corrective Measure Option 2: Existing Pump and Treat with MNA

Under this option, 10 monitoring wells would be added to the existing monitoring network, injection of treated groundwater would be eliminated, and a retention basin and irrigation system would be installed to reuse the treated groundwater. As described for Corrective Measure Option 1, the impact of well construction activities would be negligible.

Construction of the retention basin, including access roads, would temporarily disturb approximately 3.4 acres (1.4 ha) of land, and require approximately 11,100 yd^3 (8,490 m^3) of earthwork, and would use about 490 yd^3 (375 m^3) of pea gravel, 1,160 yd^3 (887 m^3) of sand, and 120 yd^3 (91.7 m^3) of rock/gravel. Trenching would be required to run about 3,000 linear ft (900 m) of piping from the existing treatment building to the retention basin and from the basin to the center-pivot irrigation system, and would have minimal additional impact. Best management practices for soil erosion and sediment control during construction would minimize soil erosion and loss. Overall, both direct impacts on site geology and soils from land disturbance, excavation work, and related erosion; and indirect impacts from consumption of geologic resources under this option would be negligible.

Corrective Measure Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA

Direct impacts on geology and soils under this option would primarily result from installation of exploratory boreholes and horizontal extraction wells, and construction of the two retention basins. (See Section 2.2.1.3). The six 6-in (15-cm) diameter stainless steel horizontal extraction wells would be connected to the existing PGPTS by installation of approximately 17,000 ft (5,180 m) of 6-in (15-cm) steel extraction piping. The completed well installations would have 5-ft (1.5-m) by 7-ft (2.1 m) by 8-in (20-cm) thick concrete pads. The wells would be installed in accordance with good engineering practice, and best management practices would be used for soil erosion and sediment control. As described for Corrective Measure Option 2, adherence to best management practices for soil erosion and sediment control during construction would minimize soil erosion and loss.

Temporary ground disturbance associated with borehole completion, monitoring and horizontal well installation, trenching for extraction piping, and two-track access roads is estimated to be 9.7 acres (3.9 ha). Geologic resource requirements to support borehole completion and well installation would include approximately 14 yd^3 (11 m^3) of concrete, 4.3 yd^3 (3.3 m^3) of sand, 0.9 yd^3 (0.7 m^3) of bentonite, and 90 yd^3 (69 m^3) of grout (typically a mixture of bentonite and Portland cement for well applications). Approximately 280 yd^3 (214.1 m^3) of rock or gravel would be required to install the access roads.

Construction of the retention basins would temporarily disturb approximately 12.0 acres (4.8 ha) and would require approximately 38,700 yd^3 (29,600 m^3) of earthwork. Geologic resources required would include about 1,690 yd^3 (1,290 m^3) of pea gravel, 4,000 yd^3 (3,060 m^3) of sand, and 440 yd^3 (336.4 m^3) of rock/gravel. Trenching would be required to run about 18,100 linear ft (5,520 m) of piping from the existing PGPTS Building to the retention basins and from the basins to the irrigation systems, but would have minor additional impact. Overall, direct impacts on site geology and soils from land disturbance and excavation work, and indirect impacts from consumption of geologic resources under this option would be minor.

Corrective Measure Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA

Direct impacts on geology and soils under this option would primarily result from installation of new vertical extraction wells and construction of retention basins as described in Section 2.2.1.4. Eighty-seven 6-in (15-cm) diameter vertical extraction wells would be installed along eight well lines to the east, southeast, and south of the Plant near and adjacent to the site boundary (see Figure 2-5). These wells would be interconnected and connected to the existing PGPTS by installation of approximately 11,200 ft (3,400 m) of 1-in (2.5-cm) and 4-in (10-cm) PVC extraction piping. These new wells would have 5-ft (1.5-m) by 7-ft (2.1-m) by 8-in (20-cm) thick concrete pads. In addition, 10 monitoring wells would be installed to augment the existing monitoring well network. All wells would be installed in accordance with good engineering practice, and best management practices would be used for soil erosion and sediment control.

Temporary ground disturbance associated with monitoring and vertical extraction well installation, running extraction piping, and installing two-track access roads is estimated to be about 7.1 acres (2.9 ha). Geologic resource requirements to support well installation activities would include approximately 87 yd^3 (67 m^3) of concrete, 19 yd^3 (15 m^3) of sand, 5.6 yd^3 (4.3 m^3) of bentonite, and 420 yd^3 (321 m^3) of grout (typically a mixture of bentonite and Portland cement for well applications). Approximately 250 yd^3 (191.1 m^3) of gravel or rock would be needed for the access roads if crushed concrete is unavailable.

Construction of the two retention basins, including the two-track access roads, would temporarily disturb approximately 7.4 acres (3.0 ha) of land onsite and would require approximately 24,000 yd^3 (18,300 m^3) of earthwork. Geologic resources required would include about 1,050 yd^3 (803 m^3) of pea gravel, 2,500 yd^3 (1,910 m^3) of sand, and 940 yd^3 (718.7 m^3) of rock/gravel. Trenching would be required to run about 15,000 linear ft (4,600 m) of piping from the existing PGPTS Building to the retention basins and from the basins to the irrigation systems, but would have minor additional impact. Best management practices for soil erosion and sediment control would be used during vertical well installation. Overall, direct impacts on site geology and soils from land disturbance and excavation work, and indirect impacts from consumption of geologic resources under this option would be minor.

Corrective Measure Option 5: Targeted Treatment with MNA

Direct impacts on geology and soils under this option would primarily result from installation of new vertical injection and extraction wells and construction of retention basins as described in Section 2.2.1.5. All wells would be installed in accordance with good engineering practice, and best management practices would be used for soil erosion and sediment control. Temporary ground disturbance associated with well installation, running piping, and installing two-track access roads is estimated at 16.0 acres (6.5 ha). Geologic resource requirements for well installation would include approximately 352 yd^3 (269 m^3) of concrete, 66 yd^3 (52 m^3) of sand, 20 yd^3 (15 m^3) of bentonite, and 1,367 yd^3 (1,050 m^3) of grout (typically a mixture of bentonite and Portland cement for well applications). Approximately 880 yd^3 (672.8 m^3) of rock/gravel would be needed for these access roads, if crushed concrete is unavailable.

Construction of the retention basin, including its access roads, would temporarily disturb approximately 3.4 acres (1.4 ha) of land, requiring approximately 11,100 yd^3 (8,490 m^3) of earthwork. Geologic resources required would include about 490 yd^3 (375 m^3) of pea gravel, 1,160 yd^3 (887 m^3) of sand, and 120 yd^3 (91.7 m^3) of rock/gravel. Trenching would be required to run about 3,000 linear ft (900 m) of piping from the existing PGPTS Building to the retention basin and from the basin to the irrigation system, but would have minimal additional impact. Construction of the service building would temporarily disturb about 0.17 acres (0.07 ha) and require about 200 yd^3 (150 m^3) of earthwork and 89 yd^3 (68 m^3) of concrete. Best management practices for soil erosion and sediment control would be used during all ground-disturbing activities. Overall, direct impacts on site geology and soils from land disturbance, excavation work, and related erosion; and indirect impacts from consumption of geologic resources under this option would be minor.

Corrective Measure Option 6: Enhanced Pump and Treat with Targeted In Situ Treatment and MNA

Installation of extraction wells, associated extraction piping, and exploratory boreholes would constitute the primary direct impacts on geology and soils. The wells would be installed in accordance with good engineering practice, and best management practices would be used for soil erosion and sediment control. Temporary ground disturbance associated with well installation, running piping, and installing two-track access roads for the base option is estimated at 9.5 acres (3.8 ha). Geologic resource requirements to support monitoring and extraction well installation and borehole completion, and two-track access roads would include approximately 23 yd^3 (17 m^3) of concrete, 5.3 yd^3 (4.0 m^3) of sand, 1.5 yd^3 (1.1 m^3) of bentonite, about 105 yd^3 (80 m^3) of grout (typically a mixture of bentonite and Portland cement for well applications), and approximately 1,300 yd^3 (994 m^3) of rock/gravel.

Construction of the two retention basins would temporarily disturb about 12.0 acres (4.9 ha). These two retention basins, including the access roads, would require approximately 38,700 yd^3 (29,600 m^3) of earthwork. Geologic resources required would include about 1,690 yd^3 (1,290 m^3) of pea gravel, 4,000 yd^3 (3,060 m^3) of sand, and 280 yd^3 (214 m^3) of rock/gravel. Overall, direct impacts on site geology and soils from land disturbance and excavation work, and indirect impacts from consumption of geologic resources under this action would be minor.

Upgraded PGPTS - A larger second retention basin would be constructed to accommodate an increased volume of extracted groundwater. Construction of this larger second basin would result in temporary disturbance of another 3.6 acres (1.5 ha). Also, a 100-ft (30-m) by 40-ft (12-m) addition to the PGPTS Building would be constructed or a similarly sized area near Playa 1 would be used to install skid-mounted treatment units. Upgrade of the treatment system is estimated to temporarily disturb another 0.3 acres (0.1 ha). Construction of the two retention basins, including two-track access roads, would require approximately 50,200 yd^3 (38,400 m^3) of earthwork. Geologic resources required would include about 2,250 yd^3 (1,720 m^3) of pea gravel, 5,100 yd^3 (3,900 m^3) of sand, and about 280 yd^3 (214 m^3) of rock/gravel. Construction of the PGPTS Building addition would require an additional 300 yd^3 (229 m^3) of earthwork and 148 yd^3 (113 m^3) of concrete. Overall, direct impacts on site geology and soils from land disturbance and excavation work, and indirect impacts from consumption of geologic resources under this component would be minor.

In situ Bioremediation - Geologic resource requirements to support installation of the *in situ* treatment system would include approximately 73 yd^3 (56 m^3) of concrete, 13 yd^3 (10 m^3) of sand, 3.7 yd^3 (2.9 m^3) of bentonite, and 261 yd^3 (199 m^3) of grout (typically a mixture of bentonite and Portland cement for well applications). Overall, direct impacts on site geology and soils from land disturbance and excavation work, and indirect impacts from consumption of geologic resources under this additional component would be negligible.

Permeable Reactive Barrier - Geologic resource requirements to support installation of the injection and monitoring wells would include approximately 40 yd^3 (30 m^3) of concrete, 9.0 yd^3 (6.9 m^3) of sand, 2.6 yd^3 (2.0 m^3) of bentonite, and 179 yd^3 (137 m^3) of grout (typically a mixture of bentonite and Portland cement for well applications). Overall, direct impacts on site geology and soils from land disturbance and excavation work, and indirect impacts from consumption of geologic resources under this additional component would be negligible.

4.2.3 Water Resources

Corrective Measure Option 1: Monitored Natural Attenuation

Under this option, the existing PGPTS would be turned off, 10 new monitoring wells would be installed to augment the existing monitoring well network, and deed restrictions would be instituted on offsite use of perched groundwater. This option does not include active remedies, so the existing perched groundwater impacts would persist longer, leading to a greater potential for migration of the perched groundwater COCs into the underlying Ogallala Aquifer.

Water and cuttings from drilling and development of the perched groundwater zone would be containerized and characterized as part of determining the appropriate waste classification and disposition as further described in Section 2.2.1. Drill cuttings from unimpacted zones would be spread around the well installation and mixed with soil to even the grade in accordance with standard well installation practice. Appropriate soil erosion and sediment control measures, and spill prevention and waste management practices would minimize any suspended sediment and pollutant transport that could result in potential water quality impacts. Because the area of construction-related land disturbance would be very small and the construction management practices would be protective of the environment, direct impacts on both surface water and groundwater from installation of the monitoring wells would be negligible.

Corrective Measure Option 2: Existing Pump and Treat with MNA

Under this option, the existing PGPTS would continue to be operated in its current configuration for the next 30 years, except that injection of the treated groundwater back into the perched zone would be discontinued. Instead, a retention basin and irrigation system to reuse the treated groundwater would be constructed as shown in Figure 2-3, 10 new monitoring wells would be installed, and deed restrictions would be instituted on offsite use of perched groundwater.

Construction-related activities would be subject to the requirements of Texas Pollutant Discharge Elimination System (TPDES) permits for the discharge of storm water associated with construction and other industrial activities. Appropriate soil erosion and sediment control measures, and spill prevention and waste management practices would minimize any suspended sediment and pollutant transport that could result in potential water quality impacts. Although this option would reduce the volume of perched groundwater available, the long-term impact would be an overall improvement in the protection of the Ogallala Aquifer.

Corrective Measure Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA

Construction-related land disturbance, particularly for horizontal extraction well installation and construction of the new retention basins, would expose soils and sediments to possible erosion and transport by heavy rainfall or wind. Appropriate soil erosion and sediment control measures, and spill prevention and waste management practices would minimize any suspended sediment and pollutant transport that could result in potential water quality impacts. Further, construction-related activities would be subject to the requirements of TPDES permits for the discharge of storm water associated with construction activities.

No contaminated water would be discharged to the ground or subsurface at Pantex during system construction or operation. Although this option would reduce the volume of perched groundwater available, the long-term impact would be an overall improvement in the protection of the Ogallala Aquifer.

Corrective Measure Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA

Construction-related land disturbance, particularly for construction of the retention basins and new vertical extraction wells, would expose soils and sediments to possible erosion and transport by heavy rainfall or wind. Appropriate soil erosion and sediment control measures, and spill prevention and waste management practices would minimize any suspended sediment and pollutant transport that could result in potential water quality impacts. Further, construction-related activities would be subject to the requirements of TPDES permits for the discharge of storm water associated with construction and other industrial activities.

No contaminated water would be discharged to the ground or subsurface at the Plant during system construction or operations. Although this option would reduce the volume of perched groundwater available, the long-term impact would be an overall improvement in the protection of the Ogallala Aquifer.

Corrective Measure Option 5: Targeted Treatment with MNA

Construction-related land disturbance, particularly for installation of the new injection and extraction wells and construction of the retention basin and storage building, would expose soils and sediments to possible erosion and transport by heavy rainfall or wind. Appropriate soil erosion and sediment control measures, and spill prevention and waste management practices would minimize any suspended sediment and pollutant transport that could result in potential water quality impacts. Further, construction-related activities would be subject to the requirements of TPDES permits for the discharge of storm water associated with construction and other industrial activities.

No contaminated water would be discharged to the ground or subsurface at the Plant during system construction or operations. Implementation of in situ treatment would result in injection of amendments to enhance either biodegradation or the reactivity of naturally occurring iron. Although this option would result in some short-term adverse impacts to perched groundwater, the long-term impact would be an overall improvement in the protection of the Ogallala Aquifer.

Corrective Measure Option 6: Enhanced Pump and Treat with Targeted In Situ Treatment and MNA

Construction-related activities under this option would expose soils and sediments, and any materials spilled during construction, to possible erosion and transport by heavy rainfall or wind. Good engineering practice, including soil erosion and sediment control measures, and spill prevention and waste management practices would minimize any suspended sediment and pollutant transport that could result in potential water quality impacts. Further, construction-related activities would be subject to the requirements of TPDES permits for the discharge of storm water associated with construction activities. Implementation of in situ treatment would result in injection of amendments to enhance either biodegradation or the reactivity of naturally occurring iron. Although this option would reduce the volume of perched groundwater available and result in some short-term adverse impacts to the perched groundwater, the long-term impact would be an overall improvement in the protection of the Ogallala Aquifer.

4.2.4 Floodplains and Wetlands

Corrective Measure Option 1: Monitored Natural Attenuation

This option would result in no change in topography or site drainage, and none of the activities would occur in playa management or floodplain. Therefore, there would be no potential impacts on floodplains or wetlands.

Corrective Measure Option 2: Existing Pump and Treat with MNA

As discussed for Option 1, there would be no potential impacts on floodplains or wetlands.

Corrective Measure Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA

As discussed for Option 1, there would be no potential impacts on floodplains or wetlands.

Corrective Measure Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA

As discussed for Option 1, there would be no potential impacts on floodplains or wetlands.

Corrective Measure Option 5: Targeted Treatment with MNA

As discussed for Option 1, there would be no potential impacts on floodplains or wetlands.

Corrective Measure Option 6: Enhanced Pump and Treat with Targeted In Situ Treatment and MNA

A detailed floodplain assessment is provided in Appendix B. This assessment led to the determination that approximately 1 acre of floodplain, less than ½ of 1 percent of the Playa 1 floodplain area, would be involved in the drilling and trenching activities of this project. Storm water runoff may have the potential to erode denuded areas and transport sediments during drilling, trenching, and re-vegetation, which would have a negative, direct, and short-term effect on existing conditions. The installation of the extraction systems on the well pads, the access roads, and sampling and maintenance of the system, has the potential to displace a small amount of floodplain volume resulting in increasing the floodplain elevation by less than 0.5 inches and increasing the area of the floodplain by less than 1 acre. Therefore, the effects of the project floodplain activities would not change conditions in a way that affects lives or property.

Two negative effects in the Playa 1 floodplain have been identified; the potential for erosion and sedimentation during drilling, trenching, and re-grading activities, and the potential for displacing floodplain volume with the installation of the extraction systems on the well pads. These minor negative effects apply only to part of the overall activities that comprise Option 6, but do not apply to the No Action alternative or to Options 1 through 5. The effects of erosion and sedimentation would be minimized by implementing controls required by Pantex Division I Specifications, Section 01558, summarized in Appendix B.

In accordance with Title CFR Part 1022, a Statement of Findings, based on the information in this document, will be published. The statement of findings will include: a brief description of the proposed action and an explanation indicating why it is in a floodplain; the alternatives considered; a statement indicating if the action conforms to State and local floodplain requirements and; a brief description of the steps to be taken to minimize potential harm to or within the floodplain. After publication, a 15-day comment period is required before implementing the proposed action.

4.2.5 Biological Resources

Corrective Measure Option 1: Monitored Natural Attenuation

Because limited acreage would be affected and the land either is in agricultural production or is highly developed, wildlife, including threatened and endangered species, would not be significantly affected by proposed activities. However, plant procedures to mitigate impacts to the Texas horned lizard and species protected by the Migratory Bird Treaty Act and/or state regulations would be followed during implementation of this option. These procedures include the use of personnel to guide vehicles and heavy equipment down access roads. Species encountered would be moved out of the path of the equipment. Deed restrictions on offsite use of perched groundwater would not affect biological resources because the perched groundwater does not provide habitat and is not used as a water supply in the vicinity of Pantex.

Corrective Measure Option 2: Existing Pump and Treat with MNA

Impacts of this option on biological resources would result primarily from the construction of the new retention basin and secondarily from installation of the 10 monitoring wells. The option, including new retention basin, wells, piping and access roads, would temporarily disturb 6.5 acres (2.6 ha). However, only 2.7 acres (1.1 ha) would be permanently disturbed. Because most of this land is used for agricultural purposes, there would be no significant disruption of natural habitat during basin construction or well installation. Thus, wildlife, including threatened and endangered species, would not be affected significantly. In fact, the retention basin would provide a temporary watering opportunity for some wildlife. Wells placed within operations areas would not significantly affect biological resources because there is minimal habitat in these areas of the Plant. However, plant procedures to mitigate impacts to the

Texas horned lizard and species protected by the Migratory Bird Treaty Act and/or state regulations would be followed during implementation of this option. Deed restrictions on offsite use of perched groundwater would not affect biological resources because the perched groundwater does not provide habitat and is not used as a water supply in the vicinity of Pantex.

Corrective Measure Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA

Installation of the new retention basins, horizontal wells and piping, access roads and new monitoring wells under this option would temporarily disturb as much as 21.7 acres (8.8 ha) within and adjacent to the Plant. Of this total, 9.0 acres (3.6 ha) would be permanently disturbed. Because the new retention basins, wells, and appurtenances would be within developed areas or on nearby agricultural land, they would not be expected to impact biological resources significantly. In fact, the retention basins would provide a temporary watering opportunity for some wildlife. The overall impacts would be similar to those described for Option 2 although more agricultural land would be disturbed. However, plant procedures to mitigate impacts to the Texas horned lizard and species protected by the Migratory Bird Treaty Act and/or state regulations would be followed during implementation of this option. Deed restrictions on offsite use of perched groundwater would not affect biological resources because the perched groundwater does not provide habitat and is not used as a water supply in the vicinity of the Plant.

Corrective Measure Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA

Installation of the new retention basins, wells, and piping under this option would temporarily disturb 14.5 acres (5.9 ha) and would permanently disturb 5.9 acres (2.4 ha) on TTU property, private agricultural land to the east and southeast, and both agricultural and operations areas on Pantex property. Also, the retention basins would provide a temporary watering opportunity for some wildlife. Although more land would be disturbed than under Option 2, little or no natural habitat would be disturbed. Therefore, the overall impacts on biological resources would be similar to those described for Option 2. However, plant procedures to mitigate impacts to the Texas horned lizard and species protected by the Migratory Bird Treaty Act and/or state regulations would be followed during implementation of this option. Deed restrictions on offsite use of perched groundwater would not affect biological resources because the perched groundwater does not provide habitat and is not used as a water supply in the vicinity of Pantex.

Corrective Measure Option 5: Targeted Treatment with MNA

Installation of all the wells (including exploratory boreholes) and piping, and construction of the service building and retention basin under this option would temporarily disturb about 19.4 acres (7.9 ha), of which about 8.4 acres (3.4 ha) would be permanently disturbed. Because the boreholes, wells, new retention basin, and appurtenances would be within developed areas or on nearby agricultural land (On both Plant property and offsite on TTU and private land) no significant impacts on biological resources would be expected. In fact, the retention basins would provide a temporary watering opportunity for some wildlife. The overall impacts would be similar to those described for Option 2 although more agricultural land would be disturbed. However, plant procedures to mitigate impacts to the Texas horned lizard and species protected by the Migratory Bird Treaty Act and/or state regulations would be followed during implementation of this option. Deed restrictions on offsite use of perched groundwater would not affect biological resources because the perched groundwater does not provide habitat and is not used as a water supply in the vicinity of Pantex.

Corrective Measure Option 6: Enhanced Pump and Treat with Targeted In Situ Treatment and MNA

Construction activities for enhancing pump and treat capabilities would result in temporary disturbance of about 21.5 acres (8.7 ha) of land presently designated as operations and agricultural areas, of which about 9.3 acres (3.7 ha) would be permanently disturbed. Because this disturbance would be within developed areas on the Plant, or on nearby agricultural land, no significant impact on biological resources would be expected. In fact, the retention basins would provide a temporary watering opportunity for some wildlife. Overall impacts would be similar to those described for Corrective Measure Option 2, although more agricultural land would be disturbed. Deed restrictions on offsite use of perched groundwater would not affect biological resources because the perched groundwater does not provide habitat and is not used as a water supply in the vicinity of the Plant.

Upgraded PGPTS - Upgrading the PGPTS would involve additional land disturbance either adjacent to the existing PGPTS Building, or south or east of Playa 1, but not within the floodplain. An estimated 3.9 acres (2.1 ha) would be temporarily disturbed, of which about 1.2 acres (0.5 ha) would be permanently disturbed. Because all affected areas are either operational or agricultural lands, no significant impact on biological resources would be expected.

In situ Bioremediation - The use of *in situ* bioremediation would result in an additional increase in temporary disturbance of about 2 acres (0.8 ha) and a permanent disturbance of about 1 acre (0.4 ha) on TTU property south of the Plant. Since the disturbed area is presently used for agricultural purposes, no significant impact on biological resources would be expected.

Permeable Reactive Barrier - Under this component, the nine vertical extraction wells southeast of the Plant would be replaced by 40 injection wells and four monitoring wells. Addition of this enhancement would not result in a noticeable change in temporary or permanent disturbance of onsite lands, but would result in a 0.2-acre permanent disturbance to offsite agricultural land. No significant impact to biological resources would be expected.

4.2.6 Air Quality

The final rule for "Determining Conformity of General Federal Actions to State or Federal Implementation Plans" requires a conformity determination for certain-sized projects in non-attainment areas. USDOE/NNSA has performed a conformity review for the proposed options and determined that a conformity determination is not necessary to meet the requirements of the conformity rule because Pantex Plant is in an attainment area for all criteria pollutants (USDOE, 2000).

Corrective Measure Option 1: Monitored Natural Attenuation

The emissions of criteria pollutants from drilling the 10 new monitoring wells are estimated to be 0.5 ton or less of particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}), carbon monoxide, and sulfur dioxide; and 2 tons of nitrogen oxides. These emissions would occur over a period of about 4 months and be expected to have minor, temporary air quality impacts. During the 30 years during which the monitoring wells would be used, air pollutant emissions would be minimal and similar to those for the existing surveillance monitoring system and would result primarily from operation of small trucks.

Corrective Measure Option 2: Existing Pump and Treat with MNA

The emissions of criteria pollutants from well drilling and retention basin excavation are estimated to be 0.5 ton or less of PM_{10}, carbon monoxide and sulfur dioxide; and 3 tons of nitrogen oxides. These emissions would occur over a period of about 4 months and be expected to have minor air quality impacts. During the 30 years of operation of this system, air pollutant emissions related to this option would be similar to those for the existing treatment and surveillance monitoring systems.

Corrective Measure Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA

The emissions of criteria pollutants from well drilling and retention basin excavation are estimated to be 2 tons or less of PM_{10}, carbon monoxide and sulfur dioxide; and 7 tons of nitrogen oxides. These emissions would occur over a period of about 1 year and be expected to have minor air quality impacts. During the 30 years of operation of this system, air pollutant emissions related to this option would be similar to those for the existing treatment and surveillance monitoring systems.

Corrective Measure Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA

The emissions of criteria pollutants from well drilling and retention basin excavation are estimated to be 5 tons or less of $PM_{10,}$ sulfur dioxide, and carbon monoxide; and 23 tons of nitrogen oxides. These emissions would occur over a period of about 2 years and be expected to have minor air quality impacts. During the 30 years of operation of this system, air pollutant emissions related to this option would be similar to those for the existing treatment and surveillance monitoring systems.

Corrective Measure Option 5: Targeted Treatment with MNA

The emissions of criteria pollutants from drilling and retention basin excavation are estimated to be 6 tons or less of PM_{10} and sulfur dioxide, 16 tons of carbon monoxide, and 76 tons of nitrogen oxides. These emissions would occur over a little more than 2 years and be expected to have minor air quality impacts. During the 30 years of operation of this system, air pollutant emissions related to this option would be similar to those for the existing treatment and surveillance monitoring systems.

Corrective Measure Option 6: Enhanced Pump and Treat with Targeted In Situ Treatment and MNA

Emissions of criteria pollutants from activities to enhance pump and treat and the additional components are presented in Table 4-1. Emissions would be temporary, for about a year, and would result from drilling and pond excavation. As indicated in the table, emissions of criteria pollutants would be minimal. Therefore, only minimal air quality impacts would be expected.

Table 4-1. Estimated Criteria Pollutant Emissions for Enhancing Extraction and Additional Treatment Components

Criteria Pollutants (tons)	Enhancing Extraction	Upgrade PGPTS	In Situ Bioremediation	Permeable Reactive Barrier
PM_{10}	0.5	0.02	0.6	0.3
Sulfur Dioxide	0.5	0.01	0.5	0.3
Carbon Monoxide	1.6	0.04	1.7	1.1
Nitrogen Oxide	7.4	0.2	7.9	4.9

Key: PM_{10}, particulate matter with an aerodynamic diameter less than or equal to 10 microns; PGPTS, Perched Groundwater Pump and Treat System.

4.2.7 Visual Resources

Corrective Measure Option 1: Monitored Natural Attenuation

Under this option, 10 monitoring wells would be installed to augment the existing groundwater monitoring network. Five wells would be in agricultural or operations area of the Plant, and the other five would be on offsite agricultural land. Although activities associated with drilling the wells would be visible from a moderate distance, they would be of short duration. Once operational, the new wells would have a low profile and would not significantly alter visual resources either offsite or onsite. Deed restrictions on the offsite use of perched groundwater would not impact the visual environment.

Corrective Measure Option 2: Existing Pump and Treat with MNA

Under this option, 10 monitoring wells and an irrigation system would be installed, and a retention basin would be constructed. Five wells would be in agricultural or operations areas of the Plant, and the other five would be on offsite agricultural land. The retention basin and irrigation system would be on agricultural land in the eastern portion of the Plant. Figures 2-2 and 2-3 show the locations of the proposed monitoring wells, and retention basin and irrigation system, respectively. Although activities associated with drilling the wells would be visible from a moderate distance, they would be of short duration. Once operational, the new wells would have a low profile and would not significantly alter visual resources either offsite or onsite. The retention basin and irrigation systems would be visible from areas of the Plant and private land across FM 2373. Although the basin and irrigation systems would be constructed in an agricultural area, their appearance would be in keeping with the developed appearance of much of the Plant and adjacent farmland, and would not have more than a minor impact on the existing view. Deed restrictions on the offsite use of perched groundwater would not impact the visual environment.

Corrective Measure Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA

Under this option, six horizontal extraction wells and associated piping, 10 monitoring wells, and two irrigation subsystems would be installed (either onsite or both onsite and offsite) and two retention basins would be constructed. The monitoring wells, retention basin, and onsite irrigation system(s) would be as described for Option 2. The new extraction wells would be as shown in Figure 2-4. The second irrigation system could be on a portion of the private agricultural land across FM 2373 shown in Figure 2-3. Installing the wells and pipeline would cause minimal short-term impacts on the visual environment, but no significant long-term impacts. Once operational, the new wells would have a low profile and would not significantly alter visual resources either offsite or onsite. The retention basins and irrigation systems would be visible from areas of the Plant and private land across FM 2373. Although the basins and irrigation systems would be constructed in an agricultural area, their appearance would be in keeping with the developed appearance of much of the Plant and adjacent farmland, and would not have more than a minor impact on the existing view. Deed restrictions on the offsite use of perched groundwater would not impact the visual environment.

Corrective Measure Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA

Under this option, 87 vertical extraction wells and associated piping, 10 monitoring wells, six irrigation subsystems, and two retention basins would be constructed onsite. Wells and piping would be placed on agricultural and operations areas within the Plant, and agricultural land on TTU and private property to the east and southeast. The monitoring wells, retention basins and irrigation systems would be as described for Option 3. The new extraction wells would be as shown in Figure 2-5. Although activities associated with drilling the wells and piping would be visible from a moderate distance, they would be of short duration. Once operational, the new wells would have a low profile and would not significantly alter visual resources either offsite or onsite. The retention basins and irrigation systems would be visible from areas of the Plant and private land across FM 2373. Although the basins and irrigation systems would be constructed in an agricultural area, their appearance would be in keeping with the developed appearance of much of Pantex and adjacent farmland, and would not have more than a minor impact on the existing view. Deed restrictions on the offsite use of perched groundwater would not impact the visual environment.

Corrective Measure Option 5: Targeted Treatment with MNA

Under this option, 203 vertical injection wells, 178 vertical extraction wells, 10 monitoring wells, and an irrigation system would be installed, and a retention basin and small service building would be constructed. The wells would be in agricultural or operations area of the Plant, and on offsite agricultural land. The new injection and extraction wells would be as shown in Figures 2-6. The service building would be adjacent to the existing PGPTS Building. The retention basin and irrigation system would be on agricultural land in the eastern portion of Pantex. Figures 2-2 and 2-3 show the locations of the proposed monitoring wells; and retention basin, irrigation system, and PGPTS Building, respectively. Although activities associated with drilling the wells would be visible from a moderate distance, they would be completed in 2 to 3 years. Once operational, the new wells would have a low profile and would not significantly alter visual resources either offsite or onsite. The retention basin and irrigation systems would be visible from areas of the Plant and private land across FM 2373. Although the basin and irrigation systems would be constructed in an agricultural area, their appearance would be in keeping with the developed appearance of much of Pantex and adjacent farmland, and would not have more than a minor impact on the existing view. Deed restrictions on the offsite use of perched groundwater would not impact the visual environment.

Corrective Measure Option 6: Enhanced Pump and Treat with Targeted In Situ Treatment and MNA

The visual impacts of implementing activities to enhance pump and treat and any or all of the additional components would be minimal, and would be less than or essentially the same as those for Corrective Measure Option 3. If all components were implemented, two basins would be constructed near the eastern Plant boundary, and the total number of wells drilled (190) would be less than half the wells proposed under Corrective Measure Option 5.

As discussed for the previous options, activities associated with drilling the wells would be visible from a moderate distance, but would be temporary. Once operational, the new wells would have a low profile and would not significantly alter visual resources either offsite or onsite. The retention basins and irrigation systems would be visible from areas of the Plant and private land across FM 2373, but would be consistent with the Plant appearance and not have more than a minor impact on the existing view.

4.2.8 Cultural Resources

Corrective Measure Option 1: Monitored Natural Attenuation

As described in Section 3.2.8, the PA/CRMP describes development of a prehistoric archaeological site location model that indicates which areas in and around the Plant site might contain archaeological sites. The areas evaluated for this option would not be expected to contain archaeological resources; therefore, in accordance with the PA/CRMP do not require additional evaluation. However, if a previously undiscovered site were to be found while implementing this proposed option, it would be protected as though it were eligible for the *National Register of Historic Places* until a formal eligibility determination could be made. In addition, none of the proposed activities would occur near any historic buildings, and so would not affect any structures determined to be eligible for the *National Register of Historic Places*.

Corrective Measure Option 2: Existing Pump and Treat with MNA

As discussed for Option 1, there would be a low probability of encountering cultural resources and procedures are in place to protect these resources should such an event occur.

Corrective Measure Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA

As discussed for Option 1, there would be a low probability of encountering cultural resources and procedures are in place to protect these resources should such an event occur.

Corrective Measure Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA

As discussed for Option 1, there would be a low probability of encountering cultural resources and procedures are in place to protect these resources should such an event occur.

Corrective Measure Option 5: Targeted Treatment with MNA

As discussed for Option 1, there would be a low probability of encountering cultural resources and procedures are in place to protect these resources should such an event occur.

Corrective Measure Option 6: Enhanced Pump and Treat with Targeted In Situ Treatment and MNA

Because some extraction well drilling and conveyance line trenching activities associated with this option would occur within ¼ mile (400 meters) of a playa, there is a higher probably of impacting prehistoric archeological resources. The PA/CRMP describes the development of a site location model that indicates prehistoric archeological sites at Pantex, and probably throughout the Llano Estacado, would be within approximately ¼ mile of playas or their major drainages. In accordance with PA/CRMP archeological resource management requirements, a surface archeological survey would be conducted by Pantex cultural resource management staff prior to any ground disturbing activities. If any signs of archeological resources are uncovered during ground disturbing activities, work would stop and the Pantex cultural resource management staff would be notified.

4.2.9 Utility Infrastructure

Corrective Measure Option 1: Monitored Natural Attenuation

Utility resource requirements associated with implementation of this option would be associated with the installation of 10 new monitoring wells. Diesel fuel would be required to operate drill rigs and water would be required to support rotary drilling of the new monitoring wells. Approximately 6,800 gal (25,600 L) of diesel fuel and 65,000 gal (246,000 L) of potable water would be required for well installation. Liquid fuels would be brought to the site as needed from offsite sources and would not be a limiting resource. No electrical power would be expected to be required for well installation. Also, overall electrical power demands would be less under this option than under current conditions because the PGPTS would be turned off.

Corrective Measure Option 2: Existing Pump and Treat with MNA

Under this option, installation of the new monitoring wells would require approximately 6,800 gal (25,600 L) of diesel fuel and construction of the retention basin would require an additional 1,390 gal (5,280 L). Liquid fuels would be brought to the site as needed from offsite sources and would not be a limiting resource. Water required for dust control and soil compaction during excavation work is estimated to be 2,470 gal (9,340 L).

A new pumping system would be added to the existing PGPTS to convey treated water through new underground piping from the PGPTS Building to the retention basin and then to a new irrigation system. About 200 MWh of electrical power would be required annually to operate this system. Otherwise, while overall maintenance requirements for an aging system would increase and possibly lead to decreased efficiency in system operations, any change in operational demands would likely be negligible.

Corrective Measure Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA

Under Option 3, installation of the exploratory boreholes and monitoring and horizontal extraction wells would require approximately 19,000 gal (72,000 L) of diesel fuel, and construction of the new retention basins would require an additional 3,870 gal (14,600 L). Liquid fuels would be brought to the site as needed from offsite sources and would not be a limiting resource. Water required for dust control and soil compaction during excavation work is estimated to be 23,800 gal (90,200 L).

A new pumping system would be added to the existing PGPTS to convey treated water through new underground piping from the PGPTS Building to the two retention basins and then to the irrigation systems. About 250 MWh of electrical power would be required annually to operate this system. The six new horizontal extraction wells proposed under this option would be operated by electric-driven pumps, which would use about 200 MWh of electrical power annually. Operation of PGPTS at the higher flows projected under this option would likely result in a small increase in electrical power demand. Operation of the new systems would increase the overall site electrical requirements, but the impact would be negligible as more than 113,000 MWh is available for use at the Plant annually. Overall, implementation of this option would have a negligible impact on site utility infrastructure.

Corrective Measure Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA

Under Option 5, approximately 72,000 gal (273,000 L) of diesel fuel would be required for well installation and another 2,590 gal (9,820 L) would be required for construction of the two retention basins. Liquid fuels would be brought to the site as needed from offsite sources and would not be a limiting resource. Water required for dust control and soil compaction during excavation work is estimated to be 9,920 gal (37,600 L).

A new pumping system would be added to the existing PGPTS to convey treated water through new underground piping from the PGPTS Building to the two retention basins and then to the irrigation systems. About 145 MWh of electrical power would be required annually to operate this system. The 87 new extraction wells under this option would be operated by electric-driven pumps which would require about 95 MWh of electricity annually, and operation of PGPTS at the higher flows projected under this option would be likely to increase the electric load demand. Operation of the new systems would increase the site electrical load, but the impact would be negligible as more than 113,000 MWh is available at the Plant annually. Overall, implementation of this option would have a negligible impact on site utility infrastructure.

Corrective Measure Option 5: Targeted Treatment with MNA

Under Option 5, approximately 249,350 gal (945,000 L) of diesel fuel would be required for installation of the exploratory boreholes and wells. Construction of the retention basin would require an additional 1,390 gal (5,280 L) of diesel fuel. Liquid fuels would be brought to the site as needed from offsite sources; therefore, would not be a limiting resource. Water required for dust control and soil compaction during excavation work is estimated to be 2,470 gal (9,340 L). The impact of water demands on site water supply infrastructure would be minor due to the relatively long timeframe (2 years) over which water would be required to support drilling, well development, and facility construction.

A new pumping system would be added to the existing PGPTS to convey treated water through new underground piping from the PGPTS Building to the retention basin and then to a new irrigation system. About 80 MWh of electrical power would be required annually to operate this system. About 60 MWh of electrical power would be required annually to operate the new well system. Less groundwater would be extracted and treated under this option than is currently being treated, which should result in a net decrease in electrical power demand, even with the addition of the other systems and facilities to support this option. Overall, implementation of this option would have a negligible impact on site utility infrastructure.

Corrective Measure Option 6: Enhanced Pump and Treat with Targeted In Situ Treatment and MNA

Monitoring and extraction well installation activities for enhancing pump and treat would require approximately 13,900 gal (52,500 L) of diesel fuel, and construction of the retention basins would require an additional 3,870 gal (14,650 L). Liquid fuels would be brought to the site as needed from offsite sources and would not be a limiting resource. Water required for dust control and soil compaction during excavation work is estimated to be 23,800 gal (90,100 L).

A new pumping system would be added to the existing PGPTS to convey treated water through new underground piping from the PGPTS Building to two retention basins and then to new center-pivot irrigation systems. About 250 MWh of electrical power would be required annually to operate these systems. The 23 new extraction wells under this action would be operated by electric-driven pumps which would require about 160 MWh of electricity annually, and operation of the PGPTS at the higher flows projected under this action would be likely to increase the electric load demand. Operation of the new systems would increase the site electrical load, but the impact would be negligible as more than 113,000 MWh is available at the Plant annually. Overall, implementation of this action would have a negligible impact on site utility infrastructure.

Upgraded PGPTS - Construction of larger retention basins would require approximately 5,000 gal (18,900 L) of diesel fuel with the addition of this enhancement. However, liquid fuels would be brought to the site as needed from offsite sources and would not be a limiting resource. Water required for dust control and soil compaction during excavation work is estimated to be about 40,400 gal (153,000 L).

Higher groundwater extraction rates and expansion of the PGPTS to accommodate the higher extraction rates would increase electrical power demands. Extracted groundwater would be conveyed to two new retention basins, following treatment, and then to new irrigation systems. It is estimated that about 410 MWh of electrical power would be required annually to operate these systems with an additional 120 MWh of electricity annually required to operate extraction wells. Operation of the expanded PGPTS at the higher flows would increase the electric load demand, but the impact would be negligible as more than 113,000 MWh is available at the Plant annually. Overall, implementation of this additional component would have a negligible impact on site utility infrastructure.

In Situ Bioremediation - Injection and extraction well installation activities for this enhancement component would require approximately 26,200 gal (99,000 L) of diesel fuel. Liquid fuels would be brought to the site as needed from offsite sources and would not be a limiting resource.

Treated perched groundwater would be conveyed to two new retention basins and then to new irrigation systems. It is estimated that about 250 MWh of electrical power would be required annually to operate these systems with an additional 50 MWh of electricity required annually to operate the extraction wells. While treatment of slightly higher flows would be needed with this enhancement and would increase the electric load demand of the PGPTS, the impact would be negligible as more than 113,000 MWh is available at the Plant annually. Overall, implementation of this additional component would have a negligible impact on site utility infrastructure.

Permeable Reactive Barrier - Injection and monitoring well installation activities for this component would require approximately 16,200 gal (61,300 L) of diesel fuel. Liquid fuels would be brought to the site as needed from offsite sources and would not be a limiting resource.

Treated perched groundwater would still be conveyed to two new retention basins and then to new irrigation systems with this enhancement. It is estimated that about 250 MWh of electrical power would still be required annually to operate the system, since there would be a negligible annualized increase in electric power demand to support the one-time injection of amendments. Overall, implementation of this additional component would have a negligible impact on site utility infrastructure.

4.2.10 Noise

Corrective Measure Option 1: Monitored Natural Attenuation

Activities associated with this option would result in some increase in noise levels from drilling additional wells and performing maintenance activities. Equipment used would include drilling rigs and trucks. Some of these activities would occur offsite and could result in some temporary increase in noise levels near residences.

Corrective Measure Option 2: Existing Pump and Treat with MNA

Activities associated with this option would result in some increase in noise levels from drilling the new monitoring wells, constructing the retention basin, installing the irrigation system, and performing operation and maintenance activities. Equipment used would include drilling rigs, earth moving and compacting equipment, and trucks. Some of these activities would occur offsite and could result in some temporary increase in noise levels near residences during construction. Operational noise would occur over a 30-year period as a result of operating the pump and treat system and the irrigation systems. This operational noise would be limited to areas close to these systems, and would not present a significant impact.

Corrective Measure Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA

Activities associated with this option would result in some increase in noise levels from drilling the new monitoring and extraction wells, constructing the retention basins, installing the irrigation systems, and performing operation and maintenance activities. Equipment used would include drilling rigs, earth moving and compacting equipment, and trucks. Some of these activities would occur offsite and could result in some temporary increase in noise levels near residences during construction. Operational noise would occur over a 30-year period as a result of operating the pump and treat system and the irrigation systems. This operational noise would be limited to areas close to these systems, and would not present a significant impact.

Corrective Measure Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA

Activities associated with this option would result in some increase in noise levels from drilling the new monitoring and extraction wells, constructing the retention basins, installing the irrigation system, and performing operation and maintenance activities. Equipment used would include drilling rigs, earth moving and compacting equipment, and trucks. Some of these activities would occur offsite and could result in some temporary increase in noise levels near residences during construction. Operational noise would occur over a 30-year period as a result of operating the pump and treat system and the irrigation systems. This operational noise would be limited to areas close to these systems, and would not present a significant impact.

Corrective Measure Option 5: Targeted Treatment with MNA

Activities associated with this option would result in some increase in noise levels from drilling additional wells, constructing the retention basin, installing the irrigation system, and performing operation and maintenance activities. Equipment used would include drilling rigs, earth moving and compacting equipment, and trucks. Some of these activities would occur offsite and could result in some temporary increase in noise levels near residences during construction. Operational noise would occur over a 30-year period as a result of operating the pump and treat system and the irrigation systems, and injecting amendment into the injection wells. This operational noise would be limited to areas close to these systems and wells, and would not present a significant impact.

Corrective Measure Option 6: Enhanced Pump and Treat with Targeted In Situ Treatment and MNA

Activities associated with this option would result in some increase in noise levels from drilling wells, installing the irrigation systems, excavating the retention ponds, and performing operation and maintenance activities. Equipment used would include drilling rigs, excavators, and trucks. Some of these activities would occur offsite and could result in some temporary increase in noise levels near the offsite residences in the vicinity of some of the proposed wells. The duration of the noise would vary depending on which and how many components were implemented during construction. Operational noise would occur over a 30-year period as a result of operating the pump and treat system and the irrigation systems, and injecting amendment into the injection wells. This operational noise would be limited to areas close to these systems, and would not present a significant impact.

4.2.11 Human Health

Well installation involves drilling through saturated and unsaturated zones of the soil. The soil removed from the saturated zones would be expected to contain COCs from the perched groundwater, presenting a potential exposure risk for the workers involved in well installation. However, these risks would be mitigated by eliminating exposure through use of appropriate personal protective equipment such as protective clothing, safety shoes/boots, and gloves and through proper training about working in areas with potential exposure to hazardous substances and briefings about the specific locations and activities.

Accidents could occur during drilling and excavation. Drilling and excavation crews would be experienced in use of their equipment and in performing their activities. Construction accident risk would be small and would be mitigated by adherence to Pantex procedures, proper training, briefings regarding the potential hazards, and implementation of safe work practices. The estimated worker-hour efforts for implementing the various corrective measure options are presented in Table 4-2. Construction efforts would range from about 2,160 person-hours for Option 1, in which 10 monitoring wells would be installed to about 80,100 person-hours for Option 5, in which 10 monitoring wells, 203 extraction wells, 178 injection wells, with associated boreholes, the retention pond, irrigation system, and a small storage building would be constructed. Based on the USDOE-wide recordable incidence rate of 3.0 for occupational injuries and illnesses per 200,000 construction labor hours worked (USDOE, 2006), no occupational injuries would be expected for any corrective measure option except Option 5. For Corrective Measure Option 5, one injury could be expected. No worker fatalities would be expected under any of the proposed corrective measure options.

Table 4-2. Potential Human Health Effects of Implementing Proposed Corrective Measure Options

Corrective Measure Option	Total Construction Labor Hours	Risk (Number of Injuries)	Risk [a] (Fatalities)
Option 1: MNA	2,160	0 (0.032)	0
Option 2: Existing Pump and Treat with MNA	2,350	0 (0.035)	0
Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA	6,575	0 (0.099)	0
Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA	12,980	0 (0.195)	0
Option 5: Targeted Treatment with MNA	80,100	1 (1.20)	0
Option 6: Enhanced Pump and Treat with Targeted Treatment and MNA	21,470	0 (0.322)	0

There were no deaths in more than 125 million construction worker hours (USDOE, 2006)

4.2.12 Waste Management

Small amounts of non-hazardous waste such as paper, rags, and protective clothing, booties, and gloves would be generated during well installation and construction activities, and during the 30 years of remedial activities proposed under all corrective measure options. This would be handled along with similar wastes from Pantex operations. Ion exchange resins and GAC used in the treatment systems during the 30 years of system operation would be periodically replaced and the spent materials returned to their respective service vendors for recycle and reuse.

In 2004, Pantex operations generated 6,050 yd^3 (4,626 m^3) of non-hazardous waste (BWXT Pantex, 2005c). The amount of non-hazardous waste generated would vary by corrective measure option based on the size of each effort, but for all options would represent less than 2 percent of that generated at the Plant. As such, these wastes would not be expected to affect waste management operations or available disposal capacity, during either well installation activities or over the 30 years this system would operate.

Corrective Measure Option 1: Monitored Natural Attenuation

Under Option 1, approximately 1.2 yd^3 (0.9 m^3) of regulated drill cuttings, about five 55-gal (208-L) drums, would be generated as a result of monitoring well installation. In addition, about 48,000 gal (182,000 L) of drilling mud, equivalent to about twelve, 4,000 gal (15,140-L) sludge boxes, would also be generated. As described in Section 2.2.1, these wastes would be characterized for disposal at an appropriate offsite disposal facility and would have minimal impact on Pantex waste management infrastructure. Ion exchange resins and GAC removed from the treatment systems during system demobilization would be returned to their respective service vendors for recycle and reuse.

Corrective Measure Option 2: Existing Pump and Treat with MNA

Regulated waste volume generated under this option would be similar to that generated under Option 1 associated with monitoring well installation. Under Option 2, ion exchange resins and GAC used in the treatment systems during the 30 years of system operation would be periodically replaced and the spent materials returned to their respective service vendors for recycle and reuse.

Corrective Measure Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA

Installation of horizontal extraction and new monitoring wells under this option would generate approximately 3.9 yd^3 (3.0 m^3) of regulated drill cuttings, about fifteen 55-gal (208-L) drums, and about 48,000 gal (182,000 L) of drilling mud, equivalent to about twelve, 4,000 gal (15,140-L) sludge boxes. As described in Section 2.2.1, these wastes would be characterized for disposal at an appropriate offsite disposal facility and would have minimal impact on Pantex waste management infrastructure.

Corrective Measure Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA

New vertical extraction well and monitoring well installation activities under Option 5 would generate approximately 17 yd^3 (13 m^3) of regulated drill cuttings, about sixty-six 55-gal (208-L) drums, and about 48,000 gal (182,000 L) of drilling mud, equivalent to about twelve, 4,000 gal (15,140-L) sludge boxes. As described in Section 2.2.1, these wastes would be characterized for disposal at an appropriate offsite disposal facility and would have minimal impact on Pantex waste management infrastructure.

Corrective Measure Option 5: Targeted Treatment with MNA

Installation of boreholes, injection wells, extraction wells, and new monitoring wells under this option would generate approximately 112 yd^3 (85 m^3) of regulated drill cuttings, about four-hundred thirty-one 55-gal (208-L) drums, and about 48,000 gal (182,000 L) of drilling mud, equivalent to about twelve, 4,000 gal (15,140-L) sludge boxes. As described in Section 2.2.1, these wastes would be characterized for disposal at an appropriate offsite disposal facility and would have minimal impact on Pantex waste management infrastructure.

Corrective Measure Option 6: Enhanced Pump and Treat with Targeted In Situ Treatment and MNA

Small amounts of non-hazardous waste such as paper; rags; and protective clothing, booties, and gloves would be generated during well installation and construction activities, and during the 30 years of remedial activities proposed to enhance pump and treat capabilities and implement additional components. This waste would be handled along with similar wastes from Pantex operations. Ion exchange resins and GAC used in the treatment systems during the 30 years of system operation would be periodically replaced and the spent materials returned to their respective service vendors for recycle and reuse.

Borehole and well installation activities to enhance pump and treat capabilities would generate approximately 8.1 yd^3 (6.2 m^3) of regulated drill cuttings, about thirty-one 55-gal (208-L) drums, and about 48,000 gal (182,000 L) of drilling mud, equivalent to about twelve, 4,000 gal (15,140-L) sludge boxes. As described in Section 2.2.1, these wastes would be characterized for disposal at an appropriate offsite disposal facility and would have minimal impact on Pantex waste management infrastructure.

Upgraded PGPTS - No incremental regulated waste generation would be expected under this component.

In situ Bioremediation - Under this component, an additional 9.1 yd^3 (6.9 m^3) of regulated drill cuttings, about 35 55-gal (208-L) drums, would be generated from extraction and injection well installation. This waste would be characterized and managed as previously described (see Section 2.2.1).

Permeable Reactive Barrier - Monitoring and injection well installation activities for the PRB would generate an additional 7.6 yd^3 (5.8 m^3) of regulated drill cuttings, about twenty-nine 55-gal (208-L) drums. Small amounts of non-hazardous waste such as paper; rags; and protective clothing, booties, and gloves would be generated during well installation and construction activities, and during the 30 years of remedial activities proposed under this option and its additional components. This waste would be handled along with similar wastes from the Plant operations. Ion exchange resins and GAC used in the treatment systems during the 30 years of system operation would be periodically replaced and the spent materials returned to their respective service vendors for recycle and reuse.

4.2.13 Transportation

Transportation of any commodity involves a risk to both transportation crewmembers and members of the public. This risk results directly from transportation related accidents. The transportation of certain materials, such as hazardous waste or special regulated waste, can pose an additional risk due to the unique nature of the material being transported. Corrective measure options include transportation of regulated wastes to an offsite waste management facility. This waste would be transported by licensed commercial waste transporters. Drill cuttings and drilling mud would be transported in vehicles designed to contain the material and preclude releases to the environment during transport. Therefore, transporting this material would not pose any hazards to either the transportation workers or the general public during their incident free operation. Only during a severe accident, would there be the possibility that the wastes could be dispersed and released to the environment. Because the expected concentrations of regulated materials would be relatively small, and the potential for accidents is small (see Table 4-3), the likelihood of any hazards to the public from a release would also be small.

Therefore, transportation risks would be limited to those resulting from traffic accidents leading to traffic fatalities. For the calculation of accident risks, vehicle accident and fatality rates are taken from data provided in *State Level Accident Rates of Surface Freight Transportation: A Reexamination*, ANL/ESD/TM 150 (Saricks and Tompkins, 1999). For offsite transportation, a single accident rate and accident fatality rate were used for all segments of the transport routes (i.e., local roads or highway). To envelope the transportation accident risks, the values selected are the highest probabilities for accident rates within the State of Texas. Accident rates are generically defined as the number of accident involvements (or fatalities) in a given year per unit of travel in that same year. Therefore, the rate is a fractional value, with accident involvement count as the numerator of the fraction and vehicular activity (total travel distance in truck kilometers) as its denominator. The accident and fatality rates used in this analysis are: 7.36 accident and 0.832 fatalities per 10 million truck-kilometers traveled. Onsite accidents were assumed to result in no fatalities due to the short distance between locations and controlled travel requirements within the site. For assessment purposes, the total number of expected accidents or fatalities is calculated by multiplying the total shipment distance for a specific waste by the accident or fatality rate.

Table 4-3 summarizes the potential transportation impacts of implementing each of the proposed corrective measure options. These impacts are associated with transport of sludge boxes and containerized drill cuttings to offsite disposal facilities, as described under Section 4.2.12. For the purposes of analysis, it was assumed that drummed drill cuttings and drilling mud would be transported to a landfill at Deer Park, Texas, which is a round trip distance of approximately 1,300 mi (2.092 km). Under all options, sludge boxes would be transported to an offsite disposal facility requiring 12 offsite trips. Under Options 4 through 6, additional trips would be required to transport drummed drill cuttings that could not otherwise be managed with other similar wastes generated at the Plant. As shown in Table 4-3, offsite waste transportation would not be expected to result in any traffic accidents or fatalities.

Table 4-3. Potential Transportation Impacts of Implementing Proposed Corrective Measure Options

Corrective Measure Option	Number of offsite trips	Round trip distance traveled (mi [km])	Estimated number of traffic accidents	Estimated number of accident fatalities
Option 1: MNA	12	15,700 (25,300)	0.012	0.0013
Option 2: Existing Pump and Treat with MNA	12	15,800 (25,400)	0.012	0.0013
Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA	13	16,900 (27,200)	0.012	0.0014
Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA	13	16,900 (27,200)	0.012	0.0014
Option 5: Targeted Treatment with MNA	18	23,400 (37,700)	0.017	0.0019
Option 6: Enhanced Pump and Treat with Targeted In Situ Treatment and MNA	15	19,500 (31,400)	0.014	0.0016

4.2.14 Socioeconomics

Corrective Measure Option 1: Monitored Natural Attenuation

Under this corrective measure option, six contract workers would be hired for about 3 months to complete the activities associated with this option. These six workers would not be expected to have a significant impact on socioeconomic conditions in the ROI. However, there is the potential for socioeconomic impacts under this option because deed restrictions on use of the perched groundwater and drilling would be imposed on land overlying the current extent of the impacted groundwater and expected extent of future migration. These restrictions could reduce the value of affected properties, which could result in property owners not realizing the full economic benefit of their property, such as when selling the property.

Corrective Measure Option 2: Existing Pump and Treat with MNA

Under this corrective measure option, six contract workers would be hired for about 3 months and another 12 contract workers for about 1 to 2 weeks to complete the activities associated with this option. These six workers would not be expected to have a significant impact on socioeconomic conditions in the ROI. However, there is the potential for socioeconomic impacts under this option because deed restrictions on use of the perched groundwater and drilling would be imposed on land overlying the current extent of the impacted groundwater and expected extent of future migration. These restrictions could reduce the value of affected properties, which could result in property owners not realizing the full economic benefit of their property, such as when selling the property.

Corrective Measure Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA

Under this corrective measure option, nine contract workers would be hired for about 4 months and another 12 contract workers for about 3 weeks to complete the activities associated with this option. These workers would not be expected to have any impact on socioeconomic conditions in the ROI. However, there is the potential for socioeconomic impacts under this option because deed restrictions on use of the perched groundwater and drilling would be imposed on land overlying the current extent of the impacted groundwater and expected extent of future migration. These restrictions could reduce the value of affected properties, which could result in property owners not realizing the full economic benefit of their property, such as when selling the property.

Corrective Measure Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA

Under this corrective measure option, six contract workers would be hired for about 10 months and another 12 contract workers for about 2 weeks to complete the activities associated with this option. These workers would not be expected to have a significant impact on socioeconomic conditions in the ROI. However, there is a potential for socioeconomic impacts under this option because deed restrictions on use of the perched groundwater and drilling would be imposed on land overlying the current extent of the impacted groundwater and expected extent of future migration. In addition, a large number of extraction wells would be on a portion of private agricultural land adjacent to Pantex. These deed restrictions and wells could reduce the value of affected properties, which could result in property owners not realizing the full economic benefit of their property, such as when selling the property.

Corrective Measure Option 5: Targeted Treatment with MNA

Under this corrective measure option, 42 contract workers would be hired for about 2 years and another 12 contract workers for about 1 to 2 weeks to complete the activities associated with this option. If these workers and their families are new to the area, some nearby small communities could experiences small, temporary impacts to services. These workers would not be expected to have a significant impact on socioeconomic conditions in the ROI. However, there is also a potential for socioeconomic impacts under this option because deed restrictions on use of perched groundwater and drilling would be imposed on land overlying the current extent of the impacted groundwater and expected extent of future migration. A large number of injection and extraction wells could be on a portion of private agricultural land adjacent to Pantex. These deed restrictions and wells could reduce the value of affected properties, which could result in property owners not realizing the full economic benefit of their property, such as when selling the property.

Corrective Measure Option 6: Enhanced Pump and Treat with Targeted In Situ Treatment and MNA

If enhancing pump and treat and all additional components were implemented, as many as 75 contract workers could be onsite at one time, but only for about 2 months. Up to 51 contract workers could be present for about 1 year. If these workers and their families are new to the area, some nearby small communities could experiences small, temporary impacts to services. These workers would not be expected to have a significant impact on socioeconomic conditions in the ROI. However, there is also a potential for socioeconomic impacts under this option because deed restrictions on use of the perched groundwater and drilling would be imposed on land overlying the current extent of the impacted perched groundwater and predicted extent of future migration. These restrictions could reduce the value of affected properties, which could result in property owners not realizing the full economic benefit of their property, such as when selling the property.

4.2.15 Environmental Justice

Corrective Measure Option 1: Monitored Natural Attenuation

Deed restrictions on use of the perched groundwater would be imposed on land overlying the current extent of the impacted groundwater and expected extent of future migration. These deed restrictions would be imposed based on the location of impacted or potentially impacted perched groundwater, and are independent of the ownership of the overlying land. In addition, wells that would be on private property adjacent to the Plant site would monitor groundwater, and their placement would be based entirely on the current or projected future location of the potentially affected groundwater. As presented in Section 3.2.15, twelve people are reported to live on the offsite property considered for placement of the proposed monitoring wells and deed restrictions. None of these 12 residents is either minority or has a Hispanic heritage. Also, based on the 2000 Census information, none of the residents are believed live on incomes that are below the poverty line. Therefore, there would be no disproportionately high or adverse effects on low-income or minority populations associated with this option.

Corrective Measure Option 2: Existing Pump and Treat with MNA

As discussed for Option 1, there would be no disproportionately high or adverse effects on low-income or minority populations associated with this option.

Corrective Measure Option 3: Enhanced Pump and Treat Using Horizontal Wells with MNA

Deed restrictions on use of the perched groundwater would be imposed on land overlying the current extent of the impacted groundwater and expected extent of future migration. These deed restrictions would be imposed based on the location of impacted or potentially impacted perched groundwater, and are independent of the ownership of the overlying land. In addition, wells that would be on private property adjacent to the Plant site would monitor or extract impacted perched groundwater for treatment, and their placement would be based entirely on the current or projected future location of the potentially affected groundwater. As presented in Section 3.2.15, twelve people are reported to live on the offsite property considered for placement of the proposed monitoring and extractions wells, irrigation systems, and deed restrictions. None of these 12 residents is either minority or has a Hispanic heritage. Also, based on the 2000 Census information, none of the residents are believed live on incomes that are below the poverty line. Therefore, there would be no disproportionately high or adverse effects on low-income or minority populations associated with this option.

Corrective Measure Option 4: Enhanced Pump and Treat Using Vertical Wells with MNA

Deed restrictions on use of the perched groundwater would be imposed on land overlying the current extent of the impacted groundwater and expected extent of future migration. These deed restrictions would be imposed based on the location of contaminated or potentially contaminated perched groundwater, and are independent of the ownership of the overlying land. In addition, wells that would be on private property adjacent to the Plant site would monitor or extract impacted perched groundwater for treatment, and their placement would be based entirely on the current or projected future location of the potentially affected groundwater. As presented in Section 3.2.15, twelve people are reported to live on the offsite property considered for placement of the proposed monitoring, extraction and injection wells, irrigation systems, and deed restrictions. None of these 12 residents is either minority or has a Hispanic heritage. Also, based on the 2000 Census information, none of the residents are believed live on incomes that are below the poverty line. Therefore, there would be no disproportionately high or adverse effects on low-income or minority populations associated with this option.

Corrective Measure Option 5: Targeted Treatment with MNA

Deed restrictions on use of the perched groundwater would be imposed on land overlying the current extent of the impacted groundwater and expected extent of future migration. These deed restrictions would be imposed based on the location of impacted or potentially impacted perched groundwater, and are independent of the ownership of the overlying land. In addition, wells that would be on private property adjacent to the Plant site would monitor, inject chemicals to treat, or extract impacted perched groundwater, and their placement would be based entirely on the current or projected future location of the potentially affected groundwater. As presented in Section 3.2.15, twelve people are reported to live on the offsite property considered for placement of the proposed monitoring, extraction and injection wells, irrigation systems, and deed restrictions. None of these 12 residents is either minority or has a Hispanic heritage. Also, based on the 2000 Census information, none of the residents are believed live on incomes that are below the poverty line. Therefore, there would be no disproportionately high or adverse effects on low-income or minority populations associated with this option.

Corrective Measure Option 6: Enhanced Pump and Treat with Targeted In Situ Treatment and MNA

Deed restrictions on use of the perched groundwater would be imposed on land overlying the current extent of the impacted perched groundwater and predicted extent of future migration. These deed restrictions would be imposed based on the location of impacted or potentially impacted perched groundwater, and are independent of the ownership of the overlying land. In addition, wells that would be on private property adjacent to the Plant site would monitor, inject chemicals to treat, or extract impacted perched groundwater, and their placement would be based entirely on the current or projected future location of the potentially affected groundwater. As presented in Section 3.2.15, twelve people are reported to live on the offsite property considered for placement of the proposed monitoring, extraction and injection wells, irrigation systems, and deed restrictions. None of these 12 residents is either minority or has a Hispanic heritage. Also, based on the 2000 Census information, none of the residents are believed live on incomes that are below the poverty line. Therefore, there would be no disproportionately high or adverse effects on low-income or minority populations associated with this option, including all enhancements to pump and treat components.

4.3 COMPARISON OF SUMMARIZED IMPACTS FOR EACH CORRECTIVE MEASURE OPTION

Table 4-4, presented below, summarizes the impacts of each corrective measure option for ease of comparison. Detailed analysis of the impacts for each category is presented in the preceding sections.

Table 4-4. Summary of Impacts for Each Corrective Measure Option

Impact Category	Option 1: MNA	Option 2: Existing Pump and Treat with MNA	Option 3: Enhanced Pump and Treat using Horizontal Wells with MNA	Option 4: Enhance Pump and Treat using Vertical Wells with MNA	Option 5: Targeted Treatment with MNA	Option 6: Enhanced Pump and Treat with Targeted *In Situ* Treatment and MNA[b]
Land Use (Acres) [Temporary/ Permanent]	2.2/1.1	6.5/2.7	21.7/8.7	14.5/5.9	19.4/8.4	27.8/11.7
Geology and Soils (Resources in cubic yards)	327	2030	6519	5272	4544	9794
Water Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Floodplains and Wetlands	None	None	None	None	None	1 acre disturbed
Biological Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Air Quality	<0.5 Tons PM_{10}, CO, SO_2 2 Tons NOX	<0.5 Tons PM_{10}, CO, SO_2 3 Tons NOX	2 Tons PM_{10}, CO, SO_2 2 Tons NOX	5 Tons PM_{10}, CO, SO_2 23 Tons NOX	6 Tons PM_{10}/SO_2 16 Tons CO 76 Tons NOX	2.7 Tons PM_{10}/SO_2 4.4 Tons CO 21 Tons NOX
Visual Resources	Minor	Minor	Minor	Minor	Minor	Minor

Table 4-4. Summary of Impacts for Each Corrective Measure Option (continued)

Impact Category	Option 1: MNA	Option 2: Existing Pump and Treat with MNA	Option 3: Enhanced Pump and Treat using Horizontal Wells with MNA	Option 4: Enhance Pump and Treat using Vertical Wells with MNA	Option 5: Targeted Treatment with MNA	Option 6: Enhanced Pump and Treat with Targeted *In Situ* Treatment and MNA[b]
Cultural Resources	None Anticipated	None Anticipated	None Anticipated	None Anticipated	None Anticipated	None Anticipated
Utility Infrastructure	Insignificant (Demand = 6,800 gal diesel & 65,000 gal water)	Insignificant (Demand = 8,190 gal diesel & 67,470 gal water)	Insignificant (Demand = 22,870 gal diesel & 88,800 gal water)	Insignificant (Demand = 74,590 gal diesel & 74,920 gal water)	Insignificant (Demand = 250,740 gal diesel & 67,470 gal water)	Insignificant (Demand = 60,170 gal diesel & 88,800 gal water)
Noise	Temporary Increase	Temporary Increase	Temporary Increase	Temporary Increase	Temporary Increase	Temporary Increase
Human Health (Injury Rate)	0.032	0.035	0.099	0.195	1.20	0.322
Waste Management	1.2 yd^3 drill cuttings 48,000 gal drilling mud	1.2 yd^3 drill cuttings 48,000 gal drilling mud	3.9 yd^3 drill cuttings 48,000 gal drilling mud	17 yd^3 drill cuttings 48,000 gal drilling mud	112 yd^3 drill cuttings 48,000 gal drilling mud	17.8 yd^3 drill cuttings 48,000 gal drilling mud
Transportation (Estimated no. accidents/no. fatalities)	0.012 / 0.0013	0.012 / 0.0013	0.012 / 0.0014	0.012 / 0.0014	0.017 / 0.0019	0.014 / 0.0016
Socioeconomics (Work Duration/ No. Workers)	3 months/ 6 workers	3 months/ 6 workers	4 months/ 9 workers	10 months/ 6 workers	24 months/ 42 workers	12 months/ 51 workers
Environmental Justice	None	None	None	None	None	None

4.4 ANALYSIS OF INTENTIONAL DESTRUCTIVE ACTS RELATED TO PROPOSED ACTION

The DOE's Office of NEPA Policy and Compliance recently issued a directive that all environmental impact statements and EAs under preparation for proposed projects explicitly consider intentional destructive acts and the potential environmental consequences of such acts.

The proposed action in this EA would augment the existing PGPTS with additional monitoring and extraction wells. The existing PGPTS is an electrical system, using no outside fuel source. No chemicals are used in the system and all wells, existing and future, would be equipped with locks. The High Explosives (HE) are adsorbed to the Granular Activated Carbon (GAC). Once the effectiveness of the GAC diminishes, the vendor removes the used GAC and takes it to an offsite facility for regeneration. The used GAC is replaced with regenerated GAC. The particles of HE are not of sufficient quantity or density to detonate.

In the SWEIS, DOE analyzed consequences to the public from several risk-significant accidents at Pantex. Although it is not possible to predict whether intentional destructive acts would occur or what the nature of the events would be, DOE considers these accident scenarios to be bounding of any intentional destructive acts that could occur regarding the implementation of corrective measures for perched aquifer groundwater underlying and in the vicinity of the Pantex Plant.

5.0 CUMULATIVE IMPACTS

Cumulative impacts are defined in CEQ regulations at 40 CFR S1508.7 as the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

With the exception of Corrective Measure Option 1, MNA, corrective measure options evaluated under the Proposed Action are intended to actively improve contaminant removal, reduce the length of time to complete cleanup, and prevent the perched COCs from reaching the Ogallala Aquifer.

There are potential long-term socioeconomic and offsite land use impacts associated with the corrective measure options: deed restrictions on offsite use of perched groundwater in the vicinity of the impacted groundwater and installation of monitoring and extraction wells on private property could reduce access to water resources, and thereby the value of affected properties. Also, workers and their families, if new to the area, could cause small, temporary impacts to the services provided by some nearby communities. There would also be an increase in electrical use over the long term. None of these involves more than a small change with respect to the current situation, and, therefore, would not affect availability of offsite resources.

Any of the Corrective Measure Options would not be expected to affect other activities or projects occurring at or near the Pantex, other than as discussed for deed restrictions. Potential impacts are localized and mostly temporary. The proposed activities would occupy offsite private land for at least 30 years, mostly by wells on private agricultural land. However, only the small amount of space occupied by the wellheads would be unavailable for use. The additional irrigation applied to agricultural land currently under or available for cultivation would not be expected to affect offsite land use. Different crops (but consistent with those grown in the area), higher yield, and more land in service could result from the additional irrigation, but these potential impacts would be consistent with land use and local agricultural practices.

Air emissions would be temporary, for at most 2 years, localized, and minor, and, therefore, would not contribute to degradation of the regional or local air quality. No hazardous waste and only small amounts of non-hazardous waste are expected to be generated, so the proposed activities would not be expected to impact available disposal capacity.

Proposed Option 6 would have the potential to impact the 100-year floodplain at Playa 1. These potential impacts would include both short and long-term impacts. Short-term impacts would occur from drilling and trenching activities, and potential maintenance on existing utilities within the 100-year floodplain. All short-term impacts would be minimized by grading and vegetating the disturbed area. Long-term impacts would occur from permanent structures, well housings, and access roads, displacing floodplain elevation and area. The long-term impacts would increase floodplain elevation less than 0.5 inches, and would have no negative impacts on lives or property. The loss of floodplain area would amount to 0.75 acres, impacting 0.35 percent of the total area, see Appendix B for details.

All proposed options except MNA would provide some level of groundwater treatment and monitoring for 30 years. These corrective measure options have been proposed to remove COCs from the perched groundwater with the intent of preventing future contamination of the Ogallala Aquifer, a primary source of drinking and irrigation water for most of the High Plains. Although there would be some minor short-term adverse impacts, the long-term and cumulative impact of any of these options would be an overall improvement in the protection of the Ogallala Aquifer.

THIS PAGE INTENTIONALLY LEFT BLANK

6.0 AGENCIES CONSULTED

Environmental Remediation is a continuing plant activity under the SWEIS. A *Biological Assessment of the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components* (BPX/MHC, 1996) addressing threatened and endangered species was prepared for the SWEIS and reviewed by the United States Fish and Wildlife Service (USFWS). In a letter dated May 9, 1996, USFWS concurred with the Biological Assessment that continuing plant activities are not likely to affect any federally listed threatened or endangered species adversely. The analysis in this EA reaches the same conclusion for the proposed corrective measure options. No further consultation with USFWS regarding threatened and endangered species is planned.

In accordance with the Pantex PA/CRMP, no consultation with the State Historic Preservation Office is required. If any new cultural resource sites were to be identified, they would be protected and evaluated in accordance with the PA/CRMP.

THIS PAGE INTENTIONALLY LEFT BLANK

7.0 REFERENCES

Battelle Memorial Institute, 1999. *Draft Final Risk Assessment, Firing Site 5, U. S. Department of Energy, Pantex Plant, Amarillo, Texas*, February.

BPX/MHC, 1996. *Biological Assessment of the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components, Battelle Pantex and Mason & Hanger-Silas Mason Co., Inc., Amarillo, Texas,* April

BWXT Pantex, 2002. *Environmental Information Document - In Support of the National Environmental Policy Act Documents for Pantex Plant, Amarillo, Texas*, January.

BWXT Pantex, 2003. *2002 Site Environmental Report for Pantex Plant,* DOE/AL/66620-2003, Amarillo, Texas, August.

BWXT Pantex, 2004a. *Final Pantex Plant Radiological Investigation Report for the U.S. Department of Energy/National Nuclear Security Administration, Pantex Plant, Amarillo, Texas*, BWXT Pantex, L.L.C., Texas, January.

BWXT Pantex/SAIC, 2004b. *Subsurface Modeling Report for the U.S. Department of Energy/National Nuclear Security Administration Pantex Plant*, Amarillo, Texas, BWXT Pantex, L.L.C., Texas, September.

BWXT Pantex, 2005. *2004 Site Environmental Report for Pantex Plant,* DOE/AL/66620-2004, Amarillo, Texas, September.

BWXT Pantex/SAIC, 2005. *Site-Wide Ecological Risk Assessment Report for the Pantex Plant for the U.S. Department of Energy/National Nuclear Security Administration, Pantex Plant, Amarillo, Texas*, February

BWXT Pantex/SAIC, 2006a. *Site-Wide Corrective Measures Study for the Pantex Plant for the U.S. Department of Energy/National Nuclear Security Administration, Pantex Plant, Amarillo, Texas*, June.

BWXT Pantex/SAIC, 2006b. *Baseline Human Health Risk Assessment for Zones 10, 11, and 12, Fire Training Area, Ditches and Playas, Independent Sites, and Groundwater. Completed for USDOE/National Nuclear Security Administration, Pantex Site Office, Amarillo, Texas*, March.

BWXT Pantex/SAIC, 2006c. *Burning Ground Human Health Risk Assessment Report for the U.S. Department of Energy/National Nuclear Security Administration, Pantex Plant, Amarillo, Texas*, May.

BWXT Pantex/SAIC, 2006d. *Nuclear Weapon Accident Residue Storage Unit Human Health Risk Assessment Report* (2006d). Completed for USDOE/National Nuclear Security Administration, Pantex Site Office, Amarillo, Texas, July.

Caldwell, 2006. *"Pantex Plant Groundwater Pump and Treat System Operation and Maintenance Services," Monthly Operations & Maintenance Report,* DRAFT, Caldwell Engineering, Inc., July.

DOC, 2005a. *Census 2000 Summary File 3 – Sample Data, DP-3, Profile of Selected Economic Characteristics,* United States Department of Commerce, Washington, DC.

DOC, 2005b. *Census 2000 Demographic Profile Highlights, American Fact Finder, Summary Files 1 and 3,* United States Department of Commerce, Washington, DC.

DOC, 2005c. *Census 2000 Summary File 1, P.1 – Total Population, P.3 – Race, P.4-Hispanic or Latino and not Hispanic or Latino by Race,* United States Department of Commerce, Washington, DC.

DOC, 2005d. *Census 2000 Summary File 3, P.53, Median Household Income in 1999 (Dollars) and P.89 Poverty Status in 1999 by Household Type*, United States Department of Commerce, Washington, DC.

Environmental Laboratory, 1987. Corps of Engineers *Wetlands Delineation Manual, Technical Report & 87-1, U.S. Army Engineer Waterways Experiment Station,* Vicksburg, Mississippi, January.

EPA, 1989. *RCRA Facility Assessment, Visual Site Inspection Report, U.S. DOE Pantex Plant, Amarillo, Texas,* EPA I.D. Number TX4890110527, A.T. Kearney, Inc., and The Earth Technology Corporation, California, March.

Nester, B., 2005a. Fax from B. Nester, BWXT Pantex, Amarillo, Texas, to C. Groome, Science Applications International Corporation, Germantown, Maryland. *Electricity Consumption at Pantex*. September 7.

Nester, B., 2005b. Letter from B. Nester, BWXT Pantex, Amarillo, Texas, to C. Groome, Science Applications International Corporation, Germantown, Maryland. *Employment Information*. August 8.

Ray, 2005. *Wildlife Database*, Comments from J. D. Ray, Wildlife Biologist, BWXT Pantex, Amarillo, Texas, to M. Layton, BWXT Pantex, Amarillo, Texas. September 9.

Saricks, C. L. and Tompkins, M. M 1999. *State-Level Accident Rates of Surface Freight Transportation: A Reexamination.* ANL/ESD/TM-150. Argonne National Laboratory, Argonne, Illinois. April 1999.

TNRCC, 1998. *Texas Natural Resources Conservation Commission Consistency Document for Implementation of the Existing Risk Reduction Rule.* July 23.

TPWD, 2005. *State of Texas Threatened and Endangered Species Listings*, Texas Parks and Wildlife Department, July 21. Online: http://www.tpwd.state.tx.us/huntwild/wild/species/endang/index.phtml

USACE, 1995. *Floodplain Delineation Report, Pantex Plant, Amarillo, Texas.* U.S. Army Corps of Engineers, Tulsa District, January 1995.

USDOE, 1996. *Final Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components*. DOE/EIS-0225, United States Department of Energy, Washington, DC. Online: http://www.eh.doe/gov/nepa/eis/eis0225/eis0225_toc.html

USDOE, 1998. *Surplus Plutonium Disposition Draft Environmental Impact Statement.* DOE/EIS-0238-D, United States Department of Energy, Washington, DC. July.

USDOE, 2000. *Clean Air Act General Conformity Requirements and the National Environmental Policy Act Process,* United States Department of Energy, Environmental, Safety, and Health, Office of NEPA Policy and Assistance, April. Online: http://www.eh.doe.gov/nepa/tools/guidance/caaguidance.pdf

USDOE, 2003. *Supplement Analysis for the Final Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components*, DOE/EIS-0225/SA-03, United States Department of Energy, Amarillo, Texas, February. Online: http://www.eh.doe.gov/nepa/sa/EIS0225-SA-03/TOCindex.html

USDOE, 2006. *DOE and Contractor Injury and Illness Experience by Operation Type by Year by Quarter – 1999 through 2004, 4th Quarter*, United States Department of Energy, Office of Environment, Safety, and Health, February 28. Online: http://eh.doe.gov/cairs/cairs/dataqtr/q044b.html.

USDOE/NNSA, 2003. *Environmental Management Performance Management Plan for Accelerating Cleanup of the Pantex Plant*, U.S. Department of Energy/National Nuclear Security Administration, Amarillo, Texas, July. [AL-PX-SW-003904]. Online: http://www.pantex.com/environment/PantexAccelercleanupvs10c.pdf

USDOE/NNSA, 2004. *Pantex Plant Cultural Resource Management Plan*, U.S. Department of Energy/National Nuclear Security Administration, Amarillo, Texas, April.

USDOE/NNSA and BWXT Pantex, 2005. *Final Environmental Assessment for the Proposed Gas Main and Distribution System Upgrade*, DOE/EA-1533, U.S. Department of Energy/National Nuclear Security Administration Amarillo, Texas, August.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A

VEGETATION AND WILDLIFE SPECIES

TABLE OF CONTENTS

A. VEGETATION AND WILDLIFE SPECIES A-1
A.1 Vegetation A-1
A.1.1 Native Vegetation A-1
A.1.2 Managed Vegetation A-1
A.2 WILDLIFE A-2
A.2.1 Upland Game A-2
A.2.2 Invertebrates A-2
A.2.3 Amphibians A-3
A.2.4 Reptiles A-3
A.2.5 Birds A-3
A.2.6 Mammals A-8
A.3 WETLAND RESOURCES A-10
A.3.1 Playa Biota A-11
A.4 References A-17

LIST OF TABLES

Table A-1. Pantex Plant All-Time Bird List A-4
Table A-2. Mammals Observed at Pantex Plant Since 1994 .... A-9
Table A-3. Wetland Species Observed in the Pantex Playas A-11
Table A-4. Amphibians Associated with Playas A-14
Table A-5. Amphibians Encountered during 1994 Herpetofaunal Survey of Pantex Plant A-15
Table A-6. Reptiles Associated with Playas A-15

A. VEGETATION AND WILDLIFE SPECIES

A.1 VEGETATION

Vegetation at Pantex is categorized as native and managed. Native vegetation consists of plant species that are common under normal, natural conditions. Managed vegetation refers to species encouraged to thrive through created conditions for cropland, rangeland, or land under the Conservation Reserve Program (CRP).

A.1.1 Native Vegetation

The native vegetation on the Pullman soils of the uplands in Carson and Potter counties is shortgrass prairie.[1,2] Dominant species in native shortgrass prairie are blue grama and buffalograss. Other typical species, although at a much lower abundance, on rangeland in good condition are sideoats grama (*Bouteloua curtipendula*), western wheatgrass (*Agropyron smithii*), vine-mesquite (*Panicum obtusum*), silver bluestem (*Bothriochloa laguroides*; previously called *Bothriochloa saccharoides*[3] or *Andropogon saccharoides*[1]), and tobosa (*Hilaria mutica*).[1] Although virgin native prairie in Carson or Potter counties is rare, some of the rangeland in good condition can be considered to have native vegetation. The native blue grama-buffalograss plant community, identified in Texas Parks and Wildlife publications as series level G4S3[4], often includes mesquite, sideoats grama, sand dropseed (*Sporobolus cryptandrus*), and species of threeawn (*Aristida* spp.).

A.1.2 Managed Vegetation

The managed vegetation of the Pullman soils on the uplands in Carson and Potter counties includes cropland, rangeland, and CRP land.[1,2] Essentially all of the vegetation on the Pantex Plant site (approximately 60 square km [approximately 25 square miles]) has been managed to some degree based on the results of the floristic surveys.[5,6] Vegetation surveys for species diversity and primary productivity conducted in 1997 resulted in the identification of four additional species.[7] These new species were ground plum (*Astragalus crassicarpus*), common curly mesquite (*Hilaria berlangeri*), hairy vetch (*Vicia villosa*) and Texas millet (*Brachaiaria texana*).

Dominant vegetation on the grazed uplands around Playa 1 is buffalograss, blue grama, and prickly pear (*Opuntia macrorhiza*). One of the rarest plant species on the Pantex Plant, the cactus called green pataya (*Echinocereus v. viridiflorus*) occurs on the uplands at Playa 1. The plantings south of Playa 1 include crabapple (*Malus sylvestris*), Tartarian honeysuckle (*Lonicera tatarica*), and Russian olive (*Eleagnus angustifolia*). Dominant vegetation on the uplands around Playa 2 is buffalograss, blue grama, and silver bluestem. Dominant vegetation on the uplands around Playa 3 is buffalograss and blue grama. Dominant vegetation on the uplands around Playa 4 (see Figure 2.5 for location) is buffalograss and blue grama. Dominant vegetation on the uplands around Playa 5 is buffalograss. The Old Bunker Area (Zone 3) on Texas Tech property has extensive areas of bare, unvegetated ground, but the dominant vegetation in the remaining area is buffalograss and silver bluestem.

The Texas Tech Research Farm headquarter's landscaping consists of lawns and trees, primarily Siberian elm (*Ulmus pumila*), with a few individuals of black locust (*Robinia pseudoacacia*), and mimosa tree (*Albizia julibrissin*). The Small Arms field in the southeastern corner of the Pantex Plant site, which was apparently cultivated at one time, is CRP land that has a very limited species composition dominated by old world bluestem *(Bothriochloa ischaemum)*. A few rare individuals of yankeeweed (*Eupatorium compositifolium*) were found on the Small Arms field. An area of WWII brick production buildings, now in ruins, in what used to be called Zone 9, includes plantings of a Siberian elm and cottonwood (*Populus deltoides*). This otherwise treeless area is covered with a weedy growth of kochia (*Kochia scoparia*), *Amaranthus* spp., and lesser amounts of buffalograss. Dominant vegetation on the uplands around Pantex Lake is buffalograss and blue grama.

A.2 WILDLIFE

Wildlife observed at Pantex is described according to category, as follows.

A.2.1 Upland Game

Playas, as islands of habitat in this extensively cultivated region, are extremely important to the abundance of upland game species, such as the ring-necked pheasant (*Phasianus colchicus*), eastern cottontail (*Sylvilagus floridanus*), and desert cottontail (*Sylvilagus audubonii*). Fall and winter pheasant densities have been reported to be much higher in upland areas with nearby playas.[2,8,9] Small remnant populations of pronghorn (*Antilocapra americana*) exist on the Southern High Plains (SHP) and use playas, as do white-tailed deer (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionus*).

Information on game densities and distribution, reported by sector, within 80-km (50-mile) and 8-km (5-mile) radii of Pantex Plant have been assembled,[10] based on information supplied by the Texas Parks and Wildlife Department. Information is reported for mule deer, white-tailed deer, pronghorn, northern bobwhite (*Colinus virginianus*), ring-necked pheasant, lesser prairie chicken (*Tympanuchus pallidicinctus*), Rio Grande wild turkey (*Meleagris gallopavo intermedia*), and scaled quail (*Callipepla squamata*). Populations and distribution of these species are dependent on availability of appropriate habitat, as well as weather and rainfall, and, as such, are variable. Although there are no surveys of the Pantex Plant site specifically for individual upland game species, observations of game species on the Pantex Plant or the immediate vicinity of the plant are recorded in four sources: (1) an ecological investigation of the Pantex Plant,[11] (2) a checklist of birds for the Pantex Plant area based on surveys in the vicinity of the Pantex Plant site, including annual breeding bird surveys adjacent to the site,[12] (3) a preliminary resident and migratory animal survey of Pantex Plant,[13] and (4) a natural resource database maintained at the Plant. Common upland game birds known to inhabit the Plant include the ring-necked pheasant, northern bobwhite, scaled quail, and mourning dove (*Zenaida macroura*). Desert cottontail and eastern cottontail are frequently observed on Pantex Plant. Historic information on surveys of desert cottontail and black-tailed jackrabbits (*Lepus californicus*) is available as part of the Grassland Biome series of ecological reports from the U.S. International Biological Program.[14] Mule and white-tailed deer are occasionally seen on the Plant.

A.2.2 Invertebrates

Information on terrestrial invertebrates of the Pantex Plant site is extremely limited. A list of 17 families of invertebrates were recorded by Rylander.[13] A study comparing macro-invertebrate abundance and densities among habitat types on the Plant was contracted and initiated in 2000, and was completed in July 2003 (Sissom 2003).[15] A total of 867 species were collected from Pantex during the growing seasons of 2000 and 2001. These included two state records, and the second report for the State of another species. Species richness varied by habitat types, and was consistently superior in the native grassland adjacent to Playa 2, as well as the edges of Playa 2 and Pantex Lake. The sites with the lowest species richness were a revegetated midgrass site on the east side of Playa 1, a mowed median site by 12-N-5A, and a sorghum field.

A study of invertebrate food webs in the playas was conducted during the spring and summer of 1995. A list of aquatic invertebrates associated with the playas is given in Section A.3.1.2. Historic information on insect taxa collected on Pantex Plant is available as part of the Grassland Biome series of ecological reports from the U.S. International Biological Program.[16,17,18]

A.2.3 Amphibians

Because wetlands are required for all or part of the amphibian life cycle, amphibians are discussed in Section A.3.1.3. A survey of herpetofauna on the Plant was conducted in August 1994 and the following three species of toads were found on the uplands: western spadefoot toad (*Scaphiopus hammondi*), great plains toad (*Bufo cognatus*), and Woodhouse's toad (*Bufo woodhouseii*).[19] The Couch's spadefoot toad (*Scaphiopus couchii*), plains spadefoot toad (*Scaphiopus bombifrons*), New Mexico spadefoot toad (*Scaphiopus multiplicatus*), spotted chorus frog (*Pseudacris clarkii*), great plains toad, and barred tiger salamander (*Ambystoma tigrinum mavortium*) were found in uplands in 2000 and 2001by contractors studying biodiversity associated with prairie dog colonies on the Plant.[20] Additional surveys for amphibians are underway through a contract with West Texas A&M University, 2003-2006.

A.2.4 Reptiles

Most habitat for reptiles at the Plant is in close proximity to playa lakes. Reptiles associated with seasonally- and temporarily-dry playas (dry period of an ephemeral playa) of the SHP have been reported.[2] The species found in dry playas, which could also be found on the uplands, include the Texas horned lizard (*Phrynosoma cornutum*), checkered garter snake (*Thamnophis m. marcianus*), western ribbon snake (*Thamnophis p. proximus*), prairie rattlesnake (*Crotalus v. viridis*), plains hognose snake (*Heterodon n. nasicus*), and bullsnake (*Pituophis melanoleucas sayi*). The bullsnake, checkered garter snake, desert kingsnake (*Lampropeltis getulus splendida*), eastern yellow-bellied racer (*Coluber constrictor flaviventris*), great plains skink (*Eumeces obsoletus*), northern earless lizard (*Holbrookia m. maculata*), plains hognose snake, prairie rattlesnake, Texas horned lizard, and western coachwhip (*Masticophis flagellum testaceus*) have been recorded on the Plant by various studies,[13,19,20,21] and/or in a reptile database maintained at the Plant. Additional surveys for reptiles are underway though a contract with West Texas A&M University, 2003-2006.

A.2.5 Birds

A checklist of the birds of the area surrounding the Pantex Plant indicates that 236 species of birds may be seen during one or more seasons of the year.[12] The checklist indicates frequency of occurrence during summer, fall, winter, and spring. The 236 species reported in the checklist compare to over 366 species that have been recorded in the Texas Panhandle. Many of the birds in the checklist are primarily associated with playas[2] and include migratory waterfowl, which are discussed in Section A.3.1 on playa biota. The all-time bird list for Pantex Plant is comprised of 180 species (Table A-1).

Avian roadside surveys were conducted during July 10-13 and September 8-10, 1992, along roads that bisected areas of plant operation and vegetated areas.[11] Of the 39 species of birds observed on Pantex Plant, six are grassland birds, eight are raptors, four are gamebirds (excluding exotics), one is a shorebird, six are wetland species, three are exotics (excluding gamebirds), four are waterfowl, and seven other types are passerines. A detailed study of birds (numbers present) using uplands in the Texas Panhandle was conducted on reduced and conventional tillage agricultural fields southeast of Panhandle, Texas,[22] which are less than 16 km (10 miles) from Pantex Plant. Reduced tillage is the practice of leaving crop residue standing after harvest, while conventional tillage involves plowing after harvest. Eastern meadowlarks (*Sturnella magna*), longspurs (*Calcarius* spp.), and savannah sparrows (*Passerculus sandwichensis*) were more common in reduced versus conventionally tilled fields in at least one season. Horned larks (*Eremophila alpestris*) were more abundant in plowed fields in all seasons except summer, probably because they prefer areas with sparse vegetation. All of the species reported in this study are typical of the agricultural uplands around Pantex Plant, except that the meadowlark on Pantex Plant is, primarily, the western meadowlark.[12,13] Historic information on bird species observed at the Pantex Plant is available as part of the Grassland Biome series of ecological reports from the U.S. International Biological Program.[23,24] The data include bird species density and standing crop biomass on grazed and ungrazed plots and seasonal roadside counts.

Table A-1. Pantex Plant All-Time Bird List*

Common Name	Scientific Name
Sharp-shinned hawk	*Accipiter striatus*
Spotted sandpiper	*Actitis macularia*
Red-winged blackbird	*Agelaius phoeniceus*
Cassin's sparrow	*Aimophila cassinii*
Rufous-crowned sparrow	*Aimophila ruficeps*
Wood duck	*Aix sponsa*
Sharp-tailed sparrow	*Ammodramus caudacutus*
Grasshopper sparrow	*Ammodramus savannarum*
Northern pintail	*Anas acuta*
American wigeon	*Anas americana*
Northern shoveler	*Anas clypeata*
American green-winged teal	*Anas crecca*
Cinnamon teal	*Anas cyanoptera*
Blue-winged teal	*Anas discors*
Mallard	*Anas platyrhyncos*
Gadwall	*Anas strepera*
Scrub jay	*Aphelocoma coerulescens*
American pipit	*Anthus rubescens*
Golden eagle	*Aquila chrysaetos*
Black-chinned hummingbird	*Archilochus alexandri*
Great blue heron	*Ardea herodias*
Short-eared owl	*Asio flammeus*
Long-eared owl	*Asio otus*
Burrowing owl	*Athene cunicularia hypugea*
Lesser scaup	*Aythya affinis*
Redhead	*Aythya americana*
Canvasback	*Aythya valisineria*
Upland sandpiper	*Bartramia longicauda*
Cedar waxwing	*Bombycilla cedrorum*
American bittern	*Botaurus lentiginosus*

Table A-1. Pantex Plant All-Time Bird List (continued)

Common Name	Scientific Name
Canada goose	*Branta canadensis*
Bufflehead	*Bucephala albeola*
Common goldeneye	*Bucephala clangula*
Great horned owl	*Bubo virginianus*
Cattle egret	*Bubulcus ibis*
Red-tailed hawk	*Buteo jamaicensis*
Rough-legged hawk	*Buteo lagopus*
Ferruginous hawk	*Buteo regalis*
Swainson's hawk	*Buteo swainsoni*
Lark bunting	*Calamospiza melanocorys*
Western sandpiper	*Calidris mauri*
Least sandpiper	*Calidris minutilla*
Semipalmated sandpiper	*Calidris pusilla*
Scaled quail	*Callipepla squamata*
Cardinal	*Cardinalis cardinalis*
Pine siskin	*Carduelis pinus*
American goldfinch	*Carduelis tristis*
House finch	*Carpodacus mexicanus*
Great egret	*Casmerodius albus*
Turkey vulture	*Cathartes aura*
Hermit thrush	*Catharus guttatus*
Willet	*Catoptrophorus semipalmatus*
Mountain plover	*Charadrius montanus*
Semipalmated plover	*Charadrius semipalmatus*
Killdeer	*Charadrius vociferus*
Lesser snow goose	*Chen caerulescens*
Ross’ goose	*Chen rossii*
Black tern	*Chlidonias niger*
Lark sparrow	*Chondestes grammacus*
Common nighthawk	*Chordeiles minor*
Northern harrier	*Circus cyaneus*
Yellow-billed cuckoo	*Coccyzus americanus*
Northern flicker	*Colaptes auratus*
Northern bobwhite	*Colinus virginianus*
Feral pigeon	*Columba livia*
Olive-sided flycatcher	*Contopus borealis*
Eastern wood-pewee	*Contopus virens*
American crow	*Corvus brachyrhynchos*
Common raven	*Corvus corax*

Table A-1. Pantex Plant All-Time Bird List (continued)

Common Name	Scientific Name
Chihuahuan raven	*Corvus cryptoleucus*
Blue jay	*Cyanocitta cristata*
Tundra swan	*Cygnus columbianus*
Fulvus whistling duck	*Dendrocygna bicolor*
Yellow-rumped warbler	*Dendroica coronata*
Black-throated green warbler	*Dendroica virens*
Yellow warbler	*Dendroica petechia*
Little blue heron	*Egretta caerulea*
Snowy egret	*Egretta thula*
Empidonax flycatcher	*Empidonax s pp.*
Horned lark	*Eremophila alpestris*
Rusty blackbird	*Euphagus carolinus*
Brewer's blackbird	*Euphagus cyanocephalus*
Merlin	*Falco columbarius*
Prairie falcon	*Falco mexicanus*
Peregrine falcon	*Falco peregrinus*
American kestrel	*Falco sparverius*
American coot	*Fulica americana*
Common snipe	*Gallinago gallinago*
Common moorhen	*Gallinula chloropus*
Greater roadrunner	*Geococcyx californianus*
Common yellowthroat	*Geothlypis trichas*
Sandhill crane	*Grus canadensis*
Whooping crane	*Grus americana*
Blue grosbeak	*Guiraca caerulea*
Bald eagle	*Haliaeetus leucocephalus*
Black-necked stilt	*Himantopus mexicanus*
Cliff swallow	*Hirundo pyrrhonota*
Barn swallow	*Hirundo rustica*
Scott’s oriole	*Icterus parisorum*
Dark-eyed junco	*Junco hyemalis*
Northern shrike	*Lanius excubitor*
Logger-headed shrike	*Lanius ludovicianus*
Ring-billed gull	*Larus delawarensis*
Franklin's gull	*Larus pipixcan*
Black rail	*Laterallus jamaicensis*
Long-billed dowitcher	*Limnodromus scolopaceus*
Marbled godwit	*Limosa fedoa*
Hooded merganser	*Lophodytes cucullatus*
Gold-fronted woodpecker	*Melanerpes aurifons*

Table A-1. Pantex Plant All-Time Bird List (continued)

Common Name	Scientific Name
Red-headed woodpecker	*Melanerpes erythrocephalus*
Lincoln sparrow	*Melospiza lincolnii*
Song sparrow	*Melospiza melodia*
Common merganser	*Mergus merganser*
Northern mockingbird	*Mimus polyglottos*
Brown-headed cowbird	*Molothrus ater*
Ash-throated flycatcher	*Myiarchus cinerascens*
Long-billed curlew	*Numenius americanus*
Black-crowned night heron	*Nycticorax nycticorax*
MacGillivray’s warbler	*Oporonis tolmiei*
Ruddy duck	*Oxyura jamaicensis*
Osprey	*Pandion haliaetus*
House sparrow	*Passer domesticus*
Savannah sparrow	*Passerculus sandwichensis*
Painted bunting	*Passerina ciris*
American white pelican	*Pelecanus erythrorhynchos*
Wilson's phalarope	*Phalaropus tricolor*
Ring-necked pheasant	*Phasianus colchicus*
Ladder-backed woodpecker	*Picoides scalaris*
Spotted towhee	*Pipilo erythrophthalmus*
White-faced ibis	*Plegadis chihi*
Eared grebe	*Podiceps nigricollis*
Pied-billed grebe	*Podilymbus podiceps*
Blue-gray gnatcatcher	*Polioptila nigriceps*
Vesper sparrow	*Pooecetes grammacus*
Sora	*Porzana carolina*
Great-tailed grackle	*Quiscalus mexicanus*
Common grackle	*Quiscalus quiscula*
Virginia rail	*Rallus limicola*
American avocet	*Recurvirostra americana*
Ruby-crowned kinglet	*Regulus calendula*
Bank swallow	*Riparia riparia*
Rock wren	*Salpinctes obsoletus*
Say's phoebe	*Sayornis saya*
Ovenbird	*Seiurus aurocapillus*
Mountain bluebird	*Sialia currucoides*
Dickcissel	*Spiza americana*
Brewer’s sparrow	*Spizella breweri*
Chipping sparrow	*Spizella passerina*
Clay-colored sparrow	*Spizella pallida*
Field sparrow	*Spizella pusilla*

Table A-1. Pantex Plant All-Time Bird List (continued)

Common Name	Scientific Name
Northern rough-winged swallow	*Stelgidopteryx serripennis*
Eastern meadowlark	*Sturnella magna*
Western meadowlark	*Sturnella neglecta*
European starling	*Sturnus vulgaris*
Tree swallow	*Tachycineta bicolor*
Bewick's wren	*Thryomanes bewickii*
Curve-billed thrasher	*Toxostoma curvirostre*
Brown thrasher	*Toxostoma rufun*
Lesser yellowlegs	*Tringa flavipes*
Greater yellowlegs	*Tringa melanoleuca*
Solitary sandpiper	*Tringa solitaria*
American robin	*Turdus migratorius*
Scissor-tailed flycatcher	*Tyrannus forficatus*
Eastern kingbird	*Tyrannus tyrannus*
Western kingbird	*Tyrannus verticalis*
Cassin's kingbird	*Tyrannus vociferans*
House wren	*Troglodytes aedon*
Barn owl	*Tyto alba*
Orange-crowned warbler	*Vermivora celata*
Nashville warbler	*Vermivora ruficapilla*
Warbling vireo	*Vireo gulvus*
Wilson's warbler	*Wilsonia pusilla*
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*
White-winged dove	*Zenaida asiatica*
Mourning dove	*Zenaida macroura*
White-throated sparrow	*Zonotrichia albicollis*
White-crowned sparrow	*Zonotrichia leucophrys*

[*]Covers records through December 2001.

A.2.6 Mammals

The presence and/or the abundance of mammals on the SHP is often closely tied to playas.[2] Both the game species discussed earlier and nongame mammals are frequently found near or closely associated with playas due to the increased abundance and diversity of food and cover, as well as the periodic availability of surface water. Thirty-seven species of mammals have been reported as associated with playas of the SHP;[9,25,26,27,28,29] these species are also found on upland sites in the SHP. Due to the increased abundance and species diversity of small mammals typically associated with playas compared to upland areas not close to playas,[2,9] small mammals are discussed in Section A.3.1.6 on playa biota.

Spotlight surveys were conducted in 2005 for large and medium-sized mammals on Pantex Plant. These were targeted for the swift fox (*Vulpes velox*), at that time a federal candidate species; however, observations were limited to badgers (*Taxidea taxus*), black-tailed jackrabbits, cottontails, coyotes and striped skunks. Possible sightings of the swift fox in the spring of 1996[30] are now considered unsubstantiated. No evidence of swift fox exists, and the closest known populations are in Dallam and Sherman Counties of the extreme northwest Panhandle. Mammals sighted on the Plant since 1994 are included in Table A-2.

Additional historic information on mammalian species observed or trapped on Pantex Plant is available as part of the Grassland Biome series of ecological reports from the U.S. International Biological Program.[14,25,26] These data include mammal density estimates from snap-trap and live-trap grid plots and lagomorph (black-tailed jackrabbit and cottontail) surveys.

Table A-2. Mammals Observed at Pantex Plant Since 1994

Common Name	Status	Status or Observations
Family Soricidae: Shrews		
Least Shrew	*Cryptotis parva*	
Family Talpidae: Moles		
Eastern Mole	*Scalopus aquaticus*	
Family Chiroptera: Bats		
Cave Myotis	*Myotis velifer*	
Eastern Red Bat	*Lasiurus borealis*	
Brazilian Free-tailed Bat	*Tadarida brasiliensis*	
Family Leporidae: Hares and Rabbits		
Desert Cottontail	*Sylvilagus audubonii*	Frequently observed.
Eastern Cottontail	*Sylvilagus floridanus*	
Black-tailed Jackrabbit	*Lepus californicus*	
Eastern Fox Squirrel	*Sciurus niger*	
Family Sciuridae: Squirrels and Allies		
Thirteen-lined Ground Squirrel	*Spermophilus tridecemlineaus*	
Black-tailed Prairie Dog	*Cynomys ludovicianus*	Common in Prairie Dog town.
Family Geomyidae: Pocket Gophers		
Yellow-faced Pocket Gopher	*Cratogeomys castanops*	
Family Heteromyidae: Pocket Mice, Kangaroo Rats		
Plains Pocket Mouse	*Perognathus flavescens*	
Silky Pocket Mouse	*Perognathus flavus*	
Merriam's Pocket Mouse	*Perognathus merriami*	
Rock Pocket Mouse	*Chaetodipus (Perognathus) intermedius*	
Hispid Pocket Mouse	*Chaetodipus (Perognathus) hispidus*	
Family Muridae: Mice and Rats		
Plains Harvest Mouse	*Reithrodontomys montanus*	
Western Harvest Mouse	*Reithrodontomys megalotis*	
White-footed Mouse	*Peromyscus leucopus*	
Deer Mouse	*Peromyscus maniculatus*	
Northern Pygmy Mouse	*Baiomys taylori*	
Northern Grasshopper Mouse	*Onychomys leucogaster*	
Hispid Cotton Rat	*Sigmodon hispidus*	
Southern Plains Wood Rat	*Neotoma micropus*	
House Mouse	*Mus musculus*	
Prairie Vole	*Microtus ochrogaster*	
Family Erethizontidae: Porcupines		
Porcupine	*Erethizon dorsatum*	

TABLE A-2. Mammals Observed at Pantex Plant Since 1994 (continued)

Common Name	Status	Status or Observations
Family Canidae: Dogs and Allies		
Coyote	*Canis latrans*	
Red Fox	*Vulpes vulpes*	
Gray Fox	*Urocyon cineroargenteus*	
Family Procyonidae: Raccoons and Allies		
Raccoon	*Procyon lotor*	
Family Mustelidae: Skunks, Weasels and Allies		
Badger	*Taxidea taxus*	
Spotted Skunk	*Spilogale spp.*	Unconfirmed, as to western or eastern
Striped Skunk	*Mephitis mephitis*	
Family Cervidae: Deer		
Mule Deer	*Odocoileus hemionus*	
White-tailed Deer	*Odocoileus virginianus*	

Source: References 13, 31, 32, 33, 34, 35, 36.

A.3 WETLAND RESOURCES

The wetland resources of the SHP are primarily associated with the playas. Haukos and Smith[2] reviewed and summarized much of the available data on the ecological characteristics of playas. The information in their study was used for the following sections describing playa ecology and biota.

Playas are the most significant topographical expression and surface hydrological features on the SHP. Also, they provide some of the most important wildlife habitat on the SHP.[2] Playas provide approximately 160,000 hectares (395,000 acres) of wetland habitat in the SHP; however, this represents only 2 percent of the total landscape. Carson County has 535 playas occupying 1,932 hectares (4,774 acres) out of the total 239,300 hectares (591,310 acres)[2] which represents less than one percent of the total landscape.

Playas are often seasonally and temporarily inundated. The hydroperiods for these wetlands are unpredictable due to rapidly changing weather patterns.[2] Generally, playas fill only with runoff from precipitation and in some cases irrigation. Most playas are dry during one or more periods each year; usually late winter, early spring, and late summer. Also, it is not uncommon for a playa to have several wet-dry cycles during a growing season, and a playa may be wet or dry at any time during the year. In most cases, playas are not in direct contact with the water table. In the vicinity of Pantex Plant, the perched water table is located at depths of approximately 75 to 100 m (250 to 300 ft); therefore, none of the playas on or near Pantex Plant intercepts the water table.

There are three playas on the main Pantex Plant (Playas 1, 2, and 3), two on the land leased from TTU as a buffer zone (Playas 4 and 5), and one (Pantex Lake) on a separate parcel of DOE-owned property.

Although the playas are ephemeral water bodies, often having water only seasonally, many playas meet the soils, hydrology, and vegetation criteria for classification as wetlands. Previous studies evaluated Playas 1, 2, 3, 4, and Pantex Lake and found that they met the soils, vegetation, and hydrology criteria for wetlands.[11,37,38] Subsequent to this determination, wetland delineations were completed on these playas using the three-criteria method from the 1987 Corps of Engineers Manual.[83] These on-the-ground determinations will be used for ecosystem management at each of the five playas. An official determination of Playa 5 has not yet been made.

A.3.1 Playa Biota

Playas are important sources of biodiversity in the High Plains.[2,40] Bolen et al.[41] theorized that the periods of flooding and drying should enhance nutrient cycling and biological productivity; however, the basic ecological functions of playas have yet to be fully studied.[11]

A.3.1.1 Vegetation

Vegetation associated with playa wetlands can vary greatly from playa to playa, even in the same geographic area, making generalizations and comparisons difficult. Flora also can vary for a given playa from year to year depending on rainfall. A few studies have attempted to identify plant species associated with playas. Haukos and Smith[11] compiled existing information on playa vegetation, reporting 346 species.

Table A-3. Wetland Species Observed in the Pantex Playas

Species		Wetland Indicator Category	Location Observed					
			Playa 1	Playa 2	Playa 3	Playa 4	Playa 5	Pantex Lake
Polygonum lapathifolium L.	Willow smartweed	FACW -	X	X		X		
Polygonum pennsylvanicum L.	Pennsylvania smartweed	FACW -	X	X		X		X
Polygonum ramosissimum Michx.	Bushy knotweed	FACW		X		X	X	
Potamogeton cf. *nodosus* Poir.	American pondweed	OBL	X					
Ranunculus sceleratus L.	Celery-leaved crowfoot	OBL	X			X		
Rorippa sinuata (T&G) Hitchc.	Yellow-cress	FACW -	X					X
Rumex altissimus Wood	Tall dock	FACW					X	X
Rumex obtusifolius L.	Bitter dock	FACW -	X		X		X	
Sagittaria lLongiloba Engelm.	Arrowhead	OBL	X			X		
Sagittaria montevidensis Chem. & Schlcht.	Arrowhead	OBL	X					
Salix gooddingii Ball	Southwestern black willow	FACW	X					
Scirpus validus Vahl	Tule or Soft-stem bulrush	OBL	X				X	X
Typha angustifolia L.	Narrow-leaved cattail	OBL	X	X		X	X	X
Veronica peregrina L. var. x.(H.B.K.)St. John & War.	Purslane speedwell	OBL	X					X

OBL = Obligate Wetland Species (probability of species occurring in wetlands > 99%).
FACW = Facultative Wetland Species (probability of species occurring in wetlands is 67-99%).
FACW - = Same as FACW but toward lower end of probability range (i.e., less likely to occur in wetlands).
Sources: References 41 and 42

Unlike most other North American freshwater wetlands that are dominated by perennial plant species, vegetative communities in playas generally are dominated by annuals, which are better able to exploit the unpredictable environment of the playas.[43] Also, many species exhibit differential emergence patterns during a growing season (ecotypes), which assures continued existence in such unpredictable environments.

The flora in playas is adapted to respond rapidly to the natural wet-dry cycles.[44] This ephemeral nature of playas tends to enhance floristic diversity and, as the environment changes over the course of the growing season, so does community structure. In flooded playas, submergent and emergent aquatic species usually dominate. Moist soil conditions with no standing water allow germination of communities dominated by annuals capable of producing large quantities of seeds.

Dry playas typically are characterized by species more commonly found in surrounding uplands, including native prairie species.[2] Often, the seasonal development of vegetative communities is exclusively from underlying seed banks (viable seed in and on the soil). Therefore, the vegetation present in a naturally functioning playa at any point is directly related to the moisture regime of previous years and the moisture regime of the current growing season, which regulates germination and seedling growth. The playa seed banks also serve as reservoirs for species of the original native prairies.[45]

The flora of the Pantex Plant playas has been investigated in several studies. Cushing[11] investigated the flora of Playas 1, 2, and 3, and Pantex Lake to determine if the playas met the hydrophytic vegetation criteria for being considered a wetland. A wetlands delineation of Playas 1, 2, 3, 4, and Pantex Lake was completed in June 1995.[46] Johnston and Williams[5] performed a floristic survey of Pantex Plant in 1993 for the purpose of identifying as many species on the Plant site as possible and conducted a follow-up study in 1995.[6] Each of the playas was observed on three occasions during both the 1993 and 1995 growing seasons. Wetland species identified in the floristic survey[5] are listed in Table A-3. The variability in playa flora is readily apparent, since none of the wetland species recorded[5] is found in all playas.

Playa 1 was formerly the only playa that typically had standing water throughout the year. The playa had been modified on one side to increase its depth and received continuous permitted wastewater discharges from the Pantex Plant Wastewater Treatment Facility (WWTF). At present, the irrigation project has diverted treated wastewater from the playa and has caused it to have dry periods. This, in turn, affects the flora found in the playa. Playa 1 is approximately 32 hectares (79.3 acres) and may receive treated wastewater effluent and storm water runoff from several small drainages. Only one drain to the playa is associated with Plant operations (Outfall 001); the others receive only storm water runoff from both agricultural and operational areas. There are three drains along the southern perimeter of Playa 1. All three include storm water from both agricultural and operational areas. Storm Water Outfalls 01 and 02 are located upstream in one of these drains, which originate from some of the operational areas of Zone 12. The western edge of Playa 1 receives storm water runoff from the Zone 4 area. Two drainages transport storm water runoff from agricultural areas that are north of the playa.

A.3.1.2 Invertebrates

Playa invertebrates respond immediately to the filling of playas with water.[2] Playa invertebrates are characterized by physiological adaptations that allow them to complete their life cycle in a short period of time, sometimes days, in response to erratic moisture regimes. MacKay[48] reported that mosquito larvae

(*Aedes* spp.) completed their lifecycle within 8 days after a playa filled, and that the clam shrimp (*Eulimnadia texana*) reached highest densities within 6 days.

Factors affecting invertebrate diversity in playas include the length of time since the playa filled with water, type of flora present, and distance from the nearest source of permanent water.[2] MacKay[48] reported that development of macroinvertebrate communities was independent of biotic interactions during the initial flooding of playas; however, if a playa floods more than once during the growing season, biotic interaction among taxa did influence community structure. Modifications that deepen playas may decrease the species diversity; however, persistent water in modified playas can result in more complex communities due to temporal succession of macroinvertebrate species.[2]

Sublette and Sublette[49] described 62 species of higher macroinvertebrate taxa; Merickel and Wangberg[50] found 60 species of macroinvertebrates; and Haukos and Smith[43] listed seven orders and 33 families of insects collected from playas. Also, in a study of playa characteristics affecting summer waterfowl use, Rhodes and Garcia[51] noted that snails (*Physa* sp. and *Lymnaea* sp.) were present in all of the playas, both modified and unmodified. An aquatic invertebrate study was conducted at Pantex Plant in 1994 and 1995 to evaluate effects of land use practices on invertebrates in the playa wetlands and to obtain information for land use management decisions. Zooplankton, insects, and other macro- and micro-invertebrates were identified from through a survey of Playas 1 through 5, Pantex Lake, and two offsite control playas. Because of inadequate precipitation in 1994, the project was discontinued until the summer of 1995.[52] The survey identified 85 species of invertebrates within the playas. The community structures at the eight playas studied were similar. Differences were attributed to colonization by flying insects and variations in the life cycles of aquatic invertebrates associated with playas. Playa community structure is linked to wet-dry cycles and is dependent on when a playa receives enough water to maintain a wet period.

Playa 1 was the only playa where invertebrate community characteristics could be attributed to Pantex Plant activities. As a result of the constant flow of water from the WWTF, the aquatic invertebrate community is more stable and less diverse.

In other studies, 25 genera of protistans (single-celled organisms) have been collected from the playas on Pantex Plant along with several additional unidentified organisms.[28] The protistans often are important food sources for macroinvertebrates. No further information is available on playa microorganisms generally or on the specific organisms found in the Pantex Plant playas.

A list of species collected from playa lakes on Pantex Plant was provided by Rylander.[13] Cushing[11] also conducted invertebrate sampling of the water column and sediments in Playas 1, 2, 3, and Pantex Lake. Neither source reported the specific playas in which each organism was found with the exception of one species. Cushing[11] reported that the crustacean amphipod *Hyalella azteca* was common in Playa 1 but was not found in any of the other Pantex Plant playas. The reason that this organism is not found in the other playas may be related to the presence of water year-round in Playa 1. Pennak[53] notes that amphipods generally are not adapted for withstanding drought and other adverse environmental conditions. During seining as part of the herpetofaunal survey, Mazeroll[19] found approximately 10 individuals of an unidentified crayfish in the man-made catchment or cattle tank in the southeast corner of Pantex Lake. This study also noted the presence of crayfish burrows in this area.

A.3.1.3 Amphibians

Amphibians require water to lay their eggs and thus are tied to the aquatic environment at least during reproduction. Therefore, virtually all amphibians occurring on the SHP are likely to be found in playas during certain portions of their lifecycle. Twelve species of amphibians are known to be associated with playas (Table A-4). Amphibian populations have been found to respond to flooding of the playas by rapid colonization and increase in numbers. This response has been reported for the eastern tiger salamander[46] and two species of toads.[41]

A herpetofaunal survey of the Pantex Plant was conducted in August 1994.[19] Seven species of amphibians were identified during this survey. These species and the locations where they were found are listed in Table A-5. Four species were found at Pantex Lake. The study noted that the largest number of individuals were found there, because a large number of upland chorus frogs (*Pseudacris triseriata feriarum*) in various stages of development from tadpoles to emerging adults were found in the cattle tank in the southeast corner of Pantex Lake. Three amphibian species were found at Playa 1; one species was found at Playa 4.[19] In 1995, bullfrogs (*Rana catesbeiana*) were observed at Playa 1.

All species recorded for Pantex (Table A-5) have the potential to occur in or near playas. Although some species were not found in the playas during the survey, all of these amphibians would be expected to occur in the playas, particularly during the early stages of life as tadpoles or larvae or for reproduction. The Couch's spadefoot toad, plains spadefoot toad, New Mexico spadefoot toad, spotted chorus frog, great plains toad, and barred tiger salamander were found in uplands in 2000 and 2001 by contractors studying biodiversity associated with prairie dog colonies on the Plant.[20] Neotenic barred tiger salamanders occur and reproduce in the WWTF.

Table A-4. Amphibians Associated with Playas

Common Name	Scientific Name
Eastern tiger salamander	*Ambystoma tigrinum tigrinum*
Plains spadefoot toad	*Scaphiopus bombifrons*
New Mexico spadefoot toad	*Scaphiopus multiplicatus*
Couch's spadefoot toad	*Scaphiopus couchi*
Great Plains toad	*Bufo cognatus*
Texas toad	*Bufo speciosus*
Woodhouse's toad	*Bufo woodhouseii woodhouseii*
Blanchard's cricket frog	*Acris crepitans crepitans*
Spotted chorus frog	*Pseudacris clarki*
Great Plains narrowmouth toad	*Gastrophryne olivacea*
Bullfrog	*Rana catesbeiana*
Plains leopard frog	*Rana blairi*
Source: References 2, 7, 39	

Table A-5. Amphibians Encountered during 1994 Herpetofaunal Survey of Pantex Plant

Scientific Name	Common Name	Location Observed*
Family Ambystomatidae		
Ambystoma tigrinum mevoritum (Adult and juveniles)	Barred tiger salamander	NE corner of site
Family Pelobatidae		
Scaphiopus hammondi	Western spadefoot toad	NE corner of site
Scaphiopus bombifrons	Plains spadefoot toad	NE corner of site
Family Bufonidae		
Bufo woodhousei	Woodhouse's toad	Playa 1; Pantex Lake; NE corner of site
Bufo cognatus	Great plains toad	Pantex Lake; NE corner of site; 0.6 mi N. of Range 2 (E. of Playa 1)
Family Hylidae		
Pseudacris triseriata feriarum	Upland chorus frog	Playa 1, Playa 4, Pantex Lake, NE corner of site
Family Ranidae		
Rana blairi	Plains leopard frog	Playa 1, Pantex Lake

*Note: Locations on the northeast corner of the site are near the old wastewater treatment facility, Buildings 13-41, 13-42, and 13-45, where several cement ponds still hold water.

Three yellow mud turtles were identified at Pantex Lake in the cattle tank during a seining event in late spring 1996.

A.3.1.4 Reptiles

Haukos and Smith[2] reported 10 reptile species associated with playas (Table A-6) and noted that, in most cases, reptiles are associated with dry playas with the exception of the yellow mud turtle (*Kinosternon flavescens flavescens*) and ornate box turtle (*Terrapene ornata ornata*). Eight species of reptiles were found on Pantex Plant during the herpetofaunal survey conducted in August 1994.[19]

Table A-6. Reptiles Associated with Playas

Common Name	Scientific Name
Yellow mud turtle	*Kinosternon flavescens flavescens*
Ornate box turtle	*Terrapene ornata ornate*
Texas horned lizard	*Phrynosoma cornutum*
Eastern checkered garter snake	*Thamnophis marcianus marcianus*
Western ribbon snake	*Thamnophis proximus proximus*
Western smooth green snake	*Opheodrys vernalis blanchardi*
Western diamondback rattlesnake	*Crotalus atrox*
Prairie rattlesnake	*Crotalus viridis viridis*
Plains hognose snake	*Heterodon nasicus nasicus*
Bullsnake	*Pituophis melanoleucus sayi*

Source: Reference 2

A.3.1.5 Birds

Birds are the most dominant and recognizable fauna associated with playas in terms of numbers, diversity, and biomass.[2,41] The playas provide an important habitat for migration, wintering, and nesting. The SHP lies within the Central Flyway, a major migratory route taken by waterfowl and other birds each spring and fall. Playas are the primary resting, feeding, and wintering habitat for migratory waterfowl. It is estimated that the High and Rolling Plains of Texas could have several million ducks, 500,000 to 750,000 geese, and 500,000 sandhill cranes at any given time during the migrational and wintering periods.[54] More than 30 shorebird species use playas during spring and fall migrations.[55] The most common wintering ducks are mallards, northern pintails, green-winged teal, and American wigeons.[38]

The playas provide needed winter cover and, most importantly, native forage in the form of seed and invertebrates necessary for waterfowl to survive.[2] Until recently, agricultural grains were considered the most important waterfowl forage on the SHP. However, Sheeley and Smith[47] found that nonagricultural (i.e., playa) seeds were an important component of the diet of shorebirds using playas, with some seeds, (and salamanders by American avocets) are consumed and are more important than grain in the diets for waterfowl. Seeds of native moist soil plants [e.g., smartweeds and barnyard grass (*Echinocloa*)] are more nutritionally complete than corn, especially with regard to amino acids (proteins) and minerals (e.g., calcium).[2]

Birds commonly use playa habitats for nesting. Species known to breed in the playa habitats include the mallard, northern pintail, blue-winged teal and cinnamon teal, northern bobwhite, western meadowlark, yellow-headed blackbird, red-winged blackbird, ring-necked pheasant, and mourning dove.[2] Ray et al.[56] reported that 10 duck species are confirmed nesters in the High Plains. American avocets, black-necked stilts, killdeer, and Wilson's phalaropes are shorebird species that nest in playa habitats. For many species (e.g., waterfowl, mourning dove, quail) the breeding season is very protracted with young observed from early spring through early fall.

Haukos and Smith[2] summarized available studies on the number of bird species associated with playas and found that estimates ranged from 108 to 185 species. As discussed in Section A.2.5, a survey of the birds on the Pantex Plant was performed in July and September 1992.[11] In this survey, 39 species of birds were recorded. Waterfowl species observed included mallard, blue-winged teal, pintail, and redhead. Wetland species recorded included red-winged blackbird, yellow-headed blackbird, white-faced ibis, cattle egret, great blue heron, and snowy egret. While the species listed in the table as wetland species and waterfowl were found in the playas most frequently, many of the other birds listed also may use the playas on occasion or seasonally. The raptors and swallows are likely to use the playas when hunting prey, and swallows drink water from playas while on the wing. Also, some upland birds such as pheasants use cover in dry portions of playas, or when the playas are dry.[2] Although the results reported by Cushing[11] indicate of some species associated with the playas, it should be noted that the route followed on their bird surveys did not include their observations of the playas. Seyffert[12] prepared a checklist of birds and their expected frequency of occurrence in the area surrounding Pantex Plant; however, this checklist did not include actual observations on the site. Approximately 15 species of ducks and geese are listed as common or abundant in the area.

A.3.1.6 Mammals

Mammals use playa basins for food, cover, and water.[27] Haukos and Smith[2] reviewed available studies and listed 37 species that occur on the SHP whose range and habitat requirements make them potential inhabitants of playas. All mammal species reported at Pantex (Table A-2) have the potential to occur in or near the playas. Most of the species reported by Rylander[13] were identified from a small-mammal trapping study in which the role of ephemeral lakes on species diversity was examined. The results indicated that, although the largest number of individuals were collected adjacent to Playa 1 (the only playa with permanent water), species diversity was greatest at the two ephemeral playas that were wet during the study (11 species), followed by the two ephemeral playas that were dry during the study (6 species) and the ungrazed grassland in the Conservation Reserve Program (6 species). The lowest diversity was found at Playa 1 with permanent water (4 species) and the intensively grazed grassland (4 species).[13]

Cushing[11] performed a small-mammal trapping survey of Pantex Plant in July, August, and September 1992. Of the 11 trapping locations, four were in or on the edges of playas (2 at Playa 1, 1 at Playa 2, and 1 at Pantex Lake). Six species were recorded at these locations.

A.4 References

1. Unger, P.W. and F.B. Pringle, *Pullman Soils: Distribution, Importance, Variability and Management*, B-1372, Texas Agricultural Experiment Station, College Station, Texas, in cooperation with USDA, Agricultural Research Service and Soil Conservation Service, 1981.

2. Haukos, D.A. and L.M. Smith, “The Importance of Playa Wetlands to Biodiversity of the Southern High Plains,” *Landscape and Urban Planning*, v. 28, pp. 83-98, 1994.

3. Hatch, S.L., and J. Pluhar, “Texas Range Plants,” Natural History Series No. 13, Texas A&M University Press, College Station Press, College Station, Texas, 1993.

4. Texas Parks and Wildlife Department, Texas Natural Heritage Program, *Plant Communities of Texas (Series Level)*, Texas Natural Heritage Program, Austin, Texas, p. 25, 1992.

5. Johnston, M.C. and J.K. Williams, “Floristic Survey, Pantex Plant Site, Carson County, Texas,” Contract No. FFP009901, prepared for the U.S. Department of Energy by Environmental Consulting, Austin, Texas, 1993.

6. Johnston, M.C., “Floristic Survey of the Pantex Plant Site Carson County, Texas,” prepared for Tetra Tech by Environmental Consulting, Austin, Texas, December 1995.

7. Pantex Plant. “Review and Report on the Integrated Plan for Playa Management at Pantex Plant,” prepared by Environmental Protection Department, December 1997.

8. Guthery, F.S. and F.C. Bryant, “Status of Playas in the Southern Great Plains,” *Wildlife Society Bulletin*, v.10(4), pp. 309-317, 1982.

9. Guthery, F.S., “Playa Basins and Resident Wildlife in the Texas Panhandle,” *Playa Lakes Symposium Proceedings*, conference held in Arlington, Texas, December 4-5, 1979, U.S. Fish and Wildlife Service (USFWS), Office of Biological Services in cooperation with the USFWS, Office of the Environment, Albuquerque, New Mexico, pp.47-51, 1981.

10. U.S. Department of Energy (DOE), “Land Use Census Pantex Plant,” prepared by Mason & Hanger Corporation for U.S. Department of Energy, Amarillo, Texas, 1991.

11. Cushing, C.E., R.R. Mazaika, and R.C. Phillips, “Ecological Investigations at the Pantex Plant Site, 1992,” prepared for the U.S. Department of Energy under Contract DE-AC06-76RLO 1830 by Pacific Northwest Laboratory, Richland, Washington, 1993.

12. Seyffert, K.D., "Checklist of Birds, Pantex Plant Site Carson County, Texas, 1994," prepared for the U.S. Department of Energy under Contract No. FFP016902, Amarillo, Texas, 1994.

13. Rylander, M.K., "Resident and Migratory Animals Survey, Pantex Plant Site, Carson County, Texas," prepared under Contract FFP011684 for the U.S. Department of Energy, Amarillo, Texas, 1994.

14. Packard, R.L., "Small Mammal Studies on Jornada and Pantex Sites, 1970-1971," *U.S. International Biological Program, Grassland Biome, Pantex Site*, Technical Report No. 188, Colorado State University, Fort Collins, Colorado, p. 81, 1972.

15. Sissom, W. D. *A Macroinvertebrate Survey of the Pantex Plant*. Final Report. West Texas A&M University, Canyon, Texas. 89 pp., 2003.

16. Huddleston, E.W., C.R. Ward, C.W. O'Brien, W.J. Fournier, and H.N. Howell, Jr., "Insect Population Studies," *U.S. International Biological Program, Grassland Biome, Pantex Site*, Technical Report No. 79, Colorado State University, Fort Collins, Colorado, p. 41, 1971.

17. Huddleston, E.W., C.W. O'Brien, W.J. Fournier, G.R. Graves, and C.R. Ward, "Insect Population Studies on the Pantex Site," *U.S. International Biological Program, Grassland Biome, Pantex Site*, Technical Report No. 192, Colorado State University, Fort Collins, Colorado, 1972.

18. Huddleston, E.W., R.A. Shaw, and M.V. Riggs, "Insect Population Dynamics Studies on the Pantex Site, 1972," *U.S. International Biological Program, Grassland Biome, Pantex Site*, Technical Report No. 280, Colorado State University, Fort Collins, Colorado, p. 44, 1975.

19. Mazeroll, A.I., L.S. Boatman, and L.H. Boomershine. "Herpetofaunal Survey, Pantex Plant Site, Carson County, Texas," prepared under contract No. FFP-19934 for the U.S. Department of Energy, Amarillo, Texas, 1994.

20. McCaffrey, R.E. *Biodiversity associated with active and extirpated black-tailed prairie dog colonies*. M.S. Thesis. Texas Tech, Lubbock, Texas. 77 pp., 2001.

21. Phillips, J.W., "Checklist of Vertebrates, Lake Meredith Recreation Area," June 23, 1989.

22. Flickinger, E.L. and G.W. Pendleton, "Bird Use of Agricultural Fields Under Reduced and Conventional Tillage in the Texas Panhandle," *Wildlife. Society Bulletin*, v. 22(1), pp. 34-42, 1994.

23. Wiens, J.A., "Avian Ecology and Distribution in the Comprehensive Network, 1970," *U.S. International Biological Program, Grassland Biome, Pantex Site*, Technical Report No. 77, Colorado State University, Fort Collins, Colorado, p. 49, 1971.

24. Wiens, J.A., J.T. Rotenberry, and J.F. Ward, "Avian Populations at IBP Grassland Biome Sites, 1971," *U.S. International Biological Program, Grassland Biome, Pantex Site*, Technical Report No. 205, Colorado State University, Fort Collins, Colorado, p. 126, 1972.

25. Packard, R.L., "Small Mammal Survey on the Jornada and Pantex Sites", *U.S. International Biological Program, Grassland Biome, Pantex Site*, Technical Report No. 114, Colorado State University, Fort Collins, Colorado, p. 48, 1971.

26. Packard, R.L., "Small Mammal Studies on Jornada and Pantex Sites, 1972," *U.S. International Biological Program, Grassland Biome, Pantex Site*, Technical Report No. 277, Colorado State University, Fort Collins, Colorado, p. 23, 1975.

27. Choate, L.L., Distribution and Natural History of Mammals on the Llano Estacado. PhD Thesis. Texas Tech University, Lubbock, p. 484 (unpublished), 1991.

28. Curtis, D. and H. Beierman, "Playa Lakes Characterization Study," U.S. Fish and Wildlife Service Region 2, Area 1, Austin, Texas, 1980.

29. Nelson, R.W., W.J. Logan, and E.C. Weller, "Playa Wetlands and Wildlife on the Southern Great Plains: A Characterization of Habitat." Prepared for U.S. Fish and Wildlife Service, FWS/OBS-83/28, p. 163, September 1983.

30. Short, R.M., Personal Communication. Letter on Threatened, Endangered, and Candidate Species for the Pantex Plant in Carson County, Texas to S. Brauning, Battelle. U.S. Fish and Wildlife Service, Letter No. 2-12-94-I-030. August 5, 1994.

31. Ramey, P.M., Memorandum on Wetlands Issue, Final Determination by the Corps of Engineers for Playas One, Two, Three, Four, and Pantex Lake to C.D. Alley, Vice President and Plant Manager MHC, January 2, 1992.

32. Texas Parks and Wildlife Department, "Annotated County Lists of Rare Species-Potter and Carson County," August 24, 2004.

33. Allison, P.S., Personal communication. Letter from P.S. Allison, Pantex Plant, to Susan Brauning, Battelle, Columbus, Ohio, December 12, 1994.

34. Pantex Plant, "1995 Environmental Report for Pantex Plant," DOE/AL/65030-9602, May 1996.

35. Green, Tim. Mammal Database maintained by the Environmental Protection Department, Pantex Plant, 1996.

36. Pantex Plant. "Management Plan for Prairie Dogs at Pantex Plant," prepared by the Environmental Protection Department, Mason & Hanger, Amarillo, Texas, 1998.

37. Pantex Plant, U.S. Department of Energy Pantex Plant Preliminary Wetland Delineations for Playas 1, 2, 3, 4, and Pantex Lake. December 28, 1990.

38. Pantex Plant, U.S. Department of Energy Pantex Plant Addendum to Preliminary Wetland Delineations for Playas 1, 2, 3, 4, and Pantex Lake. December 30, 1991.

39. Department of the Army, US Army Corps of Engineers, Wetlands Research Program Technical Report Y-87-1, "Corps of Engineers Wetlands Delineation Manual," Environmental Laboratory, Waterways Experiment Station, Vicksburg, Mississippi, January 1987.

40. Bolen, E.G., C.D. Simpson, and F.A. Stormer, "Playa Lakes: Threatened Wetlands on the Southern Great Plains," *31st Annual Great Plains Agricultural Council Proceedings*, U.S. Forest Service, Publication 31, pp. 23-30, 1979.

41. Bolen, E.G., L.M. Smith, and H.L. Schramm, Jr., "Playa Lakes: Prairie Wetlands of the Southern High Plains," *BioScience*, v. 39(9), pp. 615-623, 1989.

42. Pettit, R.D., "Herbage Dynamics Studies at the Pantex Site, 1972," *U.S. International Biological Program, Grassland Biome, Pantex Site*, Technical Report No. 260, Colorado State University, Fort Collins, Colorado, p. 32, 1974.

43. Haukos, D.A. and L.M. Smith, "Ecology of Playa Lakes." Waterfowl Management Handbook Leaflet 13.3.7, Office of Information Transfer, U.S. Fish and Wildlife Service, Fort Collins, Colorado, 7 pp, 1992.

44. Pantex Plant, "1994 Environmental Report for Pantex Plant," DOE/AL/65030-9506, June 1995.

45. Clark, J.P., Letter from J.P. Clark, Chief Operations Division, Tulsa District, Corps of Engineers, to Anthony G. Ladino, U.S. Department of Energy regarding the wetland delineations for Playas 1, 2, 3, 4, and Pantex Lake. December 11, 1991.

46. Herrera Environmental Consultants, "Final Wetlands Delineation--Pantex Lake and Playas 1, 2, 3, and 4," prepared for Mason & Hanger Corporation, Pantex Plant, Amarillo, Texas. June 1995.

47. Sheeley, D.G. and L.M. Smith, "Tests of Diet and Condition Bias in Hunter-Killed Northern Pintails." *Journal of Wildlife Management*, 51: 765-769, 1989.

48. MacKay, W.P., S.J. Loring, T.M. Frost, and W.G. Whitford, "Population Dynamics of a Playa Community in the Chihuahuan Desert," *Southwestern Naturalist*, v. 35, pp. 393-402, 1990.

49. Sublette, J.E., and M.S. Sublette, "The Limnology of Playa Lakes on the Llano Estacado, New Mexico and Texas," *Southwestern Naturalist*, v. 12, pp. 369-406, 1967.

50. Merickel, F.W. and J.K. Wangberg, "Species Composition and Diversity of Macroinvertebrates in Two Playa Lakes on the Southern High Plains," *Southwestern Naturalist*, v. 26, pp. 151-158, 1981.

51. Rhodes, M.J., and J.D. Garcia, "Characteristics of Playa Lakes Related to Summer Waterfowl Use," *Southwestern Naturalist*, v. 26, pp. 231-235, 1981.

52. Kennedy, J. And Cook, R. "Macroinvertebrate Study of Pantex and Selected Off-site Playas," Contract No. FFP017303 for the U.S. Department of Energy by ECS Technical Services, Austin, Texas and The University of North Texas, Denton, Texas, 1996.

53. Pennak, R.W., "Fresh-Water Invertebrates of the United States." Second Edition. Ronald Press Co., 1978.

54. Ray, James D. Personal communication. Letter from James D. Ray, Waterfowl Biologist, Region 1, Texas Parks and Wildlife Department, to Duane Tolle, Battelle, regarding waterfowl estimates for the counties surrounding Pantex Plant, June 30, 1994.

55. Davis, C. A., and L. M. Smith. *Ecology and Management of Migrant Shorebirds in the Playa Lakes Region of Texas*. Wildlife Monogram, 140, 1-45, 1998.

56. Ray, J. D., B. D. Sullivan, and H. W. Miller. *Breeding Ducks and Their Habitats in the High Plains of Texas*. Southwestern Naturalist 48(2): 241-248, 2003.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX B

ASSESSMENT OF IMPACT TO THE PLAYA 1 FLOODPLAIN

TABLE OF CONTENTS

B. Assessment of Impact to the Playa 1 Floodplain B-1
B.1 Background and History B-1
B.2 Description of Work B-2
B.2.1 Physiography B-2
B.2.2 Existing Conditions B-2
B.2.3 Land Use B-3
B.2.4 Hydrogeologic Conditions B-3
B.2.5 Soils B-3
B.2.6 Flora B-3
B.2.7 Fauna B-3
B.3 Floodplain Effects, Alternatives, and Mitigation B-3
B.3.1 Effects of Floodplain Activities on Lives and Property B-5
B.3.2 Alternatives B-5
B.3.3 Mitigation B-5
B.4 Summary B-5

LIST OF TABLES

Table B-1. Playa 1 Floodplain Cumulative Impacts Table B-4

B. ASSESSMENT OF IMPACT TO THE PLAYA 1 FLOODPLAIN

Corrective Measure Option 6, Enhanced Pump and Treat with Targeted In Situ Treatment and MNA, would result in impacts to the 100-year floodplain of Playa 1. These impacts would result from drilling and trenching activities for ten of an additional 25 vertical extraction wells and associated conveyance lines that would connect to an upgraded PGPTS or to skid mounted treatment units.

In accordance with the regulations contained in Title 10 Code of Federal Regulations (CFR) Part 1022, Compliance with Floodplain and Wetlands Environmental Review Requirements, the U.S. Department of Energy National Nuclear Security Administration (USDOE/NNSA) has established policy and procedures to consider impacts on floodplains and wetlands as part of its decision-making process. This policy was developed in response to Executive Order 11990—Protection of Wetlands (May 24, 1977), and Executive Order 11988—Floodplain Management (May 24, 1977). These executive orders require federal agencies to evaluate and, to the extent possible, minimize the impacts of their projects on floodplains and wetlands. Under USDOE/NNSA policy, a floodplain or wetlands assessment is required for any activities involving floodplains or wetlands.

This assessment examines how a USDOE/NNSA project to install up to 10 perched aquifer extraction wells and approximately 4,000 feet of conveyance lines would affect a floodplain. The project is associated with the 100-year floodplain of Playa 1, located on USDOE/NNSA Pantex Plant property in Carson County, Texas (See Figure 2-7).

To assess the project's effects on the floodplain, information was gathered about the existing conditions and the activities to be associated with the project. This information was then used to predict and evaluate the positive and negative, direct and indirect, and long- and short-term effects.

This project would install up to 10 perched aquifer extraction wells and approximately 4,000 feet of conveyance line that would connect to the existing PGPTS, or to self contained skid-mounted treatment units installed in the field. Construction of these wells and conveyance lines would include the following:

- Drill up to 10 perched aquifer extraction wells using an Air-Rotary Casing Hammer (ARCH) drill rig.
- Complete and develop the wells.
- Trench to install approximately 4,000 feet of conveyance lines to connect the wells to the treatment system.

B.1 BACKGROUND AND HISTORY

Historical waste management practices at the Plant have resulted in impacts to perched groundwater. These historical practices include disposal of spent solvents to unlined pits and sumps, and disposal of HE wastewaters and industrial wastes to unlined ditches and playas. As a result, HE, solvents, and metals may be found in the perched groundwater underlying Pantex Plant. The perched groundwater plume has migrated past the Plant boundaries and onto adjacent landowners' property to the southeast (USDOE/NNSA, 2003).

The perched groundwater underlying Pantex Plant is currently being treated to remove constituents of concern (COCs), as an interim stabilization measure. However, additional measures are being evaluated in the CMS/FS to determine a remedy that best achieves permanence, cost effectiveness, and cleanup requirements by minimizing the potential for COCs to reach the Ogallala Aquifer. The USDOE/NNSA now needs to implement corrective measures to fulfill the requirements of RCRA (as administered under the Texas Administrative Code) and CERCLA.

B.2 DESCRIPTION OF WORK

Up to ten extraction wells would be drilled within the floodplain of Playa 1 to encounter areas of perched groundwater exhibiting a substantial saturated thickness and yield. Drilling in the floodplain is necessary to effectively minimize a mound of perched groundwater, created through infiltration of industrial wastewaters, that is causing chemicals to move toward the southeast corner of Pantex and adjacent offsite properties. These wells would be installed using an ARCH drilling rig, and each well would require approximately 2,500 square feet of working area for drilling, installation, and development, plus an access road into the work area. Each access road would be the shortest distance from an existing road to the work area. Each extraction well would have a 6 ft. by 6 ft. concrete pad to support a 4 ft. by 4 ft. well housing. Environmental sampling and scheduled routine maintenance at each extraction well location would require that the access roads remain in place during the expected life of the well. All other working areas would be returned to grade and re-vegetated as required.

The approximately 4,000 feet of conveyance line would be trenched 4 ft. deep and 1.5 ft. wide, and would accommodate both water and power lines. The process of trenching, placement of conveyance lines, and backfilling would disturb approximately a 4 ft. wide area the length of the trench. All conveyance lines would be trenched the shortest distance possible in the floodplain to connect all of the extraction wells to the treatment system. All trenched areas would be returned to grade and revegetated as required.

B.2.1 Physiography

Pantex Plant lies on the Southern High Plains (SHP) portion of the Great Plains at an average elevation of 3,500 feet. The surface of the SHP is nearly flat, but generally slopes southeastward at a rate of 1.5 to 1.9 m/km (8 to 10 ft/mile). The principal features of relief on the SHP are numerous shallow depressions called playas. These playas are internally drained, ephemeral, and were formed by the interaction of pedogenic, geomorphic, hydrochemical, and biologic processes contemporaneous with the deposition of the Blackwater Draw formation.

The climate in the area is classified as semiarid, and is characterized by hot summers and relatively cold winters. The average annual rainfall is 49.7 cm (19.56 in.). Seventy-five percent of the annual precipitation falls between April and September. The region is classified as windy, with wind speeds exceeding 11 km/hour (7 miles/hour) more than 95 percent of the year. The potential gross lake surface evaporation in the area is estimated to be about 350 percent of the annual precipitation, or approximately 178 cm (70 in.) per year (BWXT Pantex, 2002).

B.2.2 Existing Conditions

Playa 1 is located in the east-central portion of Pantex Plant. The areal extent of the 100-year floodplain is approximately 87 hectares (216 acres), which includes 32 hectares (79 acres) of wetland (Herrera Environmental Consultants, 1996). The limit of the 100-year floodplain is delineated at an elevation of 3,521.5 feet (USACE, 1995).

B.2.3 Land Use

Current land use, in and adjacent to the project area, includes 66 acres (27 ha) of short-grass prairie, 92 acres (37 ha) of revegetated uplands (formerly cultivated areas), 38 acres (15 ha) of cultivated land, and 33 acres (13 ha) of industrial use land (wastewater treatment facility). The cultivated lands are managed by Texas Tech Research Farms under a Service Agreement between USDOE/NNSA and Texas Tech University.

B.2.4 Hydrogeologic Conditions

Playa 1 is an internally drained, closed basin that receives direct stormwater runoff from a watershed of approximately 2,546 acres (1,018 ha). The runoff is either from overland sheet flow, or through channels and ditches that feed into the playa. Interaction between surface water and groundwater in the Pantex Plant area is limited to infiltration of direct precipitation and runoff, mainly through playas and ditches, to the perched and Ogallala aquifers.

B.2.5 Soils

The soils, in and adjacent to the Playa 1 floodplain and wetland, are in the Pullman-Randall soil association. At Playa 1, this association includes Pullman clay loams (PuA and PuB, respectively); the Estacado clay loams (EsB); the Pep clay loams (PeC); and the Randall clays (Ra).

B.2.6 Flora

The upland area surrounding Playa 1 has vegetation typical of short-grass prairie in the area, which is dominated by buffalograss (*Buchloe dactyoides*), blue grama (*Bouteloua gracilis*), a large stand of natural sideoats grama (*Bouteloua curtipendula*), and plains prickly pear (*Opuntia macrorhiza*). The Pullman and Estacado soils adjacent to Playa 1 also support managed cropland, consisting of either sorghum or winter wheat. The upland areas at Pantex Plant are being managed based partly on the results of floristic surveys (BWXT Pantex 2002). The 1995 survey identified 52 species in the Pantex Plant uplands. There are no records of federally protected or candidate plant species occurring on Pantex Plant.

B.2.7 Fauna

The faunal diversity in and near the project area at Playa 1 is typical of Pantex Plant and is consistent with species commonly found in the northern portions of the Southern High Plains, as referenced in Section 3.2.5 of this document. No critical habitat for threatened or endangered species is located on the Pantex Plant, or in Carson County (BWXT Pantex, 2002).

B.3 FLOODPLAIN EFFECTS, ALTERNATIVES, AND MITIGATION

The floodplain effects of this project are those identified from the project description that would or could modify the existing conditions of the Playa 1 floodplain. The following project activities have been identified as potentially affecting the existing floodplain conditions at Playa 1:

- Drilling, completing, and developing the extraction wells.
- Trenching and installing of conveyance lines.
- Returning impacted areas to original, natural grade and revegetating with native grasses.
- Installing the extraction systems on the wells.

- Installing permanent access roads to the extraction wells.
- Sampling and maintaining the extraction well system.

Floodplain effects are evaluated as positive or negative, direct or indirect, and long-term or short-term. At Pantex Plant, playa wetlands and floodplains are managed as multiple-resource, sustainable ecosystems. Project effects that are consistent with this management goal are considered positive, and effects that are not consistent with this goal are considered negative. In addition, project effects that reduce the size of the managed ecosystems are considered negative, and effects that increase the size of these ecosystems are considered positive. The identification of indirect and direct effects indicates whether or not the impacts to the floodplain or wetland are subject to intervening circumstances. Long- and short-term effects are determined by the relative permanence of the action in the floodplain or wetland.

The drilling, trenching, and regrading activities of this project have the potential to impact the floodplain at Playa 1, as described in Table B-1, below. Approximately 1.86 acres of floodplain, less than 1 percent of the Playa 1 floodplain area, would be involved in the drilling and trenching activities of this project. Drilling activities at each well are estimated to disturb 2,500 sq ft, or 25,000 sq ft for the ten wells. Trenching to install approximately 4,000 ft of piping from the wells to the treatment system is estimated to disturb 24,000 sq ft. Access roads to the wells are estimated to disturb 32,000 sq ft. Drilling, trenching and road installation results in a total disturbance of 81,000 sq ft, or 1.86 acres. Storm water runoff may have the potential to erode denuded areas and transport sediments during drilling, trenching, and revegetation, which would have a negative, direct, and short-term effect on existing conditions. The installation of the extraction systems on the well pads, the access roads, and sampling and maintenance of the system, has the potential to displace a small amount of floodplain volume and would have a negative, direct, and long-term effect on existing conditions.

Table B-1. Playa 1 Floodplain Cumulative Impacts Table

Playa 1 Areas of Concern	1996 SWEIS Background	CMS Project Impacts	Potential Future Impacts	Cumulative Impacts
100-yr floodplain elevation (ft)	3521.5	3521.56	3521.56	Long-term displacement of 1.86 acres of floodplain results in less than 0.75-inch change in the 100-year floodplain elevation with no potential impacts to lives or property.
Wetland elevation (ft)	3510	3510	3510	Wetland elevation is not affected.
100-yr floodplain surface area (acres)	216	217.86	217.86	Increase of 100-year floodplain acres by 1.86 acres. Impact of a decrease of 1.86 acres of existing beneficial floodplain habitat, which would be a loss of 0.86 percent of the existing floodplain habitat.
Impacted floodplain acres (Short-term)	0	1.86	3.15	Potential short-term impacts to 3.15 acres of floodplain from future maintenance of roads, fences, underground utility lines, utility poles, extraction wells, and conveyance lines. All short-term impacts are mitigated by regrading and revegetating disturbed area.
Wetland acres	79	79	79	Wetland acres are not affected.

B.3.1 Effects of Floodplain Activities on Lives and Property

The effects of the project floodplain activities would not change conditions in a way that affects lives or property either positively or negatively, directly or indirectly, in either the long-or short-term.

B.3.2 Alternatives

The implementation of the No Action Alternative, Options 1 through 5, and Option 6 without the Enhanced Pump and Treat, would not make any changes to the existing Playa 1 floodplain; therefore, no positive or negative, direct or indirect, long- or short-term effects on existing conditions in the Playa 1 floodplain would occur.

B.3.3 Mitigation

Two negative effects in the Playa 1 floodplain have been identified -the potential for erosion and sedimentation during drilling, trenching, and regrading activities, and the potential for displacing floodplain volume with the installation of the extraction systems on the well pads.

The negative effects apply only to part of the project in Option 6, but do not apply to the No Action Alternative or to Options 1 through 5. The negative effects of erosion and sedimentation should be minimized by controls such as silt/sediment fencing, geotextiles, riprap, gabions, etc. Contractors selected to perform the work would be required to propose erosion/sedimentation controls for review and approval by Pantex, as required by Pantex Plant Division I Specifications, Section 01558. The negative effects of displacing floodplain volume would be mitigated by placing, when possible, any extraction wells outside the boundaries of the 100-year floodplain at Playa 1.

B.4 SUMMARY

In accordance with Title CFR Part 1022, a Statement of Findings based on the information in this document will be published. The statement of findings will include a brief description of the proposed action and an explanation indicting why it is located in a floodplain, the alternatives considered, a statement indicating if the action conforms to State and local floodplain requirements and a brief description of the steps to be taken to minimize potential harm within the floodplain. After publication, a 15-day comment period is required before implementing the proposed action.

B.5 REFERENCES

USDOE/NNSA, 2003. *Environmental Management Performance Management Plan for Accelerating Cleanup of the Pantex Plant*, U.S. Department of Energy/National Nuclear Security Administration, Amarillo, Texas, July. [AL-PX-SW-003904]. Online: http://www.pantex.com/environment/PantexAccelercleanupvs10c.pdf

BWXT Pantex, 2002. *Environmental Information Document – In Support of the National Environmental Policy Act Documents for Pantex Plant*, Amarillo, Texas, January.

Herrera Environmental Consultants, 1996. *Floodplains and Wetlands Assessment – Pantex Lake and Playas 1, 2, 3, and 4*, Herrera Environmental Consultants, Inc., 2200 Sixth Avenue, Suite 601, Seattle, Washington, April.

USACE, 1995. *Floodplain Delineation Report, Department of Energy Pantex Plant, Amarillo, Texas*, U.S. Army Corps of Engineers, Tulsa District, Floodplain Management Services Planning Division, P.O. Box 61, Tulsa, Oklahoma, January.