Preassessment Screen Determination: White Sands Test Facility

Doña Ana County, New Mexico

New Mexico Office of Natural Resources Trustee
Albuquerque, New Mexico

March, 2016

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SECTION 1 | INTRODUCTION, AUTHORITIES, AND DELEGATIONS

1.1 INTRODUCTION

The National Aeronautics and Space Administration (NASA) White Sands Test Facility (WSTF, "the Site") is located near Las Cruces, New Mexico. WSTF has supported testing of space flight equipment and hazardous materials for nearly 50 years. The area, approximately 18 miles northeast of Las Cruces, was chosen for the Johnson Space Center Propulsion Systems Development Facility in 1962 because of its isolated location and topography. Construction of the facilities began in 1963, and in 1965 the name was changed to White Sands Test Facility. The WSTF was built primarily to support the Apollo Program, and at the peak of the Apollo era in the mid-1960s, WSTF employed over 1,700 people. By 1970, WSTF was facing closure. However, due to its unique test facilities, existing buffer zones, and other advantages, hazard tests for the Space Shuttle Program began at the facility. WSTF currently employs 750 people (NASA 2013a, Corbett 2013).

Past activities included developing, qualifying, refurbishing, and testing spacecraft propulsion systems, subsystems, and ground support equipment; investigating flight hardware anomalies; testing materials and components; and performing hazard and failure analyses (NASA 2013a). The tanks and impoundments storing waste materials in support of these activities have caused releases of hazardous substances to the environment. The Site currently includes propulsion testing facilities for rocket systems; materials and components laboratories for testing the quality of space flight materials; and technical services offices that provide expertise for developing ground support equipment (NASA 2013a, Corbett 2013).

This document serves as the Preassessment Screen Determination (PAS) for the Site, prepared in accordance with the United States Department of the Interior (DOI) Natural Resource Damage Assessment (NRDA) regulations in the Code of Federal Regulations (CFR) at Title 43 Part 11.

1.2 AUTHORITY

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended, at Title 42 of the United States Code (USC) § 9601, *et seq.*, the Oil Pollution Act of 1990, 33 USC § 2701, *et seq.*, and the Federal Water Pollution Control Act of 1972 (FWPCA; also known as the Clean Water Act), as amended, 33 USC § 1251, *et seq.*, authorize the Federal Government, States, and Indian tribes to recover

damages for injuries to natural resources and their supporting ecosystems, belonging to, managed by, appertaining to, or otherwise controlled by them:

> *"In the case of an injury to, destruction of, or loss of natural resources under subparagraph (C) of subsection (a) of this section liability shall be to the United States Government and to any State for natural resources within the State or belonging to, managed by, controlled by, or appertaining to such… Provided, however, that no liability to the United States or State or Indian tribe… shall be imposed under subparagraph (C) of subsection (a) of this section, where the party sought to be charged has demonstrated that the damages to natural resources complained of were specifically identified as an irreversible and irretrievable commitment of natural resources in an environmental impact statement, or other comparable environment analysis, and the decision to grant a permit or license authorizes such commitment of natural resources, and the facility or project was otherwise operating within the terms of its permit or license…"* (42 USC § 9607 (f)(1))

In New Mexico, the Natural Resources Trustee (the Trustee) is designated under the Natural Resources Trustee Act (New Mexico Statutes Annotated [NMSA] 1978, §§ 75-7-1 to -5) to act pursuant to these federal authorities. Specifically:

> *"The natural resources trustee shall act on behalf of the public as trustee of natural resources within the state or belonging to, managed by, controlled by or appertaining to the state, including protecting and representing the state's interest under applicable federal laws regarding injury to, destruction of or loss of natural resources in the state."* (NMSA 1978, § 75-7-2A)

Under CERCLA, a natural resource is defined in relevant part as "land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States… any State or local government, any foreign government, [or] any Indian tribe." (42 USC § 9601 (16))

Based on a review of available information, the natural resource most clearly affected by releases from the Site is groundwater. In New Mexico, all underground waters are public waters and belong to the public of the State of New Mexico (NMSA 1978, § 72-12-18). "The public waters of [New Mexico] are owned by the state as trustee for the people… and it is authorized to institute suits to protect the public waters against unlawful use, or to bring any other action whether authorized by any particular statute, if required by its pecuniary interests or for the general public welfare." State ex rel. Reynolds v. Mears, 1974-NMSC-070, 86 N.M. 510, 515 (internal citations omitted). The Trustee is therefore authorized to assert trusteeship over groundwater.

1.3 PURPOSE AND DETERMINATION

As described in the DOI NRDA regulations, a PAS provides the basis for the Trustee's determination of whether further investigation and assessment efforts are warranted and

that there is a reasonable probability of making a successful claim against the party or parties responsible for the release of hazardous substances to the environment:

> *"The purpose of the preassessment screen is to provide a rapid review of readily available information that focuses on resources for which the Federal or State agency or Indian tribe may assert trusteeship under section 107(f) or section 126(d) of CERCLA. This review should ensure that there is a reasonable probability of making a successful claim before monies and efforts are expended in carrying out an assessment."* (43 CFR § 11.23(b))

This PAS is based on a review of readily available information on hazardous substances released from the Site and potential impacts of the release(s) on those natural resources under the trusteeship of New Mexico. Much of the data and information relied upon for this PAS was compiled and collected to support remedial decisions and activities at the Site. The Trustee intends to collect additional data and/or coordinate with ongoing remedial action data collection efforts to inform the nature and extent of natural resource injuries, as necessary. Further, while the hazardous substances at the Site were not present prior to building the facility, the Trustee intends to gather information, as necessary, to establish the baseline quality of the habitat and resources.

The Trustee has determined that there is a reasonable probability of making a successful claim for damages to trust natural resources. Specifically, in accordance with 43 CFR § 11.23(e), the Trustee has determined that:

1. A release of a hazardous substance has occurred;
2. Natural resources for which the Trustee may assert trusteeship under CERCLA have been or are likely to have been adversely affected by the discharge or release;
3. The quantity and concentration of the released hazardous substance is sufficient to potentially cause injury, as that term is used in this part, to those natural resources;
4. Data sufficient to pursue an assessment are readily available or likely to be obtained at a reasonable cost; and
5. Response actions, if any, carried out or planned do not or will not sufficiently remedy the injury to natural resources without further action.

As defined at 43 CFR § 11.14(ee), reasonable costs means, among other things, that the anticipated cost of the assessment is expected to be less than the anticipated damage amount.

The remainder of this document presents a summary of available information on the Site and the release of hazardous substances; a preliminary identification of resources at risk; potentially injured resources and resource services; and a preliminary determination regarding the five PAS criteria described above.

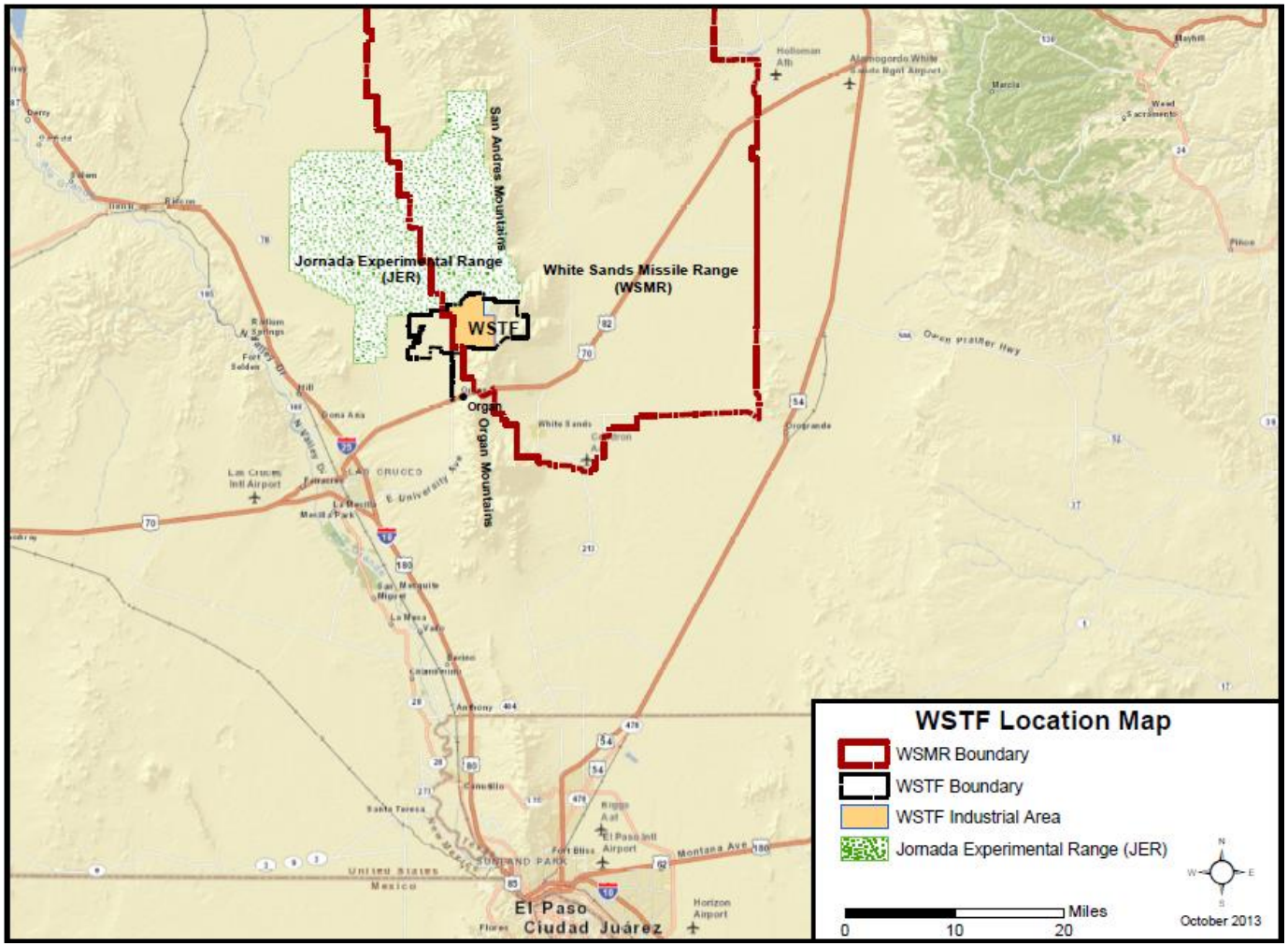
SECTION 2 | INFORMATION ON THE SITE AND THE RELEASE OF HAZARDOUS SUBSTANCES

2.1 SITE BACKGROUND

The Site is located in southern New Mexico, near Las Cruces (Exhibit 2-1). It was established to support the NASA Apollo Space Program in the early 1960s (NASA 2013a). Work during that time involved developing, qualifying, refurbishing, and testing spacecraft propulsion systems, subsystems, and ground support equipment; investigating flight hardware anomalies; testing materials and components; and performing hazard and failure analyses (NASA 2013a). Current operations at the Site include serving as a field test facility under NASA's Lyndon B. Johnson Space Center, which provides testing services to NASA for the United States space programs and support to the Department of Defense, Department of Energy, private industry, and foreign government agencies (NASA 2013a). Activities at the Site are primarily associated with the development and testing of the limits of spacecraft propulsion systems and subsystems. In addition, there are also several laboratories that conduct simulated use tests for space station materials, and compatibility testing (NASA 2013a).

As a result of Site operations, hazardous substances were disposed of and released to the environment, and have come to be located outside of the WSTF property boundaries. Some tanks and impoundments in what are defined as the 200, 300, 400, and 600 industrial areas of the Site (described in more detail below) were closed under the requirements of the Resource Conservation Recovery Act (RCRA). The closure areas were permitted under a post-closure care permit in the early 1990s and continue to be monitored in accordance with the Hazardous Waste Permit issued by the New Mexico Environment Department (NMED), and with related plans (NASA 2013a, NASA 2013b). In 1996, NASA also developed and implemented a strategy intended to remediate contaminated groundwater based on human health risk and the environmental and hydrological characteristics of the Site. NASA currently operates a plume treatment system intended to prevent further migration of the groundwater contaminant plume. As described in more detail below, the routine groundwater monitoring program provides useful information for understanding the nature and extent of groundwater contamination. Injuries to other natural resources, in addition to groundwater resources, may exist (e.g., geologic or biological injuries). However, based on the information readily available, this PAS focuses on determination of injury to groundwater resources.

EXHIBIT 2-1 WHITE SANDS TEST FACILITY (WSFT) SITE MAP (FROM NASA 2014A)



2.2 REGULATORY HISTORY AND ACTIONS

WSTF operations generated hazardous wastes that were historically managed in surface impoundments and underground storage tanks (i.e., referred to as the 100, 200, 300, 400, 500, 600, 700, and 800 Areas). Leaks from these waste areas and tanks contributed to the contamination of groundwater beneath the Site, starting in the early 1960s (NASA 2013a; 2014a; 2014b). NASA is required by post-closure care requirements specified by the NASA WSTF Hazardous Waste Permit to investigate and assess historical releases of hazardous substances to the subsurface, and to determine whether the soils beneath the closed Hazardous Waste Management Units (HWMUs) are continuing sources of groundwater contamination. NASA develops quarterly groundwater monitoring reports, and other Site investigation reports that describe conditions at the Site and the need for any additional remedial actions (NASA 2013a; 2014a; 2014b).

NASA has completed a number of remedial investigations and has removed contaminated source materials from various WSTF industrial areas. The 200, 300, 400, and 600 areas are under post-closure care, with caps completed in 1989. NASA continued to investigate the vadose zone[1] below each of the caps to determine the potential for continued groundwater contamination (NASA 2013a; 2014a; 2014b). In 1996, NASA developed its plan for remediating groundwater contamination at the Site using a three-phase approach: 1) stabilizing the leading edge of the groundwater plume in the alluvial aquifer, 2) intercepting the high concentration portion of the plume within fractured bedrock in the mid-plume constriction area, and 3) investigating contaminant source areas for remediation. Routine groundwater monitoring and remedial investigations are ongoing (NASA 2013a; 2014a; 2014b).

There are over 220 groundwater monitoring locations across the Site from which NASA collects groundwater samples to analyze for volatile organic compounds (VOCs) (e.g., trichloroethene [TCE], tetrachloroethene [PCE]), n-nitrosodimethylamine [NDMA], and several inorganics (e.g., arsenic, chromium, nickel). As part of their groundwater remediation plan, NASA also operates two groundwater treatment systems: the plume front treatment system (PFTS) and the mid-plume interception and treatment system (MPITS) (NASA 2014a). The PFTS is an interim measure, pump-and-treat groundwater remediation system at the leading edge of the contaminant plume designed to stabilize plume migration. The PFTS utilizes air stripping and ultraviolet photolysis to remove VOCs and nitrosamines from the groundwater, and the treated water is re-injected into the aquifer (NASA 2014a). The MPITS is a similar system to the PFTS and was built to intercept groundwater with high contaminant concentrations within the fractured bedrock of the mid-plume constriction area (NASA 2014a).

A rough estimate of the time that will be required for full remediation of contaminated groundwater can be calculated by dividing the total mass of contamination in the aquifers

[1] The unsaturated zone, below the surface of the land, down to the first saturated zone (aquifer).

by the mass removed annually through remediation (i.e., if an aquifer has 1,000 kg of a contaminant and the contaminant is being removed at a rate of 10 kg/year, then a simplified calculation is that it will take 100 years to return the aquifer to an uncontaminated state). This approach does not account for the likelihood that recovery rates will decline over time. Reported data for the mass of contaminants in the aquifer and recent rates of mass removal by the remediation systems are provided in NASA reports (2013a; 2014a). An estimated 75 kg of TCE is being removed per year in the plume front area and an estimated 4,663 kg was released; assuming that 65 percent of the mass is in the bedrock, it would take approximately 40 years to remove all of the TCE. Based on the information in the NASA reports, the mass of contaminants in the mid-plume area is being removed at a slower rate. If remedial activities continue in the future at rates recently observed and documented in NASA reports, it can be assumed that a contaminant plume will continue to exist at the Site for more than 100 years. Additional information on the Site and groundwater monitoring and remediation can be found in Site reports (e.g., NASA 2013a; NASA 2014a).

2.3 HISTORY OF CURRENT AND PAST OPERATIONS AND SOURCES OF RELEASES

The waste impoundments and storage tanks (described in Section 2.2) leaked wastes and hazardous substances, which infiltrated soils and groundwater. The various industrial areas and sources of contamination at the Site are described briefly in Exhibit 2-2 (NASA 2013a, NASA 2014b). Though this PAS is focused on CERCLA hazardous substances, additional compounds, such as Freon, were released along with the hazardous substances described below. Little historical data are available describing the exact nature and amounts of chemical wastes that were contained or released at WSTF, therefore NASA derived release estimates based on numerical models (NASA 2013a; NASA 2014b).

EXHIBIT 2-2 SUMMARY OF CURRENT AND PAST OPERATIONS AND SOURCES OF RELEASES

INDUSTRIAL AREA	FACILITIES AND ACTIVITIES	CONTAMINANTS
100	Administrative offices and support facilities, including firefighting, vehicle maintenance, and warehousing facilities. The 100 Area Burn Pit, in operation from 1969 to 1983, was a potential source of contamination to the subsurface. NASA estimates approximately 1,000 gallons of flammable liquids were burned in the pit each year during operation.	• Specific contaminants unknown, but unlikely to be a significant source of contamination.
200	Laboratories, clean rooms, hardware fabrication and various testing facilities, including materials, oxygen, detonation, and hypervelocity impact testing facilities. Two of the major sources of contamination in the 200 Area are the Chemistry Lab Tank and the Clean Room Tank, which are considered the primary sources of TCE in groundwater. The Chemistry Lab Tank, installed in 1964 with a storage capacity of 1,500 gallons, received wastes from metallurgical and etching laboratory operations including propellants and solvents. The 4,000 gallon Clean Room Tank received wastes generated by precision cleaning of flight hardware from 1964 to 1979 including TCE and other substances. The 200 Area is also the primary source of PCE, with lesser contributions from the 100, 300, 400, and 600 Areas. This HWMU was closed in 1989 and has been under post-closure care.	• Primary source of TCE; • Also likely source of Freon 113, Freon 11, chromic acid, isopropyl alcohol, and other solvents.
300	Altitude chambers, engine test stands, and a former wastewater treatment impoundment (a closed HWMU). The 300 Area surface impoundments, which began operations in 1965, have leaked, resulting in one of the primary sources of NDMA at WSTF. TCE was also used in this area to clean pipelines and is likely a source for TCE contamination in groundwater.	• Primary source of NDMA; • Also likely source of TCE, hydrazine, monomethyl hydrazine, unsymmetrical dimethylhydrazine, Aerozine 50, nitrogen tetroxide, Freon 113, and isopropyl alcohol.
400	Altitude chambers, engine test stands, and a former wastewater treatment impoundment (a closed HWMU). Surface impoundments in this area, which became operational in 1964, are another source of NDMA. Similar to the 300 Area, TCE was used here to clean pipelines.	• Primary source of NDMA; • Also likely source of hydrazine, monomethyl hydrazine, unsymmetrical dimethylhydrazine, Aerozine 50, nitrogen tetroxide, Freon 113, isopropyl alcohol, Freon 11, Freon 21, and TCE.
500	Two separate areas with cryogenic gas storage; breathing air generation; and fuel, oxidizer, and waste fuel storage. Another source of NDMA is the 500 Area fuel storage area, which consists of a 20,000 gallon storage tank with secondary containment that is used to store hydrazine fuel. No further investigation was recommended in this area as NASA concluded that NDMA levels in soil were below NMED soil screening levels during their investigation in 2000 and 2001.	• Potential minor source of NDMA.

INDUSTRIAL AREA	FACILITIES AND ACTIVITIES	CONTAMINANTS
600	Groundwater supply wells, groundwater monitoring and remediation systems, wastewater treatment lagoons, and a closed HWMU. The 600 Area surface impoundments, in operation from 1968 to 1986, contained saltwater and an undetermined amount of hazardous waste from the 200 Area. NASA recently performed a soil vapor extraction pilot test in 2012 to determine if the vadose zone is a continuing source of contamination to groundwater. Although NASA concluded that the vadose zone is not a source of continuing contamination, NMED has not yet approved a final recommendation for this area.	• Unlikely a source of continuing contamination to groundwater.
700	Closed landfill and high energy blast facilities. The 24 acre landfill was used for the disposal of solid waste between 1964 and 1997 and is a source of groundwater contamination. Routine groundwater monitoring is performed in this area.	• Potential source of groundwater contamination. • Hazardous wastes (e.g., spent solvents, waste paints, and soft goods [e.g., textiles] contaminated with hydrazine and oxidizer) may have been disposed to this landfill prior to 1987.
800	Hazardous fluids and materials test cells.	• Unknown.
Notes: Information from NASA 2014b.		

2.4 HAZARDOUS SUBSTANCES RELEASED

As discussed in Section 2.2, hazardous substances at the Site have been released from multiple sources. Available NASA WSTF reports identify three CERCLA hazardous substances, listed below, which are the focus of this PAS. Each of the three primary contaminants is present in groundwater over a large area.

- **Trichloroethene (TCE)** – TCE was primarily used for component servicing and cleaning. TCE is a clear, colorless, and nonflammable liquid that possesses a sweet and fruity odor, which is characteristic of chloroform. When in the atmosphere, TCE is destroyed by photooxidation with a half-life of three to eight days in the summer and approximately two weeks in the winter (ATSDR 2007). Thus, TCE's transport is limited in air, but can be continually volatilized from contaminated surface waters or emissions sources, ensuring its persistence in air. The biodgredation in anaerobic conditions (e.g., groundwater) is slow, making it relatively persistent in subsurface waters. Studies indicate that TCE has a low tendency to bioaccumulate (ATSDR 1997).

  Studies on the neurological effects of acute TCE inhalation in animals have produced results similar to the human studies (ATSDR 1997). Effects from human occupational studies include central nervous system depression, decreased appetite, gastrointestinal irritation, headaches, mucous membrane irritation, skin irritation, developmental abnormalities, liver damage, renal failure, and cardiac dysrhythmias, among others (ATSDR 2007).

- **Tetrachloroethene (PCE)** – PCE was also primarily used for component servicing and cleaning. It is a synthetic chemical with physical properties (e.g., color, scent) similar to TCE. Also similar to TCE, PCE can cause central nervous system depression, liver damage, kidney damage, and causes skin, throat, and eye irritation in humans (ATSDR 2008).

- **N-Nitrosodimethylamine (NDMA)** – NDMA was primarily used in propulsion system testing programs (e.g., production of rocket fuel). It is a yellow liquid with faint characteristic or no distinct color. It is highly mobile in soil, giving it the potential to leach into groundwater (EPA 2014 and references therein).

  Effects include headache, fever, nausea, jaundice, vomiting, abdominal cramps, enlarged liver, dizziness, and reduced function of liver, kidneys, and lungs (EPA 2014; ATSDR 1989). In animal studies, exposure has caused tumors of the liver, respiratory tract, kidneys, and blood vessels (EPA 2014; WHO 2006; and references therein).

2.5 POTENTIALLY RESPONSIBLE PARTIES

The Trustee has identified NASA and the Department of Defense as the potentially responsible parties, as defined under CERCLA. From 1963 through the present, the WSTF has been owned and operated by NASA. At this time there are no other identified sources for the hazardous substances at the Site.

2.6 DAMAGES EXCLUDED FROM LIABILITY UNDER CERCLA OR CWA

Regulations at 43 CFR § 11.24(b) provide that trustees must determine whether the damages being considered are barred by specific defenses or exclusions from liability under CERCLA or the Clean Water Act (CWA). These determinations are as follows:

> *"(1) The authorized official shall determine whether the damages:*
>
> *(i) Resulting from the discharge or release were specifically identified as an irreversible and irretrievable commitment of natural resources in an environmental impact statement or other comparable environmental analysis, that the decision to grant the permit or license authorizes such commitment of natural resources, and that the facility or project was otherwise operating within the terms of its permit or license, so long as, in the case of damages to an Indian tribe occurring pursuant to a Federal permit or license, the issuance of that permit of license was not inconsistent with the fiduciary duty of the United States with respect to such Indian tribe; or*
>
> *(ii) And [sic] the release of a hazardous substance from which the damages have resulted have not occurred wholly before the enactment of CERCLA; or*
>
> *(iii) Resulted from the application of a pesticide product registered under the Federal Insecticide, Fungicide, and Rodenticide Act 7 USC 135-135k; or*
>
> *(iv) Resulted from any other Federally permitted release, as defined in section 101 (10) of CERCLA; or*
>
> *(v) Resulting from the release or threatened release of recycled oil from a service station dealer described in section 107(a)(3) or (4) of CERCLA if such recycled oil is not mixed with any other hazardous substance and is stored, treated, transported or otherwise managed in compliance with regulations or standards promulgated pursuant to section 3014 of the Solid Waste Disposal Act and other applicable authorities."*

The trustees must also determine whether the discharge meets one or more of the exclusions provided in section 311(a)(2) or (b)(3) of the CWA.

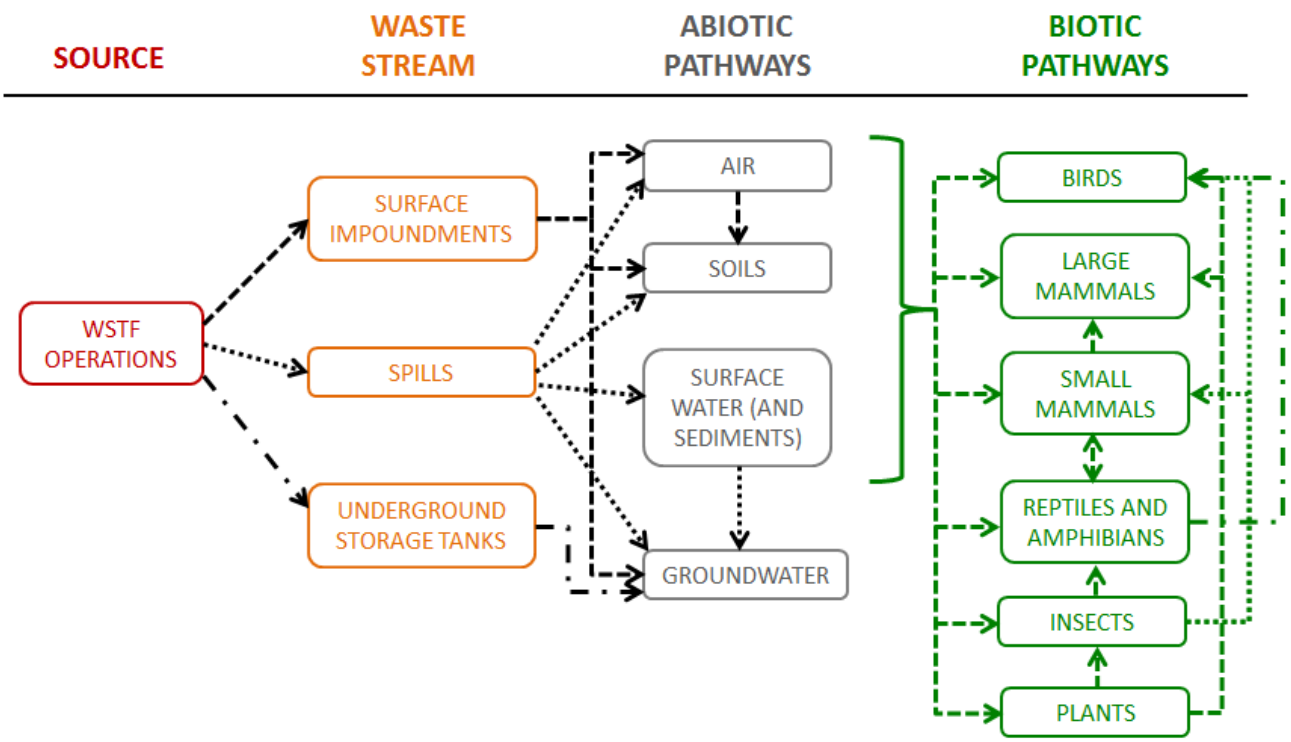
The Trustee determined, based on currently available information, that the potential injuries referred to herein do not meet any of the above defenses or exclusions, nor are they subject to the exceptions to liability provided in 107(f), (i), and (j) and 114(c) of CERCLA, and section 311 (a)(2) or (b)(3) of the CWA. Therefore, the continuation of an assessment of injuries to natural resources is not precluded.

SECTION 3 | PRELIMINARY IDENTIFICATION OF RESOURCES POTENTIALLY AT RISK

3.1 PRELIMINARY IDENTIFICATION OF PATHWAYS

Natural resources have likely been exposed to hazardous substances through the sources and physical transport processes (i.e., pathways) described in Section 2. As a result, injuries to resources have likely occurred in the form of a reduction in services. A summary of the sources and potential pathways is presented in Exhibit 3-1.

EXHIBIT 3-1 CONCEPTUAL SITE MODEL OF POTENTIAL PATHWAYS AND RECEPTORS



3.2 POTENTIALLY AFFECTED RESOURCES AND RESOURCE SERVICES

The Trustee is authorized to act as a trustee of natural resources for purposes of pursuing compensation on behalf of the public. CERCLA broadly defines "natural resources" to include:

> *"…land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States… , any State or local government, any Indian tribe, or, if such resources are subject to a trust restriction on alienation, any member of an Indian tribe."* 42 USC § 101(16)

Trusteeship also extends to the ecosystems supporting the resources 40 CFR § 300.600.

According to the regulations, quantification of natural resource damages involves consideration of the reduction in "services" provided by the resources. See generally 43 CFR § 11.70 – 11.84. Accordingly, the regulations provide that the PAS will contain a preliminary estimate of the services of the resources identified as potentially affected (43 CFR § 11.25(e)(2)). Services are defined as "the physical and biological functions performed by the resource, including the human uses of those functions" (43 CFR § 11.14(nn)). Services may include "both public use and nonuse values such as existence and bequest values" (43 CFR § 11.83 (c)).

There is evidence that sources of hazardous substances exist and potential pathways for those hazardous substances to reach natural resources are likely complete. Based on readily available data, injury to groundwater has been determined and described in this PAS. However, as additional information becomes available, other natural resource injuries may be determined (e.g., for soil or biological resources), and these injuries may be evaluated at a later time. Therefore, descriptions of all potentially injured natural resources are provided below.[2]

3.2.1 GROUNDWATER RESOURCES

The surficial site lithology consists of coalescent alluvial fan deposits of the late Tertiary Santa Fe Group. Underlying the Santa Fe Group alluvium in the area of the facilities are Paleozoic limestone and Tertiary andesite bedrock at a depth of 15 to 160 feet below ground surface (bgs). Groundwater is typically located at depths of 100 to 180 feet within fractured bedrock (NASA 2012).

In the Mid-plume area, Tertiary rhyolites and tuff are present at a depth of 300 to 350 feet bgs. Groundwater is typically located at depths ranging from 320 to 380 feet bgs within fractured bedrock. A flow-banded rhyolite has been identified as potentially serving as a localized barrier to flow, such that the contaminant plume bifurcates around this unit. A major fault, the Western Boundary Fault, is located to the west of the Mid-Plume area. West of the fault the bedrock is several hundred to a few thousand feet bgs, and the plume is located within the Santa Fe Group alluvial and basin-fill materials.

[2] At this time, air is considered a pathway and is not described in this PAS.

The groundwater table slopes west from the San Andres Mountains toward the Rio Grande. In areas where the water table is in bedrock, groundwater typically moves through an irregular fracture system under the influence of a steep hydraulic gradient of 0.05 ft/ft. Faults, fractures, and solution channels locally influence flow directions, which can lead to uncertainty in understanding and controlling contaminant movement. The gradient flattens substantially to 0.0002 ft/ft in the thick Santa Fe Group basin fill, where flow is comparatively even (NASA 2002, 2012).

Based on available information, groundwater in the area was potable prior to releases from facility operations (Wilson *et al.* 1981).

Groundwater Resource Services

The services provided by groundwater have been widely documented, and range from provision of water for drinking, agricultural, and industrial purposes, to drought protection, assimilative capacity, and prevention of land subsidence (e.g., NRC 1997, EPA 1995). Changes in the quality or quantity of these services influence groundwater benefit values.

As recognized by the regulations, services include both use and non-use values (Exhibit 3-2). Use values may be associated with current extractive uses or *in situ* services. Non-use values may be motivated by a desire to preserve groundwater for future generations (bequest value) or simply to protect and maintain natural resources in an uncontaminated state (existence value).

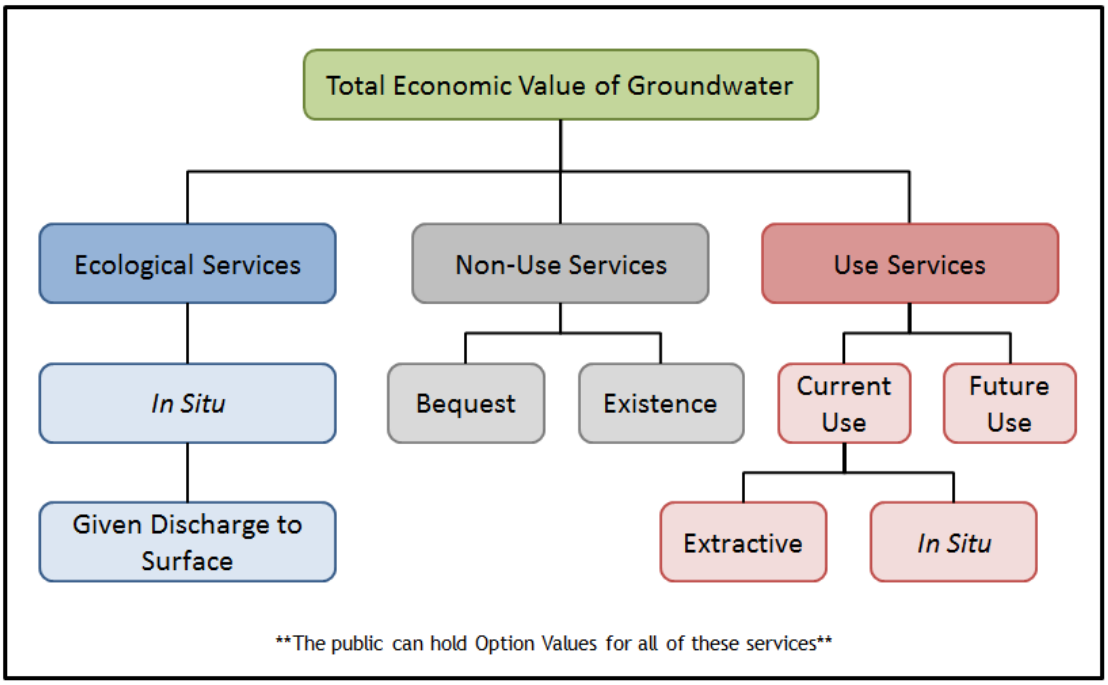
Because uncertainty exists regarding the quantity and quality of groundwater services that may be available in the future, and the level of demand for those services, the public also holds an option value for groundwater. Several economic studies have estimated households' willingness to pay for protection programs and other measures that would reduce or eliminate future threats of contamination (e.g., see Bergstrom *et al.* 2001 for a summary of these studies). This value – a total value for groundwater services under uncertain future conditions of groundwater demand and supply – is referred to as *option value* (Freeman 2003). Option value is particularly relevant in areas where water may become increasingly scarce, where demand for groundwater is highly uncertain, or where there are multiple sources of contaminants threatening the viability of groundwater as a potable water source. The conclusion that the public holds a value for the option to use groundwater in the future, absent current use, is also supported by EPA's policy guidance to its CERCLA groundwater restoration program, which states:

> *"Recognizing that ground waters of the United States are valued natural resources, the Agency carries out CERCLA response actions in a manner that ensures Superfund remedies are protective by, among other things, restoring contaminated groundwater to benefit uses."* (EPA 2009)

The value placed on groundwater by New Mexico is demonstrated by the statutory and regulatory scheme the state has developed for its protection. The New Mexico Water Quality Act, NMSA 1978, §§ 74-6-1 *et seq.*, created the Water Quality Control

Commission (WQCC) with the authority to adopt water quality standards and regulations to prevent or abate water pollution, including in aquifers. Pursuant to that authority, the WQCC adopted regulations at New Mexico Administrative Code (NMAC) 20.6.2 for ground and surface water protection. NMAC 20.6.2.3101 declares that the purpose of "controlling discharges onto or below the surface of the ground is to protect all groundwater of the state of New Mexico which has an existing concentration of 10,000 mg/l or less TDS for present and potential future use as domestic and agricultural water supply, and to protect those segments of surface waters which are gaining because of ground water inflow, for uses designated in the New Mexico Water Quality Standards" (emphasis added).

EXHIBIT 3-2 GROUNDWATER SERVICES



3.2.2 GEOLOGIC RESOURCES (SOILS)

The Site is located within the Mexican Highland Section of the Basin and Range Province (NASA 2002). The Basin and Range Province is an extensional tectonic feature that is characterized by north-trending mountain ranges separated by basins. The soils in this area are sandy to silty, loamy soils and are associated with alluvial fan deposits. The Site also has abundant, shallow arroyos that flow to the west.[3]

[3] An arroyo is an ephemeral or intermittent stream bed that is typically only active during precipitation events, either temporarily or seasonally.

Soils at the Site provide a variety of services including nutrient recycling, facilitating energy transfer up the food chain, and allow for the production of plants and invertebrates. Soil resources are necessary for breeding, nesting, foraging, and resting habitat for a variety of migratory bird species, including State and Federally listed endangered and threatened animals. Geologic resources are essential to the long-term survival and reproduction of plants and invertebrates (e.g., Federally endangered Sneed Pincushion Cactus [*Coryphantha sneedii*]), which function as the base of the food chain.

Although NASA work plans indicate the collection and analytical testing of soil boring samples (e.g., NASA 2013b), limited data are publicly available. Injury to this resource is not determined at this time, but may be investigated during the assessment.

3.2.3 SURFACE WATER RESOURCES (INCLUDING SEDIMENTS)

As mentioned above, numerous arroyos exist in this desert landscape, but are active only during temporary or seasonal precipitation events. As a result, the arroyo sediments behave more like soils for most of the year. There are few distinct stream channels extending from the western side of the San Andreas Mountains (the side adjacent to the Site), but heavy thunderstorms do result in swift, shallow flows that begins to infiltrate the coarser alluvium that exists within a mile of the slope break (NASA 2002). Water from these events typically remains within the semi-permanent channels on the western mountain flank and then flow as sheet-flood onto the alluvial plain. Only very heavy precipitation events cause runoff to extend beyond the mountainside.

Though infrequent (i.e., the area receives an average of 10 inches of rain per year), precipitation could serve as a pathway for contaminants in surface soils and sediments to be transported to areas away from the Site. At this time, insufficient information exists to determine injury to this resource. However, cost-effective research conducted during the assessment may indicate injury to surface water and sediments.

3.2.4 BIOLOGICAL RESOURCES

The biological community in the area of the Site is typical of an arid desert environment, with shrubs and grasses dominating the vegetative community. Some species include burro grass (*Scleropogon brevifolius*), yucca (*Yucca* spp.), snakeweed (*Xanthocephalum sarothrae*), sagebrush (*Artemisia* spp.), and honey mesquite (*Prosopis glanulosa*). The most dominant grasses are fluff grass (*Erioneuron pulchellum*), tobosa grass (*Hilaria mutica*), and alkali sacaton (*Sporobolus airoides*), while patches of grama grasses (*Bouteloua* spp.) occur less frequently. Larger plant species include tarbush (*Flourensia cernua*), creosotebush (*Larrea tridentata*), Russian thistle (*Salsola kali*), lotebush (*Ziziphus obtusifolia*), Morman tea (*Ephedra trifurca*), littleleaf sumac (*Rhus microphylla*), night shade (*Solanum eleagnifolium*), narrow leaf globemallow (*Sphaeralcea angustiforlim*), Western pink verbena (*Verbena ambrosifollia*), soaptree yucca (*Yucca elata*), and the desert Christmas cactus (*Opuntia leptocaulis*). Ball cacti (*Coryphantha vivipara*) are also located in the area, but have not been seen in bloom to differentiate between subspecies (NASA 2002).

These plant species support higher trophic level communities of biota, including insects, small mammals, birds, and larger mammals such as deer and antelope. These grass and scrubland areas provide important hunting opportunities for raptors to capture small to medium-sized prey items. For example, Swainson's (*Buteo swainsoni*) and red-tailed (*Buteo jamaicensis*) hawks have been observed on power poles along the Site's road system, feeding on prey, searching the desert floor for prey, and sunning themselves in the morning (NASA 2002).[4] Golden eagles (*Aquila chrysaetos*) are also found in the area, using upland habitats in the nearby San Andreas Mountains for nesting while hunting in the lowland areas.

There is evidence that other species utilize the Site area as well, ranging from reptiles to large mammals. These species may have also been exposed to and potentially injured by Site-related releases of hazardous substances:

> **Reptiles** – specimens of the Texas horned lizard (*Phrynosoma cornutum*) have been found in the Site area (NASA 2002).
>
> **Mammals** – the most common mammals include the desert cottontail (*Sylvilagus auduboni*), blacktailed jackrabbit (*Lepus californicus*), white-throated woodrat (*Neotoma albigula*), mule deer, and banner-tailed kangaroo rat (*Dipodomys spectablis*). Coyotes (*Canus latrans*) and gray foxes (*Urocyon cinereoargenteus*) have also been observed (NASA 2002).

Though data and information are scarce regarding biological resources and their exposure to hazardous substances at the Site, additional information may become available, or cost-effective research or literature information may be utilized during the assessment to determine injury to biota.

3.3 EXPOSED AREAS AND CONTAMINANT CONCENTRATION ESTIMATES

Through the processes noted in Section 2 and Exhibit 3-1, Site-related hazardous substances have come to be located in groundwater at the Site, contaminating the groundwater resources.

The regulations define injury as a:

> *"…measurable adverse change, either long- or short-term, in the chemical or physical quality, or the viability of a natural resource resulting either directly or indirectly from exposure to a release of a hazardous substance, or exposure to a product or reactions resulting from the release of a hazardous substance."* (43 CFR § 11.14 (v))

Under the regulations, injury to groundwater has occurred when a release of hazardous substances has caused one of the following:

> *(i) Concentrations of substances in excess of drinking water standards…;*

[4] Large stick nests made of honey mesquite and desert sumac were also found in the mid-plume constriction area, providing an indication that some bird species nest in the area.

(ii) Concentrations of substances in excess of water quality criteria, established by section 1401(1)(d) of the SDWA…;

(iii) Concentrations of substances in excess of applicable water quality criteria, established by section 304(a)(1) of the CWA…; or

(iv) Concentrations of substances sufficient to have caused injury as defined in paragraphs (b), (d), (e), or (f) of this section to surface water, air, geologic, or biological resources, when exposed to ground water." (43 CFR § 11.62(c)(1)(i-iv))

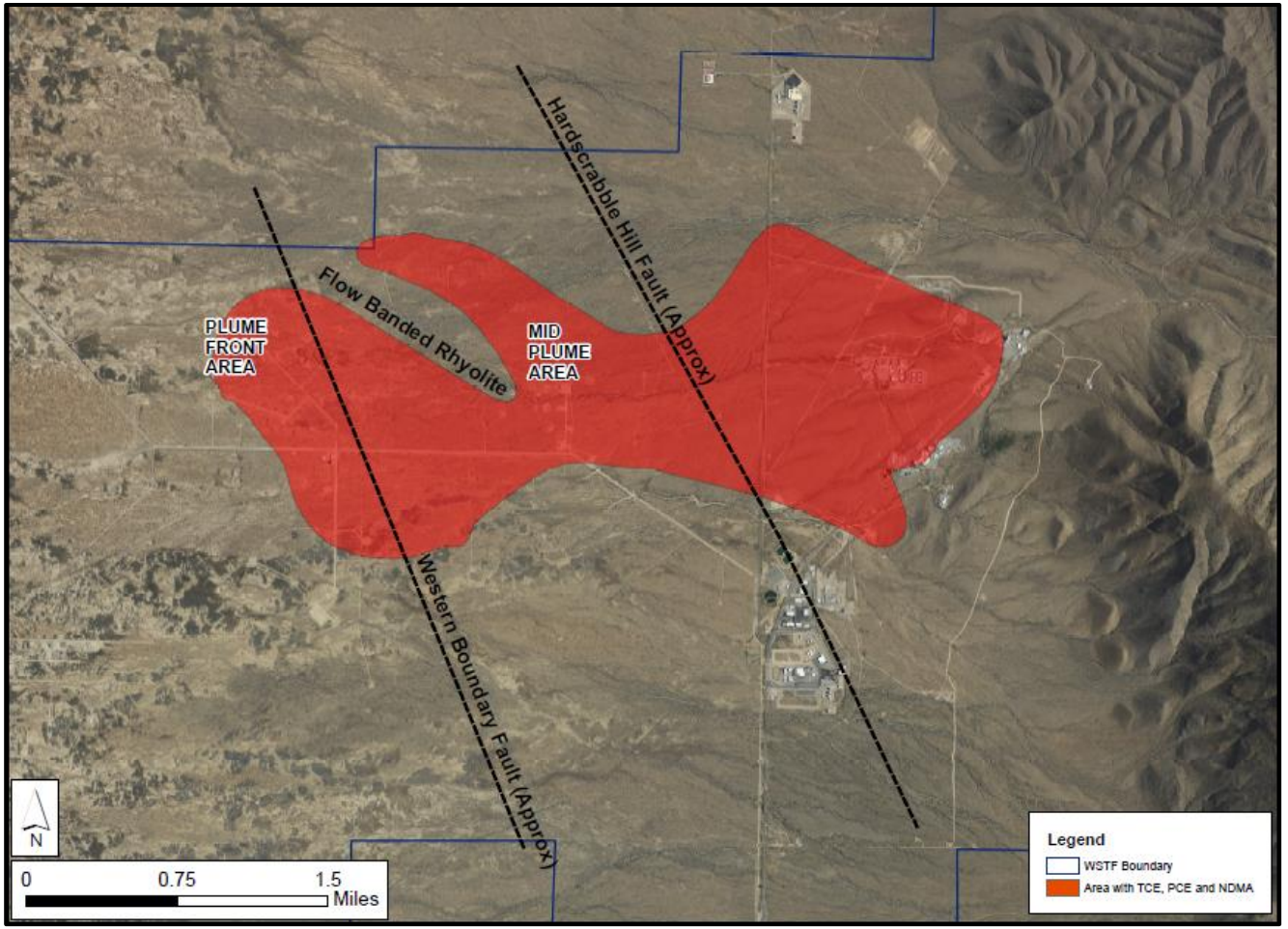
Groundwater contaminant concentrations exceed Maximum Contaminant Levels (MCLs), indicating injury to the groundwater resource. Example maximum contaminant concentrations in Site groundwater samples collected by NASA are provided in Exhibit 3-3. Further, groundwater contaminant concentrations exceed cleanup levels provided under the NMED Hazardous Waste Permit (NMED 2009). Maximum concentrations in TCE and PCE exceed the respective MCLs by over 100-fold and 7-fold respectively, and maximum concentrations in NDMA exceed its clean-up level. Areas where groundwater currently exhibits contamination above cleanup levels have been defined in NASA reports and are shown in Exhibit 3-4. Thus, the Trustee has determined that trust natural resources have been injured.

EXHIBIT 3-3 DATA ON GROUNDWATER CONTAMINATION AT WSTF

CONTAMINANT	MAXIUMUM OBSERVED CONTAMINANT CONCENTRATIONS (PPB)[1]	PLUBE BOUNDARY / CLEANUP LEVEL (PPB)[1]	MAXIMUM CONTAMINANT LEVEL (PPB)[2]
Trichloroethene (TCE)	600[3]	5[4]	5
Tetrachloroethene (PCE)	38	1.1[5]	5
N-Nitrosodimethylamine (NDMA)	29.9	0.0042	N/A

[1] Values in source document may originally be in other units, e.g. NDMA was reported in parts per trillion. Maximum concentration values were provided by NMED. Plume boundary levels are as shown in maps in NASA 2013a and can be considered as the level to which remediation may be required (NASA 2013a).
[2] Values are EPA regulated drinking water contaminant standards: http://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants.
[3] Database contains TCE concentrations up to 2,000 ppb, but values greater than 600 ppb are qualified with the following explanation; "… results for the sample dilution are much higher than expected. A dilution error at the laboratory is the suspected cause of the elevated results. However, no evidence of analytical error was found by laboratory personnel."
[4] The TCE delineation value of 5 ppb on Figure 4 of NASA 2013a differs from the cleanup value of 2.6 ppb in the referenced report.
[5] The PCE delineation value of 1.1 ppb on Figure 5 of NASA 2013a differs from the cleanup value of 5 ppb in the referenced report.

EXHIBIT 3-4 AREA OF CONTAMINATED GROUNDWATER BENEATH WSTF



Map generated using digitized plume boundaries for NDMA, PCE, and TCE presented in NASA (2013a) and professional judgment regarding hydrology and geology.

SECTION 4 | PREASSESSMENT SCREEN CRITERIA

4.1 SUMMARY OF PREASSESSMENT SCREEN CRITERIA AND INFORMATION

Title 43 CFR § 11.23(e) outlines five criteria that must be met before trustees may proceed with a NRDA. These criteria are:

1. *"A discharge of oil or a release of a hazardous substance has occurred;*
2. *Natural resources for which the trustees may assert trusteeship under CERCLA have been or are likely to have been adversely affected by the discharge or release;*
3. *The quantity and concentration of the discharged oil or released hazardous substance is sufficient to potentially cause injury, as that term is used in this part, to those natural resources;*
4. *Data sufficient to pursue an assessment are readily available or likely to be obtained at reasonable cost; and*
5. *Response actions, if any, carried out or planned do not or will not sufficiently remedy the injury to natural resources without further action."*

These criteria are satisfied for the releases of hazardous substances covered by this PAS, as presented below.

CRITERION 1 – A RELEASE OF A HAZARDOUS SUBSTANCE HAS OCCURRED

There have been releases of hazardous substances, as defined by CERCLA, from the WSTF to the environment. These releases have occurred as direct discharges, infiltration from unlined waste ponds, and leaks from underground storage tanks. Hazardous substances that have been released include, but are not limited to, TCE, PCE, and NDMA. These substances are listed as hazardous substances in Federal Regulations at 40 CFR 302.4, pursuant to section 102(a) of CERCLA and section 311 of the Federal Water Pollution Control Act.

CRITERION 2 – NATURAL RESOURCES FOR WHICH THE TRUSTEES MAY ASSERT TRUSTEESHIP UNDER CERCLA HAVE BEEN OR ARE LIKELY TO HAVE BEEN ADVERSELY AFFECTED BY THE RELEASE

The Trustee is designated under 42 USC § 9607 (f)(2)(B), 33 USC § 2706(b)(3), 33 USC § 1321(f)(5), and NMSA 1978, §§ 75-7-2., to act on behalf of the public as a trustee for natural resources including their supporting ecosystems, belonging to, managed by,

controlled by, or appertaining to the State of New Mexico. Accordingly, the Trustee has trusteeship over groundwater, which has been exposed to releases of hazardous substances from the Site (i.e., TCE, PCE, and NDMA). Finally, groundwater resources at the Site have been injured due to the exposure to Site-related hazardous releases as described in Criterion 3, below.

CRITERION 3 – THE QUANTITY AND CONCENTRATION OF THE RELEASED HAZARDOUS SUBSTANCES ARE SUFFICIENT TO POTENTIALLY CAUSE INJURY

Injury is defined as a measurable adverse change, either long or short-term, in the chemical or physical quality or viability of a natural resource resulting either directly or indirectly from exposure to a discharge or release of a hazardous substance, or exposure to a product of reactions resulting from such discharge or release.

Under the regulations, injury to groundwater has occurred when a release of hazardous substances has caused one of the following:

> *"An injury to the ground water resource has resulted from the discharge of oil or release of a hazardous substance if one or more of the following changes in the physical or chemical quality of the resource is measured:*
>
> *(i) Concentrations of substances in excess of drinking water standards, established by sections 1411-1416 of the SDWA, or by other Federal or State laws or regulations that establish such standards for drinking water, in ground water that was potable before the discharge or release;*
>
> *(ii) Concentrations of substances in excess of water quality criteria, established by section 1401(1)(d) of the SDWA, or by other Federal or State laws or regulations that establish such criteria for public water supplies, in ground water that before the discharge or release met the criteria and is a committed use, as the phrase is used in this part, as a public water supply;*
>
> *(iii) Concentrations of substances in excess of applicable water quality criteria, established by section 304(a)(1) of the CWA, or by other Federal or State laws or regulations that establish such criteria for domestic water supplies, in ground water that before the discharge or release met the criteria and is a committed use as that phrase is used in this part, as a domestic water supply; or*
>
> *(iv) Concentrations of substances sufficient to have caused injury as defined in paragraphs (b), (d), (e), or (f) of this section to surface water, air, geologic, or biological resources, when exposed to ground water."* (43 CFR § 11.62(c)(1)(i-iv))

The quantity and concentrations of released hazardous substances have injured natural resources at the Site. Contaminant chemistry has been measured in groundwater and compared to maximum contaminant levels for drinking water (Exhibit 3-3). Exceedances of these thresholds indicate an injury to the groundwater resources.

CRITERION 4 – DATA SUFFICIENT TO PURSUE AN ASSESSMENT CAN BE OBTAINED AT A REASONABLE COST

Data currently exist from past and ongoing groundwater monitoring efforts (e.g., NASA 2013a; NASA 2014a). These data were collected from areas surrounding the WSTF to determine the extent of the groundwater contaminant plume as well as from the plume itself.

Data sufficient to pursue an assessment can be obtained at a cost that is substantially less than the anticipated monetary damage amount. Any efforts to gather additional data can be scaled to the likely scale of the injury and damage claim.

CRITERION 5 – RESPONSE ACTIONS, IF ANY, CARRIED OUT OR PLANNED DO NOT OR WILL NOT SUFFICIENTLY REMEDY THE INJURY TO NATURAL RESOURCES WITHOUT FURTHER ACTION

Remediation of injured groundwater is ongoing and may contribute to the long-term restoration of the groundwater resource. However, remediation efforts are not anticipated to address interim lost use (i.e., the injuries and lost services from the time of the hazardous substance releases) or necessarily ensure a return of natural resources to baseline conditions. Therefore, additional compensatory restoration may be required to make the public whole for these hazardous substance releases and the interim natural resource service losses they have induced.

4.2 CONCLUSION

Following the review of information described in this PAS, the Trustee has made a preliminary determination that the criteria specified in 43 CFR Part 11 have been met. The Trustee has further determined that there is a reasonable probability of making a successful claim for damages with respect to natural resources over which the Trustee has trusteeship. Therefore, the Trustee has determined that an assessment of natural resource damages is warranted. The information contained herein shall be used to direct further investigations and does not preclude consideration of other resources later found to be affected or other parties identified as responsible for hazardous substance releases.

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