# CHAPTER 3

# DESCRIPTION OF THE AFFECTED ENVIRONMENT

## 3.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

This chapter provides information and data for the affected environment at the proposed CISF and surrounding vicinity. Topics include land use (3.1), transportation (3.2), geology and soils (3.3), water resources (3.4), ecological resources (3.5), meteorology, climatology, and air quality (3.6), noise (3.7), historic and cultural resources (3.8), visual and scenic resources (3.9), socioeconomics (3.10), environmental justice (3.11), public and occupational health (3.12), and waste management (3.13).

## 3.1 Land Use

This section describes land uses near the proposed CISF. It also provides a discussion of off-site areas and the regional setting and includes a map of major land use areas. Major transportation corridors are identified in Section 3.2.

WCS controls approximately 5,666 ha (14,000 acres) of land in northwestern Andrews County. Within this property boundary, WCS currently operates a commercial waste management facility on approximately 541 ha (1,338 acres) of land (the existing facility).The CISF would be located north of and adjacent to the existing facility, approximately 300 m (984 ft) from the north edge of the rail loop as seen in Figure 3.1-1. The approximate coordinates for the centroid of Phase I of the CISF facility are Latitude 32° 27’ 08” N and Longitude 103° 03’ 35” W with an elevation of 1,043.587 m (3,423.843 ft) above mean sea level (msl).

The proposed CISF would be a 130 ha (320 acre) plat situated within Andrews County, north of Texas State Highway 176, about 0.6 km (0.37 mi) from the Texas/New Mexico state line (Figure 3.1-1). It is located north of WCS’ existing radioactive waste storage, processing, and disposal facilities and is surrounded by WCS’ controlled property. The proposed CISF is currently unfenced, except for a gravel-covered road and a railroad spur that borders the south side of the property, and it is undeveloped.

The CISF would be located near the boundary between the Southern High Plains Section (Llano Estacado) of the Great Plains Province to the east and the Pecos Plains Section to the west. The boundary between the two sections is the Mescalero Escarpment, locally referred to as Mescalero Ridge. This part of Andrews County is a gently southeastward sloping plain with a natural slope of about 2.4 to 3 m (8 to 10 ft) per mi as seen on the topographic map in figure 3.1-2. The Elliott Littman oil field is to the northwest, the Freund and Nelson oil fields are to the south, the Paddock South and Drinkard oil fields are to the southwest, and the Fullerton oil field is to the east. On-site soils are primarily of the undulating Blakeney and Conger soil association (76%), the Triomas and Wicket soil association (8%), the Ratliff soil association (14%), and the Jalmar-Penwell association (2%). These soils consist of well drained, fine sandy loam and fine sand underlain by gravelly loam and cemented material. On-site soils are common to areas used for rangeland and wildlife habitat; see section 3.5, Ecological Resources in this ER for more information.

The WCS controlled property contains several permitted and licensed facilities. WCS has two approved RCRA permits from the TCEQ and a TSCA authorization from the EPA. WCS also possesses Radioactive Material Licenses (RML) for the management and disposal of Low-Level Radioactive Wastes (LLRW) and uranium Byproduct Material License, respectively.

Land uses within a few miles of the CISF include agriculture, cattle ranching, drilling for and production from oil and gas wells, quarrying operations, uranium enrichment, municipal waste disposal, and the surface recovery and land farming of oil field wastes.

The Permian Basin Materials sand and gravel quarry and a large spoil pile are located west of the proposed CISF. Approximately 1.6 km (1 mi) west and adjacent to the quarry is the Sundance Services oil recovery and solids disposal facility. DD Landfarm, a non-hazardous oilfield waste disposal facility that closed in August 2013 and is undergoing decommissioning and post-closure monitoring, is located approximately 4 km (2.5 mi) west of the proposed CISF. Vacant land situated immediately to the north and east supports oil and gas production. Cattle are not allowed to graze on land controlled by WCS; however, cattle grazing on other nearby properties occur throughout the year. Approximately 2.5 km (1.6 mi) southwest of the proposed CISF, in Lea County, New Mexico, is the URENCO NEF. This plant enriches natural uranium by centrifuge for the commercial nuclear power industry. The Lea County Sanitary Waste Landfill is located approximately 3 km (1.8 mi) south/southwest of the proposed CISF, across New Mexico Highway 176, just across the Texas-New Mexico state line. Land further north, south and west has been mostly developed by the oil and gas industry. Land further east is ranchland.

Although various crops are grown within Andrews County, Texas and Lea County, New Mexico, local and county officials report there is no agricultural activity in the vicinity of the proposed

CISF, except for domestic livestock ranching. The principal livestock for both Andrews and Lea counties is cattle. Milk cows comprise a substantial portion of the cattle in Lea County; however, the nearest dairy farms are about 32 km (20 mi) northwest of the proposed CISF, near the city of Hobbs, New Mexico. There are no milk cows in Andrews County, Texas. The number of farms and acres of farmland decreased slightly within Lea County between 1992 and 1997, whereas the number of farms in Andrews County increased during this same timeframe.

Land use classification in the vicinity of the CISF is primarily rangeland, built-up land, and barren land. Rangeland is an extensive area of open land on which livestock graze and includes herbaceous rangeland, shrub and brush rangeland, and mixed rangeland. Built-up land and barren land constitute the other two land use classifications in the vicinity of the proposed CISF. The above indicated land use classifications are identical to those used by the USGS. No special land use classifications (e.g., Native American reservations, national parks, prime farmland) are within the vicinity of the proposed CISF.

Except for the proposed construction of the CISF, Eddie Lea County Alliance for a proposed CISF in Hobbs and the siting of the International Isotopes, Inc. depleted uranium hexafluoride de-conversion and fluorine extraction facility approximately 24 km (15 mi) west of Hobbs, New Mexico, there are no other known current, future, or proposed land use plans, including staged plans, for the proposed CISF or immediate vicinity. Similarly, as the proposed CISF is not subject to local or county zoning, land use planning, or associated review process requirements, there are no known potential conflicts with land use plans, policies, or controls.

The only industrial facilities located within 1.6 km (1 mi) of the proposed CISF boundary are URENCO USA, Permian Basin Materials and Sundance Services, Inc (Figure 3.1-3). There are no transportation or military facilities within 6.4 km (4 mi) of the proposed CISF. The closest transportation facility is the Lea County Airport, which is approximately 29 km (18 mi) from the proposed CISF. Cannon Air Force Base is the closest military facility at a distance of approximately 217 km (135 mi).

There are three counties (Andrews County, Texas Gaines County, Texas and Lea County, New Mexico) within a 24 km (15 mi) radius of the CISF. Andrews is the largest city within Andrews County. The City of Andrews has a small population with no substantial growth forecasted and is outside the 24 km (15 mi) radius. Hobbs is the largest city in Lea County and is the nearest population center of 25,000 or more. Hobbs is experiencing recent population growth rates on the order of 2% for 2013 to 2014; however, no substantial growth is expected. Hobbs is about 28.2 km (17.5 mi) northwest of the proposed CISF and thus is outside the 24 km (15 mi) radius. The 24 km (15 mi) radius area around the proposed CISF has a very low population supported by oil and gas production, some industry, and ranching. There is very little seasonal variation in the population. The nearest residences are situated approximately 6.1 km (3.8 mi) west of the CISF. Beyond is the city of Eunice, New Mexico which is approximately 8 km (5 mi) to the west of the CISF.

Except for a historical marker and picnic area approximately 5.5 km (3.3 mi) from the CISF at the intersection of New Mexico Highways 234 and 18, there are no known public recreational areas or state or federal parks within 8 km (5 mi) of the proposed CISF.

Ecosystems in and around the proposed CISF are typical of the much larger region of west Texas and adjacent areas of New Mexico. The terrain is gently rolling and characterized by shallow washes, some of which are bordered by trees. Soil texture ranges from clay loam to fine sand. Natural vegetation in the region consists primarily of low desert grassland with scattered shrubs and cacti. With few exceptions, the flora and fauna in and around the proposed CISF area consist of species that occur widely throughout the region.

Most of the area has been grazed in the past. Areas of pristine habitat do not exist near the facilities area. Cattle and other livestock have grazed the region in the past, when the area was primarily ranchland. As in other areas of desert grassland, overgrazing has reduced the importance of many native grasses and increased shrub cover. Yucca and snakeweed, which are species indicative of overgrazing, are present over much of the area, as are invasive exotic weeds.

Construction and operation of the industrial facilities described above have removed or altered some of the previously available habit in the vicinity of the proposed CISF. Remaining areas of habitat have been fragmented by the construction of roads and other rights-of-way. In spite of past and ongoing disturbances, the resulting mosaic of land use supports the types of flora and fauna typical of the region.

Known sources of water in the proposed CISF vicinity include the following: a man-made pond on the adjacent quarry property to the west that is stocked with fish for private use; Baker Spring, a seasonally intermittent surface water feature situated west of the CISF; several cattle watering holes where groundwater is pumped by windmill and stored in above ground tanks; a well about 4 km (2.5 mi) to the east; and Monument Draw, a natural, shallow drainage way situated west and southwest of the CISF. Several longtime, local residents indicated that Monument Draw contains water for only a short period of time following a significant rainstorm. There are also three "produced water" lagoons for industrial purposes on the adjacent quarry property to the west and a man-made pond at the Eunice Municipal Golf Course approximately 16 km (10 mi) west of the CISF. There are no commercial fisheries or invertebrate catches.

## 3.2 TRANSPORTATION

Transportation services to the CISF would include the delivery of equipment, supplies, and staff, including contractors needed to work and provide miscellaneous maintenance activities at the CISF. The mode of transportation for these types of services would be by road. The transportation of solid and radioactive waste generated at the CISF would also be by road, respectively, to the Lea County Municipal Landfill or to one of WCS existing license disposal facility (i.e., the Federal Waste Disposal Facility or the RCRA Landfill).

The DOE would be responsible for transporting spent nuclear fuel (SNF) from existing commercial nuclear power reactors to the CISF. SNF would be transported to the CISF by rail. Approximately 3,000 canisters are expected to be transported over 40 years. SNF would be shipped in transportation packages licensed pursuant to 10 CFR Part 71 and in compliance with requirements established by the U.S. Department of Transportation (DOT). Spent fuel received at the CISF would be stored until such time that a geologic repository for its disposal is constructed and operable as required under the Nuclear Waste Policy Act of 1982.

### 3.2.1 Connected Environmental Impacts Associated with SNF Transport from Shutdown Decommissioned Reactors

The DOE is also responsible for the transportation of SNF from the shutdown and decommissioned reactors across the country. Studies have been performed by the DOE to determine the level of work that would be needed to improve the infrastructure that would be required to remove SNF currently in storage at 12 shutdown and decommissioned reactors for transport to an ISFSI or a geologic repository. The evaluated shutdown sites include: Maine Yankee, Yankee Rowe, Connecticut Yankee, Humboldt Bay, Big Rock Point, Rancho Seco, Trojan, La Crosse, Zion, Crystal River, Kewaunee, and San Onofre (DOE, 2013a). The locations of the shutdown decommissioned reactor sites are depicted in Figure 3.2-1.

These sites have no operating nuclear power reactors. NRC has received notification that their reactors have permanently ceased power operations and that nuclear fuel has been permanently removed from their reactor vessels. Shutdown reactors at sites also having operating reactors are not included in this evaluation.

Not all of the shutdown reactor sites have rail access to transport SNF to an interim storage facility or geologic repository. Such sites would either require upgrades to provide rail access or transport by heavy haul truck to an intermodal rail transfer facility. Because of the size and weight of the licensed shipping casks, shipment by rail is the practical cross-country transportation option for SNF to be delivered to an ISFSI or a geologic repository. Transport by heavy haul trucks to an intermodal rail transfer facility could occur at a shutdown and decommissioned reactor site that does not have rail access. In that case, a heavy-haul transfer truck typically traveling at speeds between 16 to 20 km/hr (10 to 12 mph) could be used to move SNF relatively short distances to a rail transfer facility as discussed in NUREG-1714 (NRC, 2001). Moreover, SNF could also be transported by barge to another rail transfer facility where the SNF would subsequently be transported by rail to WCS.

The environmental impacts to the affected areas would be attributable to radiation doses received by members of the public along the transportation routes. Over the next several years, the DOE is expected to commission new transportation systems needed to transport SNF from existing commercial reactor sites, including the shutdown reactor sites, to a CISF or geologic repository. Other environmental impacts would be attributable to upgrades that would be required to the railroad lines leading from the former reactor sites to a CISF or geologic repository. The connected environmental impacts potentially associated with the transportation of SNF and upgrades required to support the removal of SNF from the shutdown and decommissioned reactor sites are discussed in Section 4.2.

### 3.2.2 Transportation Corridor

The transportation corridor for delivery of equipment and supplies, as well as for workers and contractor hired to provide services at the CISF within the region-of-interest are primarily Texas State Highway 176 in Andrews County, Texas and New Mexico State Highways 18 and 8 in Lea County, New Mexico.

SNF would be transported from existing commercial nuclear power facilities across the U.S. using rail lines operated primarily by the Union Pacific Railroad to Monahans, Texas (Figure 3.2-

2). SNF would subsequently be transported by rail from Monahans, Texas, approximately 169 km (105 mi) north through Eunice, New Mexico to the CISF. The transportation of SNF from Monahans, Texas to the CISF would be on existing rail owned and operated by the TNMR. The transportation corridor represents the rail operated by the TNMR from Monahans, Texas to the CISF (Figure 3.2-3).

The TNMR recently upgraded the rail lines (Class 1) to accommodate heavier loads expected to be transported to WCS. The TNMR rail lines are sufficient to transport SNF to the proposed CISF.

### 3.2.3 Rail Spur to the Proposed CISF

WCS operates a rail track from Eunice, New Mexico that encircles its facilities in Andrews County, Texas. SNF would be transported along the transportation corridor from Monahans, Texas to Eunice, New Mexico. WCS would transport the SNF along its rail track via a locomotive to the Transfer Facility at the CISF.

WCS would construct a rail sidetrack, approximately 1.6 km (1 mi) in length, from its existing rail spur leading into the Transfer Facility at the CISF (Figure 3.2-4).

SNF would be receipt inspected prior to acceptance at the CISF. After acceptance, the dual-purpose canisters would be offloaded in compliance with requirements specified in the license.

## 3.3 GEOLOGY AND SOILS

This section identifies the geological, seismological, and geotechnical characteristics of the CISF and its vicinity.

Some areas immediately adjacent to the proposed CISF have been thoroughly studied in recent years in preparation for construction of other facilities such as the WCS byproduct material (11e2) disposal unit, the Texas Compact LLRW disposal unit, the FWF unit, the radioactive waste storage and processing facility, the NEF in New Mexico, the International Isotopes, Inc. uranium hexafluoride de-conversion facility in New Mexico, and the former Atomic Vapor Laser Isotope Separation (AVLIS) site in New Mexico. Data are available from these investigations in the form of various reports (NEF, 2005) (DOE, 2013a). These documents and related materials provide a substantial database and description of geological conditions for the CISF.

In addition, WCS has performed additional field investigations, where necessary, to confirm site-specific conditions. The site subsurface conditions were explored with eighteen soil borings (SAR Chapter 2, Geotechnical Engineering report from GEOservices in Attachment E). The boring locations and depths were selected by GEOservices and surveyed by WCS personnel (SAR Chapter 2, Attachment E Figures 3, 4, and 5). N-values were recorded in the field and noted on the boring logs. Soil samples collected during drilling were sent to a lab for visual classification and laboratory testing including: Atterberg Limits; Natural Moisture Content; Particle Size Analysis; Resistivity of Soil; Consolidated Undrained Triaxial Test; Standard Proctor Moisture-Density Tests; California Bearing Ratio; and Consolidation.

### 3.3.1 Regional Geology

This section discusses the regional geology ascending from a depth of approximately 427 m (1,400 ft), which includes the lowermost underground source of drinking water, to the ground surface. Figure 2-14, of the SAR, shows surficial lithological exposures, topography, infrastructure, and governmental boundaries in the area surrounding the WCS permitted area, consisting of 542 ha (1,338 acres). Two cross sections in the vicinity of the proposed CISF were created using boring logs from former site investigations. The locations of the cross sections are shown in Figure 3.3-1 and the North-South and East-West Cross Sections are shown in Figures 3.3-2 and 3.3-3.The associated boring logs are included in Attachment 3-1.

The geologic formations of concern beneath the CISF comprise, from oldest to youngest; the Triassic Dockum Group, the Cretaceous Trinity Group Antlers Formation, the Late Tertiary stratigraphic equivalent of the Ogallala Formation, the Late Tertiary/Quaternary Gatuña Formation or Cenozoic Alluvium (note that the Gatuña Formation and Cenozoic Alluvium are sometimes used interchangeably), the Pleistocene windblown sands of the Blackwater Draw Formation, and Holocene windblown sands, and playa deposits. A regional hard caliche pedisol, termed the Caprock caliche, developed on all pre-Quaternary formations before the Blackwater Draw sands were deposited. A stratigraphic column for the above units is provided in Figure 3.3-4. This stratigraphic column adopts the nomenclature of Lehman for the Dockum Group and includes the entire stratigraphic sequence typical of the Central Basin Platform of the west Texas Permian Basin (Lehman T. , 1994a) (Lehman T. , 1994b) (Bebout, D.G. and Meador, K.J., 1985).

### 3.3.2 Basic Geologic and Seismic Information

The proposed CISF would be located over the north-central portion of a prominent subsurface structural feature known as the Central Basin Platform. The Central Basin Platform is a deep-seated horst-like structure that extends northwest to southeast from southeastern New Mexico to eastern Pecos County, Texas. The Central Basin Platform is flanked on three sides by regional structural depressions known as the Delaware Basin to the southwest and the Midland Basin to the northeast, and by the Val Verde Basin to the south. From the Cambrian to late Mississippian, west Texas and southeast New Mexico experienced mild structural deformation that produced broad regional arches and shallow depressions (Wright, 1979). The Central Basin Platform served intermittently as a slightly positive feature during the early Paleozoic (Galley, 1958). During the Mississippian and Pennsylvanian, the Central Basin Platform uplifted between ancient lines of weakness (Hills, 1985), and the Delaware, Midland, and Val Verde Basins began to subside, forming separate basins. Late Mississippian tectonic events uplifted and folded the platform and were followed by more intense late Pennsylvanian and early Permian deformations that compressed and faulted the area (Hills, 1963). Highly deformed local structures formed ranges of mountains oriented generally parallel to the main axis of the platform (Wright, 1979). This period of intense late Paleozoic deformation was followed by a long period of gradual subsidence and erosion that stripped the Central Basin Platform and other structures to near base-level (Wright, 1979), forming the Permian Basin. The expanding sea gradually encroached over the broad eroded surfaces and truncated edges of previously deposited sedimentary strata. New layers of arkose, sand, chert pebble conglomerate, and shale deposits accumulated as erosional products along the edges and on the flanks of regional and local structures.

Throughout the remainder of the Permian, the Permian Basin slowly filled with several thousand feet of evaporites, carbonates, and shales. From the end of the Permian until late Cretaceous, there was relatively little tectonic activity except for periods of slight regional uplifting and downwarping. During the early Triassic, the region was slowly uplifted and slightly eroded. These conditions continued until the late Triassic, when gentle downwarping formed a large land-locked basin in which terrigenous deposits of the Dockum Group accumulated in alluvial flood plains and as deltaic and lacustrine deposits (McGowen, 1979). In Jurassic time, the area was again subject to erosion. A large continental shelf sea submerged a large part of the western interior of North America (including west Texas and southeastern New Mexico) during the Cretaceous Period. A thick sequence of Cretaceous rocks was deposited over most of the area. Locally, the Cretaceous sequence of sediments was comprised of a basal clastic unit (the Trinity, Antlers, or Paluxy sands) and overlying shallow marine carbonates. Uplift from the west and southward and eastward–retreating Cretaceous seas were coincident with the Laramide Orogeny, which formed the Cordilleran Range west of the Permian Basin.

The Laramide Orogeny uplifted the region to essentially its present position, supplying sediments for the nearby late Tertiary Ogallala Formation. The major episode of Laramide folding and faulting occurred in the late Paleocene. There have been no major tectonic events in North America since the Laramide Orogeny, except for a brief period of minor volcanism during the late Tertiary in northeastern New Mexico and in the Trans-Pecos area. Hills (1985) suggests that slight Tertiary movement along Precambrian lines of weakness may have opened joint channels, which allowed the circulation of groundwater into Permian evaporite layers. The near-surface regional structural controls may be locally modified by differential subsidence related to groundwater dissolution of Permian salt deposits (Gustavson, 1980).

There is no volcanic activity near the site. There is no evidence of volcanic activity near the site in the recent past.

### 3.3.3 Vibratory Ground Motion

WCS lies in a region with crustal properties that indicate minimum risk due to faulting and seismicity. Crustal thickness is the most reliable predictor of seismic activity and faulting in intracratonic regions. Crustal thickness in the vicinity of the WCS site is approximately 50 km (30 mi), one of the three thickest crustal regions in North America (Mooney, W.D. and L.W. Braile, 1989). In comparison, the crustal thickness of the Rio Grande Rift is as little as 12 km (7.5 mi) in places.

In 2016 WCS completed a Probabilistic Seismic Hazard Evaluation using NRC guidance for the WCS site. The Seismic Hazard Evaluation (SAR Chapter 2 Attachment D) was prepared under the technical supervision of Dr. Ivan Wong, head of Seismic Hazards Group, AECOM, Oakland, CA and the analysis was performed consistent with the professional standards of the Texas Board of Professional Geoscientists and under the supervision of Cynthia K. Crain (P.G. #1585).

The objectives of the Seismic Hazard Analysis were to (1) estimate the levels of ground motions that could be exceeded at a specific annual frequency (or return period) at the site by performing a probabilistic seismic hazard analysis (PSHA), (2) incorporate the site-specific effects of the near-surface geology on the ground motions, and (3) develop Design Response Spectra (DRS) at the ground surface for the site and corresponding histories.

Significant earthquakes (moment magnitude [**M**] $\geq$ 5.0), however have occurred in the site region including the 1992 **M** 5.0 Rattlesnake Canyon earthquake about 30 km from the WCS site. Some occurences of induced seismicity have also proven to be spatially correlated to active hydrocarbon production in the region. Typical of the central U.S., there is a marked absence of Quaternary faults and few of the known earthquakes can be associated with a specific geologic structure. In the 2014 U.S. Geological Survey (USGS) National Hazard Maps, the site area was characterized as one of relatively low seismic hazard.

Spectral-analysis-of-surface-wave (SASW) surveys were performed at the WCS site by the University of Texas at Austin to obtain shear-wave velocity ($V_s$) profiles down to the Trujillo sandstone at a depth of about 600 feet.

To estimate ground motions, four Next Generation of Attenuation (NGA)-West2 ground motion prediction models for the western U.S. (WUS) and the EPRI (2013) models for the central and eastern U.S. (CEUS) were utilized. For the NGA-West2 models, a time-averaged shear wave velocity (Vs) in the top 100 ft (Vs30) of 760 m/sec was used. The EPRI (2013) ground motion models are defined for hard rock or a Vs30 of 2,830 m/sec and greater. To address the epistemic uncertainty on which models are appropriate, both the NGA-West2 and EPRI (2013) models were used in the PSHA weighted 0.60 and 0.40, respectively.

Based on the PSHA and the inputs of the seismic source model and ground motion models, seismic hazard curves for both firm and hard rock were calculated. The absence of late-Quaternary faulting and the low to moderate rate of background seismicity, even that associated with petroleum recovery activities, results in relatively low seismic hazard at the WCS site. The largest contributor to the hazard at the WCS site is the background seismicity (the Southern Great Plains seismic source zone and Gaussian smoothing).

A site response analysis was performed to estimate ground motions at the WCS site incorporating the site-specific geology. The hazard curves were weighted based on the weights assigned to the NGA-West2 and EPRI (2013) ground motion models and a 10,000 year return period horizontal Uniform Hazard Spectrum (UHS) was calculated. A 10,000-year return period vertical UHS was also calculated using the NRC V/H ratios. On Table 3 in Attachment D is the horizontal and vertical UHS for a return period of 10,000 years. The ground surface design response spectrum peak horizontal acceleration for 0.01 seconds is 0.25 g and the vertical is 0.175 g.

Historic and recent seismic activity for the Texas regional area from 1973 to 2015 can be seen on Figure 3.3-5.

### 3.3.4 Faulting

Two types of faulting were associated with early Permian deformation. Most of the faults were long, high-angle reverse faults with several hundred feet of vertical displacement that often involved the Precambrian basement rocks (Hills, 1985) (Bebout, D.G. and Meador, K.J., 1985). The second type of faulting is found along the western margin of the Central Basin Platform where long strike-slip faults, with displacements of tens of miles, are found (Hills, 1985). All of the major faulting in the vicinity of the Central Basin Platform occurred in response to tectonic forces active before the global plate tectonic reorganization that created the North American continent (Bally, A.W., C.R. Scotese, and M.I. Ross, 1989). The Paleozoic faults exhibit low natural microseismicity as a result of passive response to relatively low levels of tectonic stress in the trailing edge of the westward-drifting North American plate. The closest Quaternary faults are in the Guadalupe Mountains (Muehlberger, 1979), about 161 km (100 mi) southwest of the WCS site.

The large structural features of the Permian Basin are reflected only indirectly in the Mesozoic and Cenozoic rocks, as there has been virtually no tectonic movement within the basin since the Permian (Nicholson, A., Jr., and A. Clebsch, Jr., 1961). The Central Basin Platform is located approximately 2,134 m (7000 ft) beneath the present land surface and the Permian and Triassic sediments drape over the top of the Platform structure. The faults that uplifted the platform do not appear to displace the younger Permian sediments. The northernmost fault, located at the Matador Uplift, terminates in lower Wolfcampian sediments.

A further comparison of the structure of the Devonian Woodford Formation to the structure of the younger Upper Guadalupe Whitehorse Group (Permian) indicates that the faults in the Devonian section do not continue upward into the overlying Permian Guadalupe Whitehorse Group. The regional geologic and tectonic information does not indicate the presence of significant post-Permian faulting within the regional study area.

Two regional stratigraphic cross sections constructed in the vicinity of the WCS site using oil and gas well logs are shown as Figures 3.3-6 and 3.3-7. The locations of the cross sections are also shown on the figures. These cross sections depict the major stratigraphic units that occur within about 610 m (2,000 ft) below ground surface in the vicinity of the site. The stratigraphic units depicted on Figures 3.3-6 and 3.3-7 include the upper OAG unit of a few tens of feet in thickness, the underlying Triassic red beds of the Dockum Group with a thickness of 305 to 457 m (1,000 to 1,500 ft), the underlying Permian Dewey Lake Formation red beds, and the Permian evaporites of the Rustler and Salado Formations. These cross sections do not indicate the presence of significant faulting in the upper 610 m (2,000 ft) of sediments within 3 to 4 miles of the CISF.

The closest areas of faulting that affect Quaternary strata are faults associated with the Basin and Range physiographic province. Tectonically, Basin and Range faulting is associated with crustal extension and thinning in southwestern North America due to right lateral shear between the Pacific plate and the North American plate. This extension is the cause of the Rio Grande Rift, which is an area with numerous Quaternary faults located approximately 200 miles west of the WCS facility.

The closest Quaternary faults listed in the USGS Quaternary Fault and Fold Database (http://earthquakes.usgs.gov/qfaults) are faults that are associated with the range-front of the Guadalupe Mountains and are located along the southwestern base of the mountain range. The closest Quaternary fault is an unnamed fault at the base of the Guadalupe Mountains, listed as fault No. 907 in the database and located approximately 167 km (104 mi) southwest of the WCS facility in Guadalupe Mountains National Park in Culberson County, Texas. This fault is a down-to-the-west range-bounding normal fault, with the most recent deformation estimated at less than 1.6 million years ago (Ma) (http://earthquakes.usgs.gov/qfaults). A second fault associated with this region is the Guadalupe Fault listed as fault No. 2058 and located 174 km (108 mi) west of the WCS facility in Chaves and Otero Counties, New Mexico. This fault may be the re-activation of a late Tertiary Basin and Range fault. The age of the faulted deposits have not been studied, but the oldest faulted strata are believed to be as old as the penultimate glaciation based on the stratigraphic sequence present, placing the oldest age of deformation at approximately 130 thousand years ago (ka). The most recent deformation of this fault is believed to be less than 15 ka. There are additional Quaternary faults located south of the two faults listed, along the southwestern base of the Guadalupe Mountains in Texas. The next closest area of Quaternary faulting listed on the USGS Quaternary Fault and Fold Database is the Alamogordo fault, which is divided into three sections. The sections of the Alamogordo fault closest to the WCS facility are fault Nos. 2045b and 2045c on the USGS Quaternary Fault and Fold Database. These faults are located approximately 274 km (170 mi) west of the WCS facility in Otero County, New Mexico. The Alamogordo fault is the range-bounding structure of the Sacramento Mountains. The faults are down-to-the west faults, much like those associated with the Guadalupe Mountain range. The most recent deformation is listed as less than 130 ka in the USGS Quaternary Fault and Fold Database. There is no surface evidence of quaternary faulting within the WCS property.

During landfill excavation activities at WCS an apparent southward-dipping reverse fault in a sandstone in the upper portion of the Triassic red beds of the original RCRA landfill excavation was located in 2004. Since regulatory criteria address the age of faults and the age of any geologic units affected or displaced by faulting, a geologic investigation of the fault was undertaken. The southeast wall of the RCRA landfill was extended about 61 m (200 ft) to the southeast in May and June 2004, yielding about 18 m (60 ft) of vertical geologic exposure along a length of about 122 m (400 ft). Two benches with subvertical walls were exposed. The relationship between faulting in the Triassic red beds and the overlying Cretaceous Antlers Formation was carefully evaluated to determine if any displacement of the younger Cretaceous deposits had occurred. The Triassic red beds are separated from the overlying Cretaceous Antlers Formation sands and gravels and from a layer of reworked altered clay by a distinct and mappable parting near the top of the gray altered layer of red beds. None of the observed fault planes or slip surfaces in the Triassic red beds in the extensively mapped section cross or offset the parting. In addition, the bedding in the Antlers Formation is continuous where observable and not calichified, and in particular, there are no indications that the Cretaceous-aged Antlers Formation was affected by the faulting in the Triassic red beds. Photos, figures and further details are included in the WCS LLRW License.

### 3.3.5 Salt Dissolution and Sink Holes

The proposed WCS CISF would be located over Permian-age halite-bearing formations, and the possibility of dissolution and its effects on the long-term performance of the CISF have to be considered. Robert M. Holt, PhD and Dennis W. Powers, PhD developed three conceptual hydrologic models of dissolution processes (shallow, deep and stratabound) based on experience and features found in the Delaware Basin west of the WCS site. Investigations showed that no features in the study area at and around the WCS site indicated any past dissolution, and the hydrologic systems at the site limit the potential for future dissolution and/or sinkholes. The full discussion and results of the study are detailed in “Evaluation of Halite Dissolution in the Vicinity of Waste Control Specialists Disposal Site, Andrews County, TX” and the report is located in Attachment F in Chapter 2 of the SAR.

### 3.3.6 Soils

Geotechnical and site boring investigations confirm a thin layer of loose sand at the surface that overlies about 12 m (40 ft) of silty sand and sand and gravel cemented with caliche. Beneath that are the Triassic red bed clays extending to depths of 396 m (1,300 ft) to 427 m (1,400 ft).

The USDA soil survey indicates the proposed CISF surface soils consist primarily of Blakeney and Conger soils, Ratliff soils, Triomas and Wickett Soils, and Jamlar-Penwell association (Figure 3.3-8). All soil mapping units were described as gently undulating by the USDA soil survey. The parent materials for the Blakeney and Conger soils are loamy eolian deposits in the Blackwater Draw formation of Pleistocene age overlying calcareous loamy alluvium in the Ogallala formation of Miocene-Pliocene age. The parent materials for the Ratliff soils are calcerous, loamy eolian deposits from the Blackwater Draw formation of Pleistocene age. The parent materials of the Triomas are sandy eolian deposits from the Blackwater Draw and the parent materials of the Wickett soils are sandy eolian deposits overlying calcareous, loamy alluvium in the Ogallala formation of Miocene-Pliocene age. The parent materials of the Jalmar are sandy eolian deposits of Holocene age over loamy eolian deposits from the Blackwater Draw formation of Pleistocene age. The parent materials of the Penwell soils are sandy eolian deposits of Holocene age. Sloping ranges from 0 to 8%.

The Soil Survey of Andrews County, Texas by the USDA is included in Attachment 3-2.

## 3.4 WATER RESOURCES

The surface water drainage feature nearest to the WCS CISF is Monument Draw in Lea County, New Mexico, a southward-draining ephemeral draw about 4.8 km (3 mi) west of the CISF boundary. The draw does not have through-going surface water drainage and, due to encroachment of Cenozoic alluvial and eolian deposits, loses surface expression after it enters Winkler County, Texas. (Note: there are two surface drainage features named Monument Draw in the vicinity: Monument Draw, New Mexico, a south-flowing ephemeral stream in Lea County, New Mexico, and Monument Draw, Texas (same name), an east-flowing ephemeral stream in Andrews County, Texas).

The CISF is on the southwestern slope of the surface water drainage divide between the Pecos River and the Colorado River. In the immediate vicinity of the CISF, the slope is southwest toward Monument Draw, New Mexico at about 9.5 m per km (50 ft per mi). The maximum and minimum elevations in the vicinity of the CISF are 1,067 m (3,500 ft) and 1,041 m (3,415 ft) msl, respectively.

In this part of west Texas, the Cenozoic Alluvium aquifer is considered a major aquifer and the Triassic Dockum Group aquifer is considered a minor aquifer. Groundwater will not be used, as a potable water source, at the proposed WCS CISF. Potable water would come from the existing potable water system at WCS.

### 3.4.1 Surface Hydrology

The CISF site would be located in western Andrews County, Texas nearly at the Texas – New Mexico border, just north of Texas State Highway 176 approximately 50 km (31 mi) west of Andrews, Texas and 8 km (5 mi) east of Eunice, New Mexico. There are no maps of special flood hazard areas for this location published by the FEMA. The Site Location and Surrounding Topography Map, SAR Chapter 2 Attachment B Figure 1.1-1, shows the CISF site location with respect to the surrounding topography and drainage features and the WCS property boundary.

From a surface water perspective, the general area is characterized by ephemeral drainages, sheet flow, minor gullies and rills, internally-drained playas, and a salt lake basin (identified in Figure 1.1-1 as a Depression Pond in the SAR Chapter 2 Attachment B). The salt lake basin is the only naturally-occurring, perennial (year-round) water body located near the CISF site; the internally drained salt lake basin is located approximately 8 km (5 mi) from the eastern boundary of the CISF site and rarely has more than a few inches of water at scattered locations within the bottom footprint. Surface drainage from the CISF does not flow into this basin. Other perennial surface water features are man-made, including various stock tanks (often replenished by shallow windmill wells) located across the area and the feature denoted as the Fish Pond on SAR Chapter 2 Attachment B Figure 1.1-1, which is located at the Permian Basin Materials quarry (formerly Wallach Concrete) west of the CISF site and is also replenished by well water. In addition, Sundance Services, LLC operates the Parabo Disposal Facility for oil and gas waste west of the site. Water collects periodically in excavated and/or diked areas at this disposal facility and in the active quarry areas at this property adjacent to and west of the WCS property in New Mexico.

The nearest surface water drainage feature to the WCS facility is Monument Draw in Lea County, New Mexico, a reasonably well-defined, southward-draining draw about 5 km (3 mi) west of the WCS site. The draw does not have through-going drainage and loses surface expression after it enters Winkler County, Texas. (Note: there are two surface drainage features named Monument Draw in the vicinity: Monument Draw, New Mexico, a south-flowing ephemeral stream in Lea County, New Mexico, and Monument Draw, Texas (same name), an east-flowing ephemeral stream in Andrews County, Texas). East of Monument Draw, New Mexico and south of the WCS facility is a local topographic high known as Rattlesnake Ridge. This poorly defined ridge parallels the Texas-New Mexico border and crests about 38 m (125 ft) higher than Monument Draw, New Mexico (Nicholson, A., Jr., and A. Clebsch, Jr., 1961).

The WCS permitted area is on the southwestern slope of the drainage divide between the Pecos River and the Colorado River. In the immediate vicinity of the WCS permitted area, the slope is southwest toward Monument Draw, New Mexico at about 15 m (50 ft) per mi. The maximum and minimum elevations of the permitted area are about 1,064 m (3,490 ft) and 1,041 m (3,415 ft) msl, respectively.

Small surface depressions (buffalo wallows) and a few established playa basins are present within a 10 km (6.2 mi) radius of the WCS facility. The largest of the surface depressions within the permitted area is a small playa about 6 ha (15 acres) in size approximately 0.8 km (0.5 mi) northeast of the existing RCRA landfill. Remnant deposits of a filled and now partially covered playa or salt lake basin are found about 4.8 km (3 mi) east of the permitted area. Surface drainage from the area north and east of the WCS facility flows eastward into this basin.

Baker Spring is a manmade feature located at a historic quarry on WCS property about 2,510 ft west of the CISF site in Lea County, New Mexico. This feature was formed by excavation of the caliche caprock to the top of the underlying red bed clays. After periods of rainfall, the depression may hold water for an extended period; during dry cycles, the depression may be dry for extended periods.

The National and Oceanic and Atmospheric Administration's NWS Office for Hobbs, New Mexico indicates that the minimum average annual precipitation recorded is 2.01 inches in 2011 and the maximum average annual precipitation recorded is 32.19 inches in 1941. The annual precipitation on average is approximately 14 inches.

The CISF site is located on the southwest-facing slope that transitions from the Southern High Plains to the Pecos Valley physiographic section. The Southern High Plains is an elevated area of undulating plains with low relief encompassing a large area of west Texas and eastern New Mexico. In Andrews County, the southwestern boundary of the Southern High Plains is poorly defined, but in this report is considered to be where the caprock caliche is at or relatively close to the surface, such as on and near the CISF site.

The main surface water drainage in the area is Monument Draw, an ephemeral stream about 4.8 km (3 mi) west of the WCS site in New Mexico. Ephemeral streams or drainage ways flow briefly only in direct response to precipitation in the immediate locality. Monument Draw is a reasonably well-defined, southward draining features (although not through-going) that is identified on the USGS topographic maps that serve as the base map source for Attachment B Figure 1.1-1, of the SAR Chapter 2.

An ephemeral drainage feature, referred to as the Ranch House Draw crosses the WCS property from east to west, generally to the south of the CISF site, as shown in Figure 1.1-1 in Attachment B, of the SAR Chapter 2. This feature is discernible from the topographic relief depicted on Figure 1.1-1 in Attachment B of the SAR Chapter 2, although it is much less pronounced than Monument Draw. This drainage feature is a relict drainage way that is choked with windblown sand and is not through-going to Monument Draw. Most of the drainage from the area of the CISF site is down slope toward the Ranch house Draw, with a small portion of the drainage from this area toward the southwest. Surface water eventually infiltrates into the windblown sands and dune fields to the south and southwest of the CISF site. There are no ephemeral drainages that cross the CISF site. Most of the immediate area of the CISF is drained from northwest to southeast by sheet flow. Sheet flow is a term describing overland flow or down slope movement of water taking the form of a thin, continuous film.

Playas, or small, internally-drained basins, occur on the WCS controlled property. The playas are dry most of the time. Some of the playas occasionally hold water after relatively large precipitation events; however, the ponded water rapidly dissipates through infiltration, evaporation, and plant uptake. An established playa basin is present on the eastern edge of the CISF site. Surface topography maps indicate approximately 10 ft of relief in the playa.

The combination of low annual precipitation, relatively high potential evapotranspiration, permeable surficial soils down gradient of the CISF site, and topographic relief results in well-drained conditions. The engineering design and construction of the CISF site would eliminate areas that might promote ponding. Diversion berms and a collection ditch would direct stormwater from upstream drainage areas around the CISF.

There are no public or private surface water drinking-water supplies in the site vicinity. Potable water supply for the WCS facility is provided by existing potable water system at WCS. There are scattered windmills in the general area that take water from isolated pockets of groundwater perched on top of the red bed clay. This water is utilized primarily for livestock watering.

The CISF site is located on the southwest-facing slope that transitions from the Southern High Plains to the Pecos Valley physiographic section.

There are no natural or man-made surface bodies of water at the proposed CISF. The proposed CISF would not located in wetlands per the National Wetlands Inventory (Figure 3.4-1). A floodplain analysis performed for the adjacent properties indicates that the proposed CISF is not within the 100-year floodplain (SAR Chapter 2 Attachment B).

### 3.4.2 Hydrologic Description

The WCS permitted area is on the southwestern slope of the drainage divide between the Pecos River and the Colorado River. In the immediate vicinity of the WCS permitted area, the slope is southwest toward Monument Draw, New Mexico at about 9.5 m per km (50 ft per mi). The maximum and minimum elevations of the permitted area are 1,064 km (3,490 ft) and 1,041 m (3,415 ft) msl, respectively.

The nearest surface water drainage feature to the proposed CISF is Monument Draw in Lea County, New Mexico, a reasonably well-defined, southward-draining draw about 0.9 km (3 mi) west of the CISF. The draw does not have through-going drainage and loses surface expression after it enters Winkler County, Texas. East of Monument Draw, New Mexico and south of the CISF is a local topographic high known as Rattlesnake Ridge. This poorly defined ridge parallels the Texas-New Mexico border and crests about 38 m (125 ft) higher than Monument Draw, New Mexico (Nicholson, A., Jr., and A. Clebsch, Jr., 1961).

Small surface depressions (buffalo wallows) and a few established playa basins are present within a 10 km (6.2 mi) radius of the CISF. The largest of the surface depressions within the permitted area is a small playa about 6.07 ha (15 acres) in size approximately 0.80 km (0.5 mi) northeast of the existing RCRA landfill. Remnant deposits of a filled and now partially covered playa or salt lake basin are found about 6 km (3.7 mi) east of the permitted area. Surface drainage from the area north and east of the proposed CISF flows eastward into this basin. Local topographic features outside the permitted area include Baker Spring to the west, small depressions or solution pans between Baker Spring and the permitted area, and a spring about 4.8 km (3 mi) to the east on the western side of the playa or salt lake basin discussed above.

Baker Spring is located in Lea County, New Mexico, about 0.58 km (0.36 mi) west of the WCS permitted area. Two minor unnamed surface draws empty into the Baker Spring depression. Baker Spring is the site of a former quarry.

In this part of west Texas, the Cenozoic Alluvium aquifer is considered a major aquifer and the Triassic Dockum Group aquifer is considered a minor aquifer (Mace, 2001).

### 3.4.3 Floods

The CISF would not be located in the 100-year floodplain. Attachment B of the SAR Chapter 2, presents the Flood Plain Study for WCS and Figure II.F.4 in Appendix 2.4.1 in that report identifies the 100-year floodplain at the location of the proposed CISF. The 100-year floodplain extends across the southern portion of the WCS property area along the ranch house drainage. The northernmost limit of the 100-year floodplain is approximately 1,219 m (4,000 ft) southeast of the CISF site while the northernmost limits of the 500-year and PMP floodplains are 1,209 m and 1,187 m (3,965 ft and 3895 ft) southeast of the CISF site respectively.

### 3.4.4 Flood History

The climate of the area is classified as semiarid, characterized by dry summers and mild, dry winters. Annual precipitation on average is approximately 14 inches and annual evaporation exceeds annual precipitation by nearly five times. The area is subject to occasional winter storms, which produce snowfall events of short duration.

Rainfall records from July 2009 through December 2015, provided by WCS from a weather station near the CISF site, indicate an average annual rainfall of 12.6 inches and a maximum twenty-four hour rainfall total of 3.62 inches (Attachment A of the SAR). According to WCS personnel, surface water runoff has not overflowed roads or existing drainage features at the WCS facility during this time frame.

### 3.4.5 Flood Design Considerations

There has been no history of flooding at the site and the site is not located in the 100-year floodplain. Almost all of the surface water runoff from the storage area would leave the CISF site just north of the southeast corner of the storage area and would drain into the large playa southeast of the site. A small amount of surface water runoff from the parking lot of the CISF would drain southwest. Flow arrows on Figure 1.1.2-2 in the SAR Chapter 2 in Attachment B, Developed Drainage Area Map, provide the detailed drainage patterns for the CISF site.

The Centralized Interim Storage Facility Drainage Evaluation and Floodplain Analysis (SAR Chapter 2 Attachment B) models the probable maximum flood flow over the existing railroad and the proposed CISF rail side track. At analysis Point 1, the peak discharge resulting from all modeled storm events flows over State Line Road. The maximum depth of flow over the road (during the 500-year and ARC III) is approximately 0.8 ft. which is equivalent to elevation 3487.3 ft. msl. The maximum depth of water on the CISF storage pad for a 500-year flood is 1.1 inches and the velocity is 1.7 ft/s.

The peak discharge resulting from all modeled storm events flows over the railroad tracks at Analysis Point 2. The maximum depth of water over the rail (during 500-year and ARC III) is approximately 1.4 ft. which is equivalent to elevation of 3466.4 ft. msl.

### 3.4.6 Effects of Local Intense Precipitation

The Floodplain Study in the SAR Chapter 2 Attachment B includes calculations for a Probable Maximum Precipitation using a 500-year frequency storm event and the limits of the flood plain. The results from modeling these additional storms describe a flood plain that is still shallow and wide, and that is too distant from the CISF to ever impact the CISF.

### 3.4.7 Probable Maximum Flood on Streams and Rivers

There are no streams or rivers on or in the vicinity of the CISF. Monument Draw, an ephemeral stream, is the closest main surface water drainage and is about 4.8 km (3 mi) west of the site in New Mexico, so the CISF would be unaffected by flooding on streams of rivers. While Monument Draw is typically dry, the maximum historical flow occurred on June 10, 1972 and measured 36.2 cubic meters per second (1,280 cubic ft per second).

### 3.4.8 Potential Dam Failures (Seismically Induced)

There are no dams on or in the vicinity of the site. The WCS RCRA and LLRW facilities currently have five (5) manmade evaporation ponds which are partially above-grade. If a seismic event were to cause slope failure the ponds are designed so all water released would flow south away from the CISF.

### 3.4.9 Probable Maximum Surge and Seiche Flooding

Surges and seiches are typically observed on lakes or seas. There are no surface bodies of water on or near the proposed CISF where such a phenomenon would be a safety concern at the site. There are currently five (5) manmade evaporation ponds at the WCS site and they are designed with spillways on the south side so any seiche or surge would flow south away from the CISF.

### 3.4.10 Probable Maximum Tsunami Flooding

WCS is located about 805 km (500 mi) from the coast. The proposed CISF is sufficient distance from the coastline that tsunami flooding is not a hazard.

### 3.4.11 Ice Flooding

The proposed CISF would not be located in an area where ice flooding is a concern. There are no streams or rivers on or in the vicinity of the site. Monument Draw, an ephemeral stream, is the closest main surface water drainage and is about 4.8 km (3 mi) west of the proposed CISF in New Mexico, so the CISF would be unaffected by ice blockage and ice flooding.

### 3.4.12 Flood Protection Requirements

WCS is not located in an area where flooding protection is required. There are no maps of special flood hazard areas for this location published by the FEMA.

### 3.4.13 Environmental Acceptance of Effluents

There are no radioactive or other effluent releases associated with the proposed CISF facility. Stormwater runoff is not expected to contain any radiological effluents and facility stormwater runoff would be directed to the natural drainage system. Domestic wastes would be directed to above ground tanks on-site and the tanks would be periodically drained and all wastes would be transported offsite for disposal.

### 3.4.14 Subsurface Hydrology

The High Plains Aquifer of west Texas, the principal aquifer in west Texas, consists of water-bearing units within the Tertiary Ogallala Formation and underlying Cretaceous rocks (Nativ, R. and G.N. Gutierrez, 1988). In terms of hydrogeology, the High Plains aquifer is viewed as a single, hydraulically connected aquifer system, and groundwater exists under both unconfined and confined conditions. The term Ogallala aquifer is used interchangeably with the High Plains aquifer since, regionally, the Ogallala Formation is the primary component of the High Plains aquifer (Dutton, A.R., and W.W. Simpkins, 1986). Regionally the sands, gravels and sandstones that have been variously ascribed to the Tertiary Ogallalla Formations, the Tertiary aged sections of the Gatuña Formation, and the Cretaceous Antlers Formation are distinct and independent. Locally, these units are situated in the same stratigraphic interval and hydrogeologically they represent a single hydrostratigraphic unit overlying the Triassic red beds, the distinctive red and purple mudstones, siltstones, and sandstones of the Triassic Dockum Group. The hydrostratigraphic unit of undifferentiated sands and sandstones of the Ogallala/Antlers/Gatuña is locally referred to as the OAG unit. However, the Ogallala and Cretaceous aquifers are evaluated independently in the literature and would be addressed individually in the discussion below. In this part of west Texas, the Cenozoic Alluvium aquifer is considered a major aquifer and the Triassic Dockum Group aquifer is considered a minor aquifer; both will be addressed below (Mace, 2001).

The shallowest water bearing zone is about 225 ft deep at the site. Figure 3.4-2 is a groundwater contour map indicating the OAG unit is largely unsaturated beneath the WCS CISF. The nearest downgradient drinking water well identified in the hydrogeologic unit is located approximately 6.5 miles to the east of the proposed CISF at a residence on the Letter B Ranch. The method of storage (dry cask), the nature of the storage casks, the extremely low permeability of the red bed clay and the depth to groundwater beneath the site preclude the possibility of groundwater contamination from the operation of the facility.

There is an extensive network of monitoring wells in the vicinity of the CISF that are monitored semi-annually (TCEQ, 2015a). During each well's monitoring event, the depth to water would be gauged, and groundwater samples would be collected when sufficient water is present. Samples collected from the monitor wells would be analyzed for radiological and non-radiological constituents (TCEQ, 2015a). WCS is a zero discharge facility so it is anticipated there would be no future impacts to groundwater from the CISF or other WCS permitted facilities.

#### 3.4.14.1 Ogallala Aquifer

The Ogallala Formation aquifer is the primary freshwater aquifer within the regional study area and serves as the principal source of groundwater in the Southern High Plains (Cronin, 1969). The southern and eastern limits of the Ogallala aquifer lie to the north and east of the WCS property. Regionally, the Ogallala aquifer thickens to the north and east of the proposed CISF as shown in cross sections in Figures 3.4-3 and 3.4-4. The saturated thickness of the Ogallala aquifer ranges from a few meters to approximately 91 m (300 ft) in the Southern High Plains (Nativ, 1988). Groundwater within the Ogallala aquifer is typically under water table conditions, with a regional hydraulic gradient toward the southeast ranging from approximately 2 m/km (10 ft/mi) to 2.8 m/km (15 ft/mi). The average hydraulic conductivity of the Ogallala aquifer is about 3.05 m/day (10 ft/day) with higher values preferentially distributed in depositional channels. Assuming an average hydraulic gradient of 2.4 m/km (12.5 ft/mi) and a porosity of 0.20, the average rate of flow in the regional Ogallala aquifer is 13 m/year (43 ft/year).

The primary sources of recharge to the Ogallala aquifer are playas, headwater creeks, and irrigation return flow (Blandford, 2003). Regionally, the recharge rate to the Ogallala aquifer is estimated to be of the order of 0.9 cm/year (0.35 in/year) (Mullican, 1997). Blandford et al., (2003) estimated predevelopment recharge at less than 0.2 cm/year (0.083 in/year). In a 2003 numerical model of the Ogallala aquifer, prescribed recharge beneath irrigated lands was on the order of 3.18 cm/year (1.25 in/year) to 5.72 cm/year (2.25 in/year), and recharge beneath non-irrigated agricultural lands ranged from 0.64 cm/year (0.25 in/year) to 5.1 cm/year (2.0 in/year) (Blandford, 2003).

Groundwater discharge from the Ogallala aquifer occurs naturally through springs, underflow, evaporation, and transpiration, but is also removed artificially through pumping. Throughout much of the Southern High Plains, groundwater discharge from the Ogallala aquifer exceeds recharge, and water levels have consistently declined over time. In some regions, however, water levels remained reasonably stable between 1960 and 2000 or even increased, indicating that recharge is the same or greater than discharge/pumping (Blandford, 2003).

Water quality data for three Ogallala aquifer wells, located within 3.2 km (2 mi) of the proposed CISF, were obtained from a review of Texas and New Mexico state records for western

Andrews County, Texas and eastern Lea County, New Mexico. Review of the water quality data indicates that the local Ogallala aquifer contains fresh to slightly saline water (TDS ≤ 3000 mg/L). Samples of OAG water have stable isotopes consistent with modern precipitation. The $^{18}O$ and $^{2}H$ concentration of samples indicate paleorecharge temperatures several degrees Celsius cooler than modern precipitation, which is consistent with the late Pleistocene ages of the water in the 55 m and 69 m (180 ft and 225 ft) zones (TCEQ, 2015a).

The Ogallala Formation, if present, is not water bearing in the WCS permitted area, consisting of 542 ha (1,338 acres).

### 3.4.14.2 Cretaceous Aquifer (Antlers Formation)

The Cretaceous aquifer of the Southern High Plains is also considered part of the High Plains Aquifer (Nativ, R. and G.N. Gutierrez, 1988). The regional hydraulic gradient of the Cretaceous aquifer is toward the southeast, similar to the overlying and often hydraulically interconnected Ogallala aquifer. The Cretaceous aquifer of the Southern High Plains consists of a basal unit (Trinity or Antlers Formation sandstone), an intermediate unit (Edwards Formation limestone), and an upper unit (Kiamichi/Duck Creek Formation sandstone and limestone). Where present and water bearing in the subsurface, the Cretaceous aquifer in the Southern High Plains is used as a source of groundwater (Nativ, R. and G.N. Gutierrez, 1988).

The Cretaceous Antlers Formation has been identified in the vicinity of the CISF and in the subsurface immediately below the CISF; however, it is unsaturated but for a few isolated perched lenses.

### 3.4.14.3 Triassic Dockum Group Aquifer

The Dockum Group regionally consists of Triassic fluvial and lacustrine clays, shales, siltstones, sandstones, and conglomerates. The Dockum Group consists of five formations, the lowermost of which is the Santa Rosa Formation, followed by the Tecovas, the Trujillo, the Cooper Canyon, and the Redonda Formations. Only the Santa Rosa, Tecovas, Trujillo, and Cooper Canyon Formations are present in the vicinity of the proposed CISF. Water from the Dockum Group aquifer is used as a replacement for, or in combination with, the Ogallala aquifer as a regional source for irrigation, stock, and municipal water (Dutton, A.R., and W.W. Simpkins, 1986). There are two water-bearing sandstone formations in the Dockum Group in the vicinity of the proposed CISF. Both yield non-potable water with less than 5,000 mg/L total dissolved solids. The Santa Rosa Formation sandstone at the base of the Dockum Group is about 76 m

(250 ft) thick and is considered the best aquifer within the Dockum Group (Bradley, R.G., and S. Kalaswad, 2003). The top of the Santa Rosa Formation sandstone is at 347 m (1,140 ft) below ground surface at the proposed CISF.

The Trujillo Formation sandstone, the other Dockum Group water-bearing formation in the area, is about 30.5 m (100 ft) thick. The top of the Trujillo Formation is about 183 m (600 ft) below ground surface. Approximately 137 m (450 ft) of very low permeability Dockum Group fluvial and lacustrine clays separate the two formations. The lower Dockum Group aquifer is recharged by precipitation where Dockum Group sediments are exposed at land surface (Bradley, R.G., and S. Kalaswad, 2003). However, most of the recharge to the sandstones in the lower Dockum Group (comprising the Santa Rosa and Trujillo Formation sandstones) is considered to have occurred during the Pleistocene some 15,000 to 35,000 years before present (Dutton, 1995) (Dutton, A.R., and W.W. Simpkins, 1986). Topographically controlled groundwater basin divides were developed during the Pleistocene by the erosion of the Pecos and Canadian River valleys. Prior to the development of these groundwater basin divides, the lower Dockum aquifer was recharged by precipitation on its outcrop area in eastern New Mexico. However, since the development of the Pecos and Canadian River valleys, the lower Dockum aquifer in Texas has been cut-off from its recharge area. Without recharge, the lower Dockum aquifer experiences a net loss of groundwater from withdrawal by wells and by seepage (Dutton, A.R., and W.W. Simpkins, 1986). The regional hydraulic gradient of the lower Dockum aquifer is toward the southeast at approximately 2.8 m/mi (15 ft/mi). Based on water levels encountered during logging of two deep wells at the existing CISF, water levels in the lower Dockum aquifer range from 869 m (2,852 ft) msl (Santa Rosa Formation) to 967 m (3,172 ft) msl (Trujillo Formation). Transmissivities of the lower Dockum aquifer ranges from 295 square m/day (3,180 $ft^2$/day) to about 0.93 square m/day (10 $ft^2$/day) and storativity, based on two values, is 0.0001 and 0.002 (Dutton, A.R., and W.W. Simpkins, 1986). Based on the transmissivity values noted above, an average thickness of 107 m (350 ft) of combined Santa Rosa and Trujillo Formation sandstones, a porosity of 0.15, and a gradient of 2.8 m/mi (15 ft/mi), the rate of groundwater flow is estimated to be between 5.2 m/year (17 ft/year) and 0.18 m/year (0.6 ft/year).

The upper portion of the Dockum Group (Cooper Canyon Formation) serves as an aquitard in the regional and local study area (Nicholson, A., Jr., and A. Clebsch, Jr., 1961) (Dutton, A.R., and W.W. Simpkins, 1986). This is supported by the fact that the hydraulic head of the lower Dockum aquifer is significantly lower than that of the overlying Ogallala aquifer throughout much of the regional study area. This relative head difference, approximately 61 m (200 ft) to 91 m (300 ft) in western Andrews County, suggests that the lower Dockum aquifer is receiving essentially no recharge from cross-formational flow (Nativ, 1988). The primary limiting factors on recharge to the Dockum Group aquifer include the low-permeability aquitard characteristics of the upper Dockum Group and cut-off by the Pecos River Valley of historical recharge areas in eastern New Mexico.

#### 3.4.14.4 Cenozoic Alluvium Aquifer

The Cenozoic Alluvium aquifer, also referred to as the Cenozoic Pecos Alluvium aquifer (Jones, 2001), is regional in extent, but is not present in the vicinity of the CISF.

#### 3.4.14.5 General Geochemical Characteristics of WCS Groundwater

The groundwater in the 69 m (225 ft) zone has significantly higher total dissolved solids than groundwater in the OAG unit. The groundwater in the OAG unit is a calcium/magnesium bicarbonate type of water with total dissolved solids in the range of 278 to 767 mg/L. The groundwater in the 69 m (225 ft) zone is a sodium sulfate type of water with total dissolved solids in the range of about 3,800 to 4,700 mg/L. Groundwater which has evolved to sulfate-type water is generally considered to have been in the subsurface for a longer time than bicarbonate-type water. The difference between the groundwater in the OAG unit and the groundwater in the 69 m (225 ft) zone suggests both a much longer residence time (i.e. much older groundwater) for the 69 m (225 ft) zone groundwater, as well as distinct separation of the shallower OAG unit from the 69 m (225 ft) zone. If groundwater from the shallow, unconfined OAG unit were readily reaching the 69 m (225 ft) zone, then it would be expected that the general water chemistry between the two zones would be similar. (TCEQ, 2015a).

## 3.5 ECOLOGICAL RESOURCES

This section describes the terrestrial and aquatic communities of the proposed CISF. This section is intended to provide a baseline characterization of the ecology at the CISF prior to any disturbances associated with construction or operation of the CISF. The impacts on ecology at the CISF from prior environmental disturbances (e.g., roads and existing radiological facilities) not associated with the proposed CISF are considered when describing the baseline condition. The plant and animal species associated with this major community are identified and their distributions are discussed. Those species that are considered important to the ecology at the CISF are described in detail. To the extent possible, these descriptions include discussions of the species' habitat requirements, life history, and population dynamics. Also, as part of the evaluation of important species at the CISF, pre-existing environmental conditions that may have impacted the ecological integrity of the CISF and affected important species are considered. Unless otherwise indicated, the information provided in this section is based on surveys conducted by WCS.

### 3.5.1 Prior Ecological Studies at the CISF

A complete ecological assessment of the proposed CISF area and adjoining areas was initially conducted in 1996-97 in conjunction with the proposed development of a LLRW processing and storage facility. That assessment was updated in 2003-04 and supplemented in 2006-07 to support further development of WCS existing treatment and radioactive waste disposal facilities to include additional facilities related to disposal of LLRW and uranium byproduct material.

### 3.5.2 General Ecological Conditions of the CISF

Natural habitats in the study area, defined as the area within a 5 km (3.1 mi) radius of the proposed CISF, are mostly shrub land with grassy patches, which are typical of the larger surrounding region. Species observed in these areas are also typical of the region. Two species of concern, the Texas horned lizard (*Phyrnosoma cornutum*) and sand dune lizard (*Sceloporus arenicolus)*, occur within the area. The former is widespread in Texas and is considered threatened because of over-collecting, incidental loss, and habitat disturbance. The latter has a specialized habitat that occurs throughout much of the region of the proposed CISF. It is a proposed candidate for protection due to the loss of habitat, primarily due to spraying to remove shinnery oak (*Quercus havardii)* to improve grazing.

### 3.5.3 Description of Important Plant and Wildlife Species

#### 3.5.3.1 Vegetation

Shrubs and grasses dominate vegetation cover within 5 km (3.1 mi) of the CISF. Shinnery oak is present in areas north, south, and west of the CISF, but not to the east. Overgrazing indicator species, such as snakeweed (*Gutierrezia sarothrae)* and soapweed (*Yucca elata)*, and weedy grass and forb species, are common throughout most areas surveyed. Soils within the study area are dominated by sandy loams and sandy soils. Stabilized sand dunes and small blowouts occur west, north, northeast, south, and southeast of the CISF. None of these are within 1.5 km (0.93 mi) of the CISF. All of these dune areas are dominated by mesquite (*Prosopis glandulosa)* (generally 1-2 m (3.3 – 6.6 ft) high, shinnery oak, and a combination of other shrub species, including sand sagebrush (*Artemisia filifolia)*, soapweed (*Yucca* sp.), and rabbitbrush (*Chrysothamnus pulchellus*) 45-80 cm (11.8 - 31.5 in) ht. Mixed forbs and grasses comprise the understory. Some grass and forb species (e.g., sunflowers *Helianthus* sp.) attain heights up to 1 m (3.3 ft), but these are not generally dominant. Grasses dominate much of the quadrant southwest of the CISF, but shinnery oak, mesquite, and soapweed are scattered throughout the area.

All areas suffer from some level of human-induced disturbance. Oil well pads, pipelines, transmission line corridors, gravel pits, and access roads are found throughout most portions of the study area. Disposal trenches for municipal, hazardous, petroleum and radioactive wastes occur near the project area. The NEF complex is located on 220 ha (543 acres). Despite the surface disturbance, vegetation cover in much of the study area is relatively dense. Bare soil areas are associated with surface disturbance, and many of these are sparsely vegetated with weedy invasive species such as Russian thistle (*Salsola iberica*).

#### 3.5.3.2 Wildlife

The mourning dove is the most abundant and widespread bird species observed. Other bird species include scaled quail (*Callipepla squamata*), Chihuahuan raven (*Corvus cryptoleucus*), greater roadrunner (*Geococcyx californianus*), American kestrel (*Falco sparverius*), brown-headed cowbird (*Molothrus ater*), and savanna sparrow (*Passerculus sandwichensis*).

The only mammals observed or positively identified in the study area from sign were black-tailed jackrabbit (*Lepus californicus*), coyote (*Canis latrans*), and gopher. Previous surveys have identified a variety of rodents [e.g., Ord's kangaroo rat (*Dipodomys ordii*), silky pocket mouse (*Perognathus flavus*), deer mouse (*Peromyscus maniculatus*), northern grasshopper mouse (*Onchomys leucogaster*), southern plains woodrat (*Neotoma micropus*), and plains harvest mouse (*Reithrodontomys montanus*)] (Ortega, Bryant, Petit, & Rylander, 1997). Collared peccaries (*Tayasu tajacu*) have been observed east of the CISF. Rodent tracks are abundant, particularly in sandy areas.

No evidence of amphibians has been found at the ephemeral pools located north and south of the CISF.

Reptiles observed in the study area include whiptail lizards (*Cnemidophorus* sp.), southern prairie lizard (*Sceloporus undulatus consubrinus*), the sand dune lizard (*Sceloporus arenicolus*), and the western hognose snake (*Heterodon nasicus*).

Common invertebrate species have been observed at various locations. Grasshoppers are abundant, and most CISF harbor one or more ant species. Flies and mosquitoes are also common. A variety of beetles, butterflies, and spiders have been observed, but not further identified.

#### 3.5.3.3 Birds

Birds were surveyed through observation and by call at the proposed CISF and its vicinity to document species, potential breeding species, seasonal migrants, and winter residents. A barn owl (*Tyto alba*) was observed at Baker Spring during the March 2004 survey. A recently dead specimen was found in the same area during the June 2006 surveys. The species is common in all four southwestern deserts. Barn owls hunt for rodents along desert washes, where trees are present. Suitable habitat exists at Baker Spring and southeast of the CISF. No washes or trees are present in areas of proposed CISF development.

All bird species encountered on and near the proposed CISF are consistent with the range information provided in (Ortega, Bryant, Petit, & Rylander, 1997) and references cited therein and with other records from the vicinity near the CISF. It is likely many of the summer resident species breed and raise their young on or in the vicinity of the CISF.

Historically, a WCS ranch manager reported seeing a female lesser prairie chicken (*Tympanuchus pallidicinctus*) near the CISF (Ortega, Bryant, Petit, & Rylander, 1997) but the sighting was never verified. Although the CISF is outside the known range of the species, areas of suitable habitat (e.g., shinnery oak) are present within a 5 km (3.1 mi) radius of the CISF. No active leks or prairie chickens have been detected during the 2004 Lyons surveys (Lyons, 2004). Surveys were conducted by a researcher who was familiar with standard techniques used to census this species in New Mexico and Texas.

New Mexico's Department of Game and Fish completed a lesser prairie chicken survey in 2000, examining the northern portion of Lea County, along with portions of Chavis, Roosevelt, and De Baca counties (Massey & Dunn, 2000). The New Mexico report did not include the area adjacent to the CISF; however, more recent surveys for the lesser prairie chicken conducted in

September 2003 and April 2004 in support of the licensing of the nearby NEF indicated the species does not occur on land of the proposed CISF. No visual sightings or aural detections were made and the researchers concluded there is little potential habitat in the survey area.

The USFWS currently lists the lesser prairie chicken as a threatened species. Recent decline in population numbers of the lesser prairie chicken, a species that prefers shinnery oak habitat, has shifted concern on public lands towards protection of this habitat.

#### 3.5.3.4 Aquatic

Aquatic ecological studies have not been conducted in the area because there are no permanent—and only occasionally ephemeral—sources of surface water available on or in the vicinity of the proposed CISF. These are insufficient to support aquatic species.

The TCEQ has confirmed that wetlands are not located in the vicinity of the proposed CISF. Pools of water are intermittently present in the vicinity of the Baker Spring outcrop, located approximately 0.58 km (0.36 mi) west of the proposed CISF. These pools may support amphibians [such as spadefoot toads (*Scaphiopus multiplicatus*) and the Texas toad (*Bufo speciosus*),)] and invertebrates adapted to take advantage of such locations.

### 3.5.4 Rare, Threatened, and Endangered Species Known or Potentially Occurring in the Project Area

The proposed CISF would be located within the known range of two species of concern; however, there are eight species of concern regionally and a migrant has the remote possibility of appearing on the CISF. These are listed in Table 3.5-1. Figure 3.5-1 shows the known occurrences of such species near the CISF.

**Table 3.5-1, Endangered Species List**

| Common Name | Genus Species | Federal Status | State Status | Note |
|---|---|---|---|---|
| Texas horned lizard | Phrynosoma cornutum | | T | |
| American Peregrine Falcon | Falco peregrinus anatum | DL | T | |
| Bald Eagle | Haliaeetus leucocephalus | DL | T | |
| Lesser Prairie-Chicken | Tympanuchus pallidicinctus | T | | |
| Northern Aplomado Falcon | Falco femoralis septentrionalis | LE | | |
| Peregrine Falcon | Falco peregrinus | DL | T | |
| Whooping Crane | Grus americana | LE | E | Potential migrant |
| Black-footed ferret | Mustela nigripes | | | Extirpated in area |
| Gray wolf | Canis lupus | LE | E | Extirpated in area |

Sources: (USFWS, 2016) (TPWD, 2016)

The Texas horned lizard has been reported as present on the property controlled by WCS by previous surveys. Suitable habitat is present throughout much of the study area, and it is likely that the species is widespread in the region, as reported by previous investigators. None were observed during the October 2004 survey.

The sand dune lizard has been reported in the area northwest of the proposed CISF in past site surveys. Habitat characteristics favorable for the species include open sandy blowouts near shinnery oak (Texas Conservation Plan, 2011). As such habitat was found in much of the study area, the species might occur in the area. However, the areas of habitat are small and isolated from each other, so no estimate of actual distribution or abundance could be made on the basis of present surveys. Areas west, north, northeast, south, and southeast of the CISF have the potential to be suitable habitat. A juvenile lizard, presumably of this species, was captured, photographed, and released from a sandy blowout location approximately 4 km (2.5 mi) southeast of the CISF. The habitat in which the specimen was collected is a small blowout with shinnery oak, sand sage, soapweed, and sparse grasses present at the periphery.

A nomination has been submitted to the BLM to designate two public land parcels within Lea County as an ACEC for the lesser prairie chicken (*Tympanuchus pallidicinctur*). The nearest nominated ACEC straddles Lea and Eddy Counties and is about 48 km (30 mi) northwest of the proposed CISF. The other nominated ACEC, which is further north, borders the northwest comer of Lea County. Currently, the BLM is evaluating this nomination and expects to make a decision within the next several years.

### 3.5.5 Major Vegetation Characteristics

The general vegetation community type at the proposed CISF is classified as Plains-Mesa Sand Scrub (Dick-Peddie, 1993) characterized by the presence of significant amounts of the indicator species shinnery oak, a low growing shrub. The community is further characterized by the presence of forbs, shrubs, and grasses that are adapted to the deep sand environment that occurs in parts of western Andrews County, Texas.

### 3.5.6 Habitat Importance

For most of the threatened, endangered, and other important species, the importance of the habitat on the proposed CISF relative to the habitat of those species throughout their entire range is rather low. Most of these species have little or no suitable habitat on the proposed CISF and the habitats present are not rare or uncommon in the local area or range-wide for these species.

A field survey conducted in October 2003 revealed that the CISF does not support sand dune lizard habitat. The primary reasons that the proposed CISF would unsuitable habitat for the sand dune lizard are the high frequency of mesquite and grassland vegetation associations, which are associated with environmental conditions that do not support sand dune lizards. Also, there is a low frequency and extent of shinnery oak dunes and large blowouts, which provide the habitat and microhabitats necessary for sand dune lizard survival.

A field survey for the lesser prairie chicken and the black-tailed prairie dog was conducted in September 2003; results indicated that these species do not occur on the WCS controlled property. A subsequent survey performed for the lesser prairie chicken in April 2004, supports the initial findings. The proposed CISF could provide suitable food sources for the lesser prairie chicken, though there are only limited water sources. Due to the high density of shrubs, the proposed CISF would not optimal prairie dog habitat.

### 3.5.7 Location of Important Travel Corridors

None of the important wildlife species identified at the proposed CISF are migratory in this part of their range; therefore, these species do not have established migratory travel corridors. However, three of the species, mule deer, lesser prairie chicken, and scaled quail, are highly mobile and utilize a network of diffuse travel corridors linking base habitat requirements (i.e., food, water, cover, etc.). These travel corridors may change from season to season as well as from year to year for each species and can occur anywhere within the species' home range.

Mule deer and scaled quail utilize and often thrive in altered habitats and can and do live in close proximity to humans and human activities. For these two species, any travel corridors that would potentially be blocked by the proposed CISF would easily and quickly be replaced by an existing or new travel corridor linking base habitat requirements for these two species.

The CISF does not provide optimal habitat for the lesser prairie chicken and has not been identified as an important travel corridor for this species.

The sand dune lizard is not a highly mobile species and is confined to small home ranges within the active sand dune-shinnery oak habitat type. Travel corridors are not important features of the lizard habitat. A field survey confirmed that the sand dune lizard is not present at the proposed CISF.

The black-tailed prairie dog is not highly mobile. Considering that prairie dogs dig extensive, deep, and permanent burrows (i.e., they do not migrate) and are not dependent on free water, travel corridors are not important features of the prairie dog habitat. A field survey found no evidence of black-tailed prairie dogs at the proposed CISF.

### 3.5.8 Important Ecological Systems

The proposed CISF contains fair to poor quality wildlife habitat. The Plains-Mesa Sand Scrub vegetative community has been impacted by past land use practices. The proposed CISF has previously been grazed by domestic livestock for over a hundred years, has a Texas state highway along the southern boundary, a rail line spur right-of-way borders the southern perimeter of the CISF, and a gravel access road runs north to south along the south and east perimeter of the CISF. The degraded habitat generally lacks adequate cover and water for large animal species, and annual grazing by domestic livestock impacts ground nesting bird species.

Based on recent field studies and the published literature, there are no onsite important ecological systems that are especially vulnerable to change or that contain important species habitats such as breeding areas, nursery, feeding, resting, and wintering areas, or other areas of seasonally high concentrations of individuals of important species. The species selected as important for the CISF are all highly mobile species, with the exception of the sand dune lizard and the black-tailed prairie dog, and are not confined to the CISF or dependent on habitats at the CISF. The Plains-Mesa Sand Scrub vegetation type covers hundreds of thousands of acres in western Andrews County Texas and is not unique to the proposed CISF.

Critical habitat for the lesser prairie chicken occurs in New Mexico northwest of the CISF. Field surveys for the lesser prairie chicken conducted in September 2003 and April 2004 indicated the species does not occur on the proposed CISF.

Although the CISF does contain sand dune/shinnery oak communities, which could be potential sand dune lizard habitat, field surveys conducted in October 2003 and June 2004 revealed that the sand dune lizards are not present on the CISF.

The high density of shrubs on the proposed CISF is not optimal prairie dog habitat. No prairie dogs were found onsite during the September 2003 survey.

### 3.5.9 Characterization of the Aquatic Environment

The CISF contains no aquatic habitat. There is a shallow playa east of the proposed CISF that contains a small amount of water for several days following a major precipitation event. This feature does not support aquatic life, and no rare, threatened, or endangered species are present. There are no intermittent or perennial water bodies or jurisdictional wetlands on the CISF. There is no hydrological/chemical monitoring station onsite, and no data have been recorded in the past.

### 3.5.10 Location and Value of Commercial and Sport Fisheries

Due to the lack of aquatic habitat (no surface water), there are no commercial or sport fisheries located on the proposed CISF or in the local area. The closest fishery, the Pecos River and Lake McMillan located on the Pecos River near Carlsbad, New Mexico, is approximately 121 km (75 mi) west of the proposed CISF.

### 3.5.11 Key Aquatic Organism Indicators

Due to the lack of aquatic life known to exist on the proposed CISF, no key aquatic indicator organisms expected to gauge changes in the distribution and abundance of species populations that are particularly vulnerable to impacts from the proposed action can be identified.

### 3.5.12 Important Ecological Systems

There are no important aquatic ecological systems onsite or in the local area that are especially vulnerable to change or that contain important species habitats, such as breeding areas, nursery areas, feeding areas, wintering areas, or other areas of seasonably high concentrations of individuals of important species.

### 3.5.13 Significance of Aquatic Habitat

The proposed CISF contains no aquatic habitat; therefore, the relative regional significance of the aquatic habitat is low.

### 3.5.14 Description of Conditions Indicative of Stress

Pre-existing environmental stresses on the plant and animal communities at the proposed CISF consist of road and rail right-of-ways and domestic livestock grazing. The impact of road and rail installation and maintenance of the right-of-way has been mitigated by the colonization of the disturbed areas by local plant species. However, the access road along the perimeter of the CISF is maintained and used by vehicles associated with the operation of the adjacent waste disposal facilities on a regular basis. The disturbed areas immediately adjacent to the road are being invaded by lower successional stage species (i.e., weeds). This pattern is expected to continue as long as the road and rail line are maintained.

Historical domestic livestock grazing and fencing of the CISF constitute a pre-existing and continuing environmental stress. Heavily grazed native grasslands tend to exhibit changes in vegetation communities that move from mature, climax conditions to mid-successional stages with the invasion of woody species such as honey mesquite and sagebrush. The proposed CISF has large stands of mesquite indicative of long-term grazing pressure that has changed the vegetative community from one dominated by climax grasses to a sand scrub community and the resulting changes in wildlife habitat.

Another periodic environmental stress is changes in local climatic and precipitation patterns. The proposed CISF would be located in an area of the Southern High Plains of Texas that experiences shifts in precipitation amounts that can affect plant community diversity and production on a short-term seasonal basis and also on a long-term basis that may last for several years. Below average precipitation that negatively impacts the plant community also directly alters wildlife habitat and may severely reduce wildlife populations.

Past livestock grazing, fencing, and the maintenance of access roads and pipeline right-of-ways represent the primary pre-existing environmental stress on the wildlife community of the CISF. The probable result of the past and current use of the proposed CISF is a shift from wildlife species associated with mature desert grassland to those associated with a grassland shrub community. Large herbivore species such as the pronghorn antelope (*Antilocapra americana*) that require large, open prairie areas with few obstructions such as fences have decreased. Other mammalian species that depend on open grasslands, such as the black-tailed prairie dog (*Cynomys ludovicianus*), are also no longer present in the immediate area. Bird species that depend on the mature grasslands for habitat, such as the lesser prairie chicken (*Tympanuchus pallidicinctus*), have decreased in the region and at the proposed CISF. Other species that thrive in a mid-successional plant community, such as the black-tailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus audubonii*), and mule deer (*Odocoileus hemionus*), have probably increased. No other environmental stresses on the terrestrial wildlife community (e.g., disease, chemical pollutants) have been documented at the proposed CISF.

### 3.5.15 Description of Ecological Succession

Long-term ecological studies of the proposed CISF are not available for analysis of ecological succession at this specific location. The property is located in a Plains Sand Scrub vegetation community, which is a climax community that has been established in western Andrews County for an extended period. The majority of the subject property is a mid-successional stage, primarily due to historic grazing of domestic livestock and climactic conditions.

Development of the proposed CISF would be limited to an access road for a neighboring property and faded two-track roads along the perimeter of the property; the two-track roads are probably used for fence maintenance. These areas contain some colonizing plants that are common to disturbed ground. An example of a disturbed ground colonizing species in western Andrews County is broom snakeweed (*Gutierrezia sarothrae*). The proposed CISF has been grazed for an unknown period of time, although regional grazing by domestic livestock has occurred for 150 years. Evidence of past grazing was also apparent from reduced amounts of standing vegetation. Moderately high densities of honey mesquite (*Prosopis glandulosa*) seedlings were observed during the vegetation survey. Reduced grass canopy from historic and contemporary livestock grazing may be contributing to the colonization of honey mesquite due to reduced competition. Honey mesquite is considered noxious on rangeland because of its ability to compete for soil moisture and its reproductive ability.

### 3.5.16 Description of Ecological Studies

The description of the ecological studies can be found in the following:

- The Ecology Group conducted an ecological assessment in 1997
- Doug Reagan and Associates of Castle Rock, Colorado conducted a habitat characterization and rare species survey in 2004
- An ecological assessment was performed in New Mexico at the proposed NEF in October 2003 and June 2004
- In 2007, Doug Reagan, working with URS, performed a survey to supplement the 2004 ecological assessment
- An environmental assessment was prepared in 2008 to support the re-licensing of the WCS processing and storage facility

### 3.5.17 Information on Rare, Threatened, and Endangered Species Sightings

No rare, threatened, or endangered species have been observed in the vicinity of the proposed CISF.

### 3.5.18 Agency Consultation

Consultation was initiated with all appropriate federal and state agencies and affected Native American Tribes. Consultation Documents are presented in Attachment 3-3.

### 3.5.19 Affects from Other Federal or State Projects on Rare, Threatened, and Endangered Species

The proposed CISF is not expected to negatively affect any rare, threatened, and endangered species or their habitats. WCS is not aware of other Federal and State projects within the region that are or could potentially affect the same threatened and endangered species or their habitats.

## 3.6 METEOROLOGY, CLIMATOLOGY, AND AIR QUALITY

### 3.6.1 Regional Climatology

The NOAA NWS, Weather Forecast Office at Midland (NWS Midland) covers the High Plains where the proposed CISF is located. The regional climate can best be described as “semi-arid continental” marked with four seasons. Summers are typically hot and dry with generally low relative humidity. July is the hottest month with high temperatures occasionally reaching above 100 degrees Fahrenheit. January is the coldest month, although the winters are not generally severe. Temperatures occasionally dip below 32 degrees Fahrenheit. Precipitation levels are generally low in this arid climate. The precipitation tends to be heavier in the summer and fall.

During the winter, the regional weather is often dominated by a high-pressure system in the central part of the western United States and a low-pressure system located over Arizona in the summer.

### 3.6.2 Site and Regional Meteorology

The Weather Forecast Office at Midland-Odessa, Texas covers the High Plains where the proposed site is located. In addition to the weather forecast office in Midland, climatological data for atmospheric variables such as temperature, pressure, winds, and precipitation are also collected at stations in Jal, New Mexico; Hobbs, New Mexico; and Andrews, Texas. Table 3.6-1 indicates the distances and directions of these stations from the site and the length of record for the reported data.

**Table 3.6-1, Weather Stations Located Near the WCS CISF**

| Station | Distance and Direction from Proposed Site | Length of Record* | Station Elevation (meters) |
|---|---|---|---|
| Hobbs, New Mexico | 32 kilometers (20 miles) north of site | 29 (1981-2010) | 1,115 |
| Jal, New Mexico | 50 kilometers (31 miles) south of site | 29 (1981-2010) | 947 |
| Andrews, Texas | 51 kilometers (32 miles) east of site | 29 (1981-2010) | 967 |
| Midland-Odessa, Texas | 103 kilometers (64 miles)southeast of site | 29 (1981-2010) | 1,118 |

* Years of compiled data for climatological analysis.

The Midland-Odessa monitoring station is the closest first-order National Weather Service station to the WCS site. First-order weather stations record a complete range of meteorological parameters for 24-hour periods, and they are usually fully instrumental and operated by the National Weather Service (http://www.ncdc.noaa.gov/homr/).

Meteorological data have been collected on the WCS property from the four onsite meteorological tower stations listed below:

- Tower 1 has been collecting data since March 2009 and has sensors at both the 2 m (6.6 ft) (lower) and 10 m (32.8 ft) (upper) height intervals. Data collected includes temperature, wind direction, wind speed, relative humidity at 2 (6.6 ft) and 10 m (32.8 ft), barometric pressure, solar radiation, and rain at 2 m (6.6 ft) only. Data averages, unless otherwise noted, are based on available historic records from 2009-2015.

- The ER Tower has been collecting data since July 2009 and has sensors at both the 2 m (6.6 ft) (lower) and 10 m (32.8 ft) (upper) height intervals. This tower measures temperature, wind direction, wind speed, relative humidity at 2 and 10 m (6.6 ft and 32.8 ft), barometric pressure, solar radiation, and rain at 2 m only. Data averages, unless otherwise noted, are based on available historic records from 2009-2015.

- The WeatherHawk West Tower has been collecting data since March 2009 and measures temperature, wind direction, wind speed, relative humidity, barometric pressure, solar radiation, and rain at roughly 3 m (10 ft). Data averages, unless otherwise noted, are based on available historic records from 2009-2015.

- The WeatherHawk East Tower has been collecting data since March 2009 and measures temperature, wind direction, wind speed, relative humidity, barometric pressure, solar radiation, and rain at roughly 3 m (10 ft). Data averages, unless otherwise noted, are based on available historic records from 2009-2015.

### 3.6.3 Maximum and Minimum Temperatures

The Western Regional Climate Center (WRCC) (WRCC, 2015) has historic temperature data for Andrews, Texas starting in 1914. Currently available temperature data spans the period from 1962 to 2010. The mean (average) maximum and minimum daily temperatures, the record high temperature and low temperature for each month, and the annual high and low temperature for these years is shown in Table 3.6-2. In Andrews, Texas the average annual maximum temperature is 77.5 degrees Fahrenheit and the average annual minimum temperature is 49.4 degrees Fahrenheit. Recent seasonal temperature data for Midland, Texas provided by the National Oceanic & Atmospheric Administration (NOAA) is provided in Table 3.6-3.

**Table 3.6-2, Summary of Maximum and Minimum Temperatures for Andrews, Texas Period of Record 1962 to 2010**

| | MEAN MONTHLY TEMPERATURE | | MEAN DAILY MAX. TEMPERATURE | | MEAN DAILY MIN. TEMPERATURE | | HIGHEST DAILY MAX. TEMPERATURE | | LOWEST DAILY MIN TEMPERATURE | |
|---|---|---|---|---|---|---|---|---|---|---|
| **MONTH** | °C | °F | °C | °F | °C | °F | °C | °F | °C | °F |
| January | 6.7 | 44.1 | 14.5 | 58.1 | -1.1 | 30.1 | 29.4 | 85.0 | -17.8 | 0.0 |
| February | 9.2 | 48.6 | 17.2 | 63.1 | 1.1 | 33.9 | 31.7 | 89.0 | -18.3 | -1.0 |
| March | 13.3 | 56.0 | 21.8 | 71.3 | 4.8 | 40.6 | 36.1 | 97.0 | -13.3 | 8.0 |
| April | 18.2 | 64.7 | 26.8 | 80.2 | 9.4 | 49.0 | 37.2 | 99.0 | -5.0 | 23.0 |
| May | 22.7 | 72.9 | 31.0 | 87.8 | 14.5 | 58.1 | 41.7 | 107.0 | 0.6 | 33.0 |
| June | 26.6 | 79.8 | 34.3 | 93.8 | 18.7 | 65.7 | 45.0 | 113.0 | 8.3 | 47.0 |
| July | 27.5 | 81.5 | 34.8 | 94.6 | 20.2 | 68.3 | 43.9 | 111.0 | 13.9 | 57.0 |
| August | 26.7 | 80.0 | 33.9 | 93.0 | 19.5 | 67.1 | 41.1 | 106.0 | 12.2 | 54.0 |
| September | 23.3 | 73.9 | 30.4 | 86.8 | 16.1 | 61.0 | 40.0 | 104.0 | 3.3 | 38.0 |
| October | 18.3 | 64.9 | 26.1 | 79.0 | 10.4 | 50.8 | 38.3 | 101.0 | -5.6 | 22.0 |
| November | 11.8 | 53.2 | 19.4 | 67.0 | 4.1 | 39.4 | 33.9 | 93.0 | -11.7 | 11.0 |
| December | 7.6 | 45.6 | 15.3 | 59.5 | -0.2 | 31.7 | 27.2 | 81.0 | -17.2 | 1.0 |
| **Annual** | **17.5** | **63.5** | **25.3** | **77.5** | **9.7** | **49.4** | **45.0** | **113.0** | **-18.3** | **-1.0** |

(WRCC, 2015)

**Table 3.6-3, Monthly Seasonal Temperatures Midland, Texas for 2000-2015**

| MONTH | AVERAGE DAILY HIGH TEMPERATURE | | AVERAGE DAILY LOW TEMPERATURE | | AVERAGE DAILY TEMPERATURE | | AVERAGE DAILY TWO-MONTH TEMPERATURE (MONTH PLUS PREVIOUS MONTH) | |
|---|---|---|---|---|---|---|---|---|
| | °C | °F | °C | °F | °C | °F | °C | °F |
| January | 14.5 | 58.1 | -0.6 | 31.0 | 6.9 | 44.5 | 7.1 | 44.7 |
| February | 16.7 | 62.0 | 1.2 | 34.2 | 9.0 | 48.1 | 8.0 | 46.3 |
| March | 21.9 | 71.4 | 5.7 | 42.3 | 13.8 | 56.8 | 11.4 | 52.5 |
| April | 27.1 | 80.8 | 10.8 | 51.5 | 19.0 | 66.1 | 16.4 | 61.5 |
| May | 31.1 | 88.0 | 15.9 | 60.6 | 23.5 | 74.3 | 21.2 | 70.2 |
| June | 34.9 | 94.9 | 20.8 | 69.4 | 27.8 | 82.1 | 25.7 | 78.2 |
| July | 34.8 | 94.7 | 21.8 | 71.2 | 28.3 | 82.9 | 28.1 | 82.5 |
| August | 34.9 | 94.9 | 21.4 | 70.5 | 28.2 | 82.7 | 28.2 | 82.8 |
| September | 30.8 | 87.4 | 17.5 | 63.5 | 24.1 | 75.5 | 26.2 | 79.1 |
| October | 25.6 | 78.0 | 11.7 | 53.0 | 18.6 | 65.5 | 21.4 | 70.5 |
| November | 19.1 | 66.3 | 4.4 | 39.9 | 11.7 | 53.1 | 15.2 | 59.3 |
| December | 14.5 | 58.1 | -0.2 | 31.7 | 7.2 | 44.9 | 9.4 | 49.0 |
| **Annual** | **25.5** | **77.9** | **10.9** | **51.6** | **18.2** | **64.7** | **18.2** | **64.7** |

### 3.6.4 Winds, Extreme Winds and Atmospheric Stability

Regionally wind speeds are usually more moderate, although relatively strong winds often accompany occasional frontal activity during late winter and spring months and sometimes occur just in advance of thunderstorms. Frontal winds may exceed 13 meters per second (30 miles per hour) for several hours and reach peak speeds of more than 22 meters per second (50 miles per hour).

Wind speed and direction data measured at the onsite WCS meteorological stations from 2010 to 2015 is shown in wind rose diagrams in Figures 3.6-1 through 3.6-5. The data used to create the wind rose diagrams is provided in Attachment A of the SAR Chapter 2. The wind roses show the percent of the time (rings) that the wind blows from each of the 16 directions (N, NNE, NE, NNW) by the length of the bars. The shading of the bars also indicates the frequency of occurrence of wind speeds within the wind speed classes shown in the figures. The onsite data indicates that for this period from 2010 to 2015 the average wind speed ranged from 6.07 knots to 10.53 knots. The wind direction is predominantly from the south. The diagrams indicate that wind gusts in excess of 22 mph generally blow from the southwest or northeast.

The neighboring NEF site analyzed wind speed and direction from the Midland-Odessa weather station for the years 1987 to 1991. Calculated annual mean wind speed was 5.1 meters per second (11.4 miles per hour), with prevailing winds from the south and a maximum 5-second wind speed of 31.2 meters per second (70 miles per hour). The Pasquill stability classes range from A to F with the most stable classes – E and F – occurring 18.9 and 13 percent of the time, respectively. The least stable classes, A and B, occur 0.3 and 3.5 percent of the time, respectively. NEF compared this data against data generated at WCS from October 1999 through August 2002 and found similar wind patterns and distribution of wind speed between Midland-Odessa and WCS locations (EIS for NEF, 2005).

### 3.6.5 Tornadoes

Two F2 Class (wind speed from 113 to 157 mph) tornadoes have been recorded in Andrews County, Texas between 1950 and 2015 according to data reported by NOAA (NOAA, 2016). NOAA reports there were eight F1 Class (wind speed 73 to 112 mph) tornadoes recorded in Andrews County since 1950. Tornados are classified using the F-scale with classifications ranging from F0-F5 as follows:

- F0-classified tornados have winds of 64 to 116 kilometers per hour (40 to 72 miles per hour)
- F1-classified tornados have winds of 117 to 181 kilometers per hour (73 to 112 miles per hour)
- F2-classified tornados have winds of 182 to 253 kilometers per hour (113 to 157 miles per hour)

- F3-classified tornados have winds of 254 to 332 kilometers per hour (158 to 206 miles per hour)
- F4-classified tornados have winds of 333 to 419 kilometers per hour (207 to 260 miles per hour)
- F5-classified tornados have winds of 420 to 512 kilometers per hour (261 to 318 miles per hour)

WCS is located about 805 kilometers (500 miles) from the coast. Because hurricanes lose their intensity quickly once they pass over land, a hurricane would most likely lose its intensity before reaching WCS and dissipate into a tropical depression.

Blowing sand or dust may occur occasionally in the area due to the combination of strong winds, sparse vegetation, and the semi-arid climate. High winds associated with thunderstorms are frequently a source of localized blowing dust. Most episodes of dust prevail for only six hours or less, when visibility is restricted to less than 0.5 mile. Statistical information is lacking on seasonal distribution intensity and duration of dust storms for the region. Recent data in Lubbock, Texas (110 miles northeast of the site) indicates blowing dust an average of 12 times in the spring and 9 times during the remainder of the year (Bomar, 1995).

### 3.6.6 Precipitation Extremes

The WRCC (WRCC, 2015) has historic precipitation data for Andrews, Texas starting in 1914. The maximum observed 24-hour rainfall (between 1914 and 2012) amount at Andrews, Texas is 19.3 cm (7.6 in) in February 1914. The meteorological station in Andrews, Texas historic precipitation and snow data for Andrews, Texas can be found in Tables 3.6-4 and 3.6-5. WCS also has four on-site meteorological stations that monitor and record onsite precipitation and the data is included in Attachment A of the SAR Chapter 2.

**Table 3.6-4, Andrews, Texas Period of Record Precipitation Data (1914-2006)**

| Precipitation cm (in) | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average | 1.24 (0.49) | 1.50 (0.59) | 1.70 (0.67) | 2.41 (0.95) | 4.19 (1.65) | 4.88 (1.92) | 5.74 (2.26) | 4.78 (1.88) | 5.72 (2.25) | 3.78 (1.49) | 1.58 (0.62) | 1.35 (0.53) | 38.86 (15.30) |
| Maximum | 11.40 (4.49) | 6.40 (2.52) | 8.46 (3.33) | 13.67 (5.38) | 14.91 (5.87) | 18.06 (7.11) | 30.23 (11.90) | 14.00 (5.51) | 20.17 (7.94) | 16.16 (6.36) | 8.00 (3.15) | 7.80 (3.07) | 78.66 (30.97) |
| Minimum | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.36 (0.14) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.36 (0.14) |
| Max 24 Hr | 5.61 (2.21) | 2.54 (1.00) | 4.70 (1.85) | 6.30 (2.48) | 7.62 (3.00) | 9.40 (3.70) | 19.30 (7.60) | 6.10 (2.40) | 8.90 (3.50) | 5.21 (2.05) | 5.33 (2.10) | 3.94 (1.55) | 19.30 (7.60) |

**Table 3.6-5, Andrews, Texas Period of Record Snow Data (1914-2006)**

| Snow cm (in) | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Average** | 3.33 (1.31) | 1.52 (0.60) | 0.08 (0.03) | 0.15 (0.06) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.08 (0.03) | 1.45 (0.57) | 1.98 (0.78) | 8.59 (3.38) |
| **Maximum** | 25.40 (10.00) | 17.78 (7.00) | 2.54 (1.00) | 6.35 (2.50) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 2.54 (1.00) | 35.56 (14.00) | 13.97 (5.50) | 52.07 (20.50) |
| **Minimum** | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) |
| **Max 24 Hr** | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

Summer rains fall almost entirely during brief, but frequently intense thunderstorms. The general southeasterly circulation from the Gulf of Mexico brings moisture from these storms into the State of New Mexico, and strong surface heating combined with orographic lifting as the air moves over higher terrain causes air currents and condensation. Orographic lifting occurs when air is intercepted by a mountain and is forcefully raised up over the mountains, cooling as it rises. If the air cools to its saturation point, the water vapor condenses and a cloud forms.

As these storms move inland, much of the moisture is precipitated over the coastal and inland mountain ranges of California, Nevada, Arizona, and Utah. Much of the remaining moisture falls on the western slope of the Continental Divide and over northern and high-central mountain ranges. Winter is the driest season in New Mexico except for the portion west of the Continental Divide. This dryness is most noticeable in the Central Valley and on eastern slopes of the mountains. In New Mexico, much of the winter precipitation falls as snow in the mountain areas, but it may occur as either rain or snow in the valleys.

Data from the Midland-Odessa Weather Station indicate the relative humidity throughout the year ranges from 51.5 to 65 percent, with the highest humidity occurring during the early morning hours.

### 3.6.6 Thunderstorms and Lightning Strikes

The mean number of annual thunderstorm days for Hobbs, New Mexico and Midland, Texas is 25.5 and 36.4, respectively (NOAA, 2004). No records are maintained for the frequency of thunderstorms and lightning at the proposed CISF; however, the actual number of events can be expected to be similar to these regional data.

### 3.6.7 Mixing Heights

Mixing height is defined as the height above the earth’s surface through which relatively strong vertical mixing of the atmosphere occurs. G.C. Holzworth developed mean annual morning and afternoon mixing heights for the contiguous United States (Holzworth, 1972). According to Holzworth’s calculations, the mean annual morning and afternoon mixing heights at the WCS site are approximately 436 meters (1,430 feet) and 2,089 meters (6,854 feet), respectively. Table 3.6-6 shows the average morning and afternoon mixing heights for Midland-Odessa, Texas.

**Table 3.6-6, Average Morning and Afternoon Mixing Heights for Midland-Odessa, Texas**

| | Winter | Spring | Summer | Fall | Annual |
|---|---|---|---|---|---|
| Morning | 290 meters<br>(951 feet) | 429 meters<br>(1,407 feet) | 606 meters<br>(1,988 feet) | 419 meters<br>(1,375 feet) | 436 meters<br>(1,430 feet) |
| Afternoon | 1,276 meters<br>(4,186 feet) | 2,449 meters<br>(8,035 feet) | 2,744 meters<br>(9,003 feet) | 1,887 meters<br>(6,191 feet) | 2,089 meters<br>(6,854 feet) |

Source: (Holzworth, 1972)

### 3.6.8 Diffusion Estimates

For normal and off-normal conditions, an atmospheric dispersion coefficient is calculated using D-stability and a wind speed of 5 m/sec and a 100 m (328 ft) distance to the controlled area boundary. The controlled area boundary is more than 100 m (328 ft) from the WCS CISF, so use of 100 m (328 ft) is conservative. For accident conditions, a dispersion coefficient is calculated using F-stability and a wind speed of 1 m/sec. These atmospheric conditions are consistent with the guidance of NUREG-1536 and NUREG-1567. The smallest vertical plane cross-sectional area of one horizontal storage module (HSM) is conservatively used as the vertical plane cross-sectional area of the building: area = HSM Width * HSM Height = 9 ft 8 in x 15 in = 20,880 $in^2$ = 13.47 $m^2$.

The atmospheric dispersion coefficients can be determined through selective use of Equations 1, 2, and 3 of Regulatory Guide 1.145 for ground-level relative concentrations at the plume centerline. For D-stability, 5 m/sec wind speed and a distance of 100 m (328 ft), the horizontal dispersion coefficient, $\sigma_y$, is 8 m per Figure 1 of (NRC, 1982). The vertical dispersion coefficient, $\sigma_z$, is 4.6 m per Figure 2 of (NRC, 1982). The correction factor at these conditions is determined to be 1.122 per Figure 3 of (NRC, 1982).

For F-stability, 1 m/sec wind speed and a distance of 100 m, the horizontal dispersion coefficient, $\sigma_y$, is 4 m per Figure 1 of (NRC, 1982). The vertical dispersion coefficient, $\sigma_z$, is 2.3 m per Figure 2 of (NRC, 1982). The correction factor at these conditions is 4 per Figure 3 of (NRC, 1982).

With the three values of $\chi$/Q determined, the higher $\chi$/Q value of the first two (Equation 1 and Equation 2) is compared with the last one (Equation 3) and the lower of those two is evaluated as the appropriate atmospheric dispersion coefficient per in Regulatory Guide 1.145 (NRC, 1982).

The parameters used and the calculated atmospheric dispersion coefficients are summarized in Table 3.6-7.

**Table 3.6-7, Atmospheric Dispersion Coefficients**

| Parameter | Normal/Off-Normal | Accident |
|---|---|---|
| Stability | D | F |
| $\overline{U_{10}}$ (m/sec) | 5 | 1 |
| A ($m^2$) | 13.47 | 13.47 |
| $\sigma_y$ (m) | 8 | 4 |
| $\sigma_z$ (m) | 4.6 | 2.3 |
| M | 1.122 | 4 |
| Equation 1 of [3] (sec/$m^3$) | 1.635E-03 | 2.806E-02 |
| Equation 2 of [3] (sec/$m^3$) | 5.766E-04 | 1.153E-02 |
| Equation 3 of [3] (sec/$m^3$) | 1.542E-03 | 8.650E-03 |
| $\chi$/Q (sec/$m^3$) | 1.542E-03 | 8.650E-03 |

### 3.6.9 Air Quality

To assess air quality, the EPA has established maximum concentrations for pollutants that are referred to as the National Ambient Air Quality Standards (http://www3.epa.gov/ttn/naaqs/criteria). Six criteria pollutants are used as indicators of air quality: ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, and lead (EPA, 2016). Both Lea and Andrews Counties are in attainment for all of the EPA criteria pollutants (EPA, 2016).

In the table below the total annual emissions (tons per year) of Criteria Air Pollutants at Andrews County, TX compared to the State of Texas are shown (Table 3.6-8).

**Table 3.6-8, Total Annual Emissions (tons per year) of Criteria Air Pollutants at Andrews County, Texas compared to State of Texas**

| County, State | VOC | $NO_x$ | CO | $SO_2$ | $PM_{2.5}$ |
|---|---|---|---|---|---|
| Andrews County, TX | 72,925 | 7,731 | 24,225 | 1,492 | 1,609 |
| State of Texas | 499,904 | 1,420,740 | 6,839,207 | 1,492 | 574,110 |

A ton is equal to 0.9078 metric ton; VOC-volatile organic compounds; NOx-nitrogen oxides; CO-carbon monoxide; SO2-sulfur dioxide; PM2.5-particulate matter less than 2.5 microns. Source: (EPA, 2016)

## 3.7 NOISE

Noise is defined as "unwanted sound." At high levels noise can damage hearing, because sleep deprivation, interfere with communication, and disrupt concentration. In the context of protecting the public health and welfare, noise implies adverse effects on people and the environment. The sound we hear is the result of a source inducing vibration in the air, creating sound waves. These waves radiate in all directions from the source and may be reflected and scattered or, like other wave actions, may turn corners. Sound waves are a fluctuation in the normal atmospheric pressure, which is measurable. This sound pressure level is the instantaneous difference between the actual pressure produced by a sound wave and the average, or barometric, pressure at a given point in space. This provides us with the fundamental method of measuring sound, which is in "decibel" (dB) units.

The dB scale is a logarithmic scale because the range of sound intensities is so great that it is convenient to compress the scale to encompass all the sound pressure levels that need to be measured. The sound pressure level is defined as 20 times the logarithm, to the base 10, of the ratio of the pressure of the sound measured to the reference pressure, which is 20 µPa (0.0002 dyne/$cm^2$). In equation form, sound pressure level in units of dB is expressed as:

$$dB = 20 \text{ Log10 } P/P_r$$

Where: P = measured sound pressure level µPa (dynes/$cm^2$)

$P_r$ = reference sound pressure level 20 μPa (0.0002 dyne/cm$^2$)

Due to its logarithmic scale, if a noise increases by 10 dB, it sounds as if the noise level has doubled. If a noise increases by 3 dB, the increase is just barely perceptible to humans. Additionally, as a rule-of-thumb the sound pressure level from an outdoor noise source radiates out from the source, decreasing 6 dB per doubling of distance. Thus, a noise that is measured at 80 dB 15 m (50 ft) away from the source would be 74 dB at 30.5 m (100 ft), 68dB at 61 m (200 ft), and 62 dB at 122 m (400 ft). However, natural and man-made obstructions such as trees, buildings, land contours, etc. would often reduce the sound level further due to dissipation and absorption of the sound waves. Occasionally buildings and other reflective surfaces may slightly amplify the sound waves through reflected and reverberated sound waves.

The rate at which a sound source vibrates determines its frequency. Frequency refers to the energy level of sound in cycles per second, designated by the unit of measurement Hertz (Hz). The human ear can recognize sounds within an approximate range of 16 Hz to 20,000 Hz, but the most predominant sounds we hear are between 1,000 Hz and 6,000 Hz (EPA, 1974). To measure sound on a scale that approximates the way it is heard by people, more weight must be given to the frequencies that people hear more easily. The "A-weighted" sound scale is used as a method for weighting the frequency spectrum of sound pressure levels to mimic the human ear. A-weighting was recommended by the EPA to describe noise because of its convenience and accuracy, and it is used extensively throughout the world (EPA, 1974).

For the purpose and scope of this report and sound level testing, all measurements would be in the A-weighted scale (dBA).

### 3.7.1 Extent of Noise Analysis

The Day-Night Average Sound Level ($L_{dn}$) is used to measure community noise levels. The $L_{dn}$ is the A-weighted equivalent sound level for a 24-hour period. Due to the potential for sleep disturbance, loud noises between 10 p.m. and 7 a.m. are normally considered more annoying than loud noises during the day. This is a psychoacoustic effect that can also contribute to communication interference, distraction, disruption of concentration, and irritation. A 10 dB weighting factor is added to nighttime equivalent sound levels due to the sensitivity of people during nighttime hours (EPA, 1974). For example, a measured nighttime (10 pm to 7 am) equivalent sound level of 50 dBA can be said to have a weighted nighttime sound level of 60 dBA (50 + 10).

For the purposes of this report, the Equivalent Sound Level ($L_{eq}$) is used to measure average noise levels during the daytime hours. The $L_{eq}$ is a single value of sound level for any desired duration, which includes all of the time-varying sound energy in the measurement period. To further clarify the relationship between these two factors, the daytime sound level equivalent averaged with the nighttime sound level equivalent equals the Day-Night Average:

$L_{eq}$ (Day) averaged with $L_{eq}$ (Night) = $L_{dn}$.

Because the nighttime noise levels are significantly lower than the daytime noise levels, the daytime $L_{eq}$ is used alone, without averaging the lower nighttime value, to provide a more conservative representation of the actual exposure.

Measurements were made at the nearby NEF in New Mexico in September 2003 during the development of that facility. The results of those measurements showed higher noise levels resulting from vehicle traffic near New Mexico Highway 234, which is an extension of Texas State Highway 176, particularly heavy-duty tractor-trailer trucks. Other noise sources were low-flying aircraft operating out of the Eunice Airport and sudden high wind gusts. Average background noise levels ranged from 40.1 to 50.4 dBA. These noise levels are considered moderate, and are below the average range of speech, which ranges from 48 to 72 dBA (HUD, 1985).

### 3.7.2 Community Distribution

The area immediately surrounding the proposed CISF is unpopulated and used primarily for disposal of various waste products, for mining, and for intermittent cattle grazing. The nearest noise receptors are five businesses that are between 0.8 km (0.5 mi) and 2.6 km (1.6 mi) from the CISF. The NEF is southwest of the CISF just across the Texas-New Mexico border. The Lea County Landfill is southwest, Sundance Specialists and Permian Basin Materials are west, and DD Landfarm is just west/southwest of the CISF. The nearest residential areas are due west of the CISF in the city of Eunice, New Mexico, which is approximately 8 km (5 mi) away. The closest residence from the center of the CISF would be approximately 6 km (3.8 mi) away on the east side of Eunice, New Mexico.

### 3.7.3 Background Noise Levels

Current point noise sources consist of operations at the WCS waste disposal facility to the south and the nearby NEF to the southwest; operating equipment at Wallach Concrete, Inc. northwest of the CISF, which includes bulldozers, cranes, and heavy-duty dump trucks and tractor-trailer trucks; and heavy-duty truck traffic at Sundance Specialists west of the CISF. The only line noise source is vehicle traffic along the southern border of the WCS property line on Texas State Highway 176.

### 3.7.4 Topography and Land Use

The CISF slopes gently to the south-southwest with a maximum relief of about 3 m (10 ft). The highest elevation is approximately 1,067 m (3,500 ft) msl in the northeast corner of the property (Figure 3.1-2). The lowest site elevation is approximately 1,064 m (3,490 ft) msl along the southwest corner of the CISF. With regard to noise mitigation, land contours with changes in elevation would help to absorb sound pressure waves that travel outward from a noise source. A flat surface would allow noise from a source to travel a greater distance without losing its intensity (perceived volume).Wooded areas, trees, and other naturally occurring items on the WCS property would also mitigate noise sources, provided those items are located between the noise and the noise receptor.

### 3.7.5 Meteorological Conditions

Noise intensities are affected by weather conditions for a variety of reasons. Snow-covered ground can absorb more sound waves than an uncovered paved surface that would normally reflect the noise. Operational noise can be masked by the sound of a rainstorm or high winds, where environmental noise levels are raised at the point of the noise receptor. Additionally, seasonal differences in foliage, as well as temperature changes, can affect the environmental efficiency of sound wave absorption (i.e., a fully leafed tree or bush would mitigate more sound than one without leaves).

Because of those variables, the noise levels, both background and after the CISF is built, would be variable. However, even when such variations are taken into consideration, the background noise levels are well within the specified guidelines.

### 3.7.6 Sound Level Standards

Agencies with applicable standards for community noise levels include the U.S. Department of Housing and Urban Development (HUD, 1985) and the EPA (EPA, 1973). The EPA has defined a goal of 55 dBA for $L_{dn}$ in outdoor spaces, as described in the EPA Levels Document (EPA, 1973). HUD has developed land use compatibility guidelines for acceptable noise versus the specific land use. On the WCS property there are no city, county, or state ordinances or regulations governing environmental noise. In addition, there are no affected American Indian tribal agencies within the sensitive receptor distances from the CISF. Thus, the CISF is not subject to local, tribal, or state noise regulations. Nonetheless, anticipated CISF noise levels are expected to typically fall below the HUD and EPA standards and are not expected to be harmful to the public's health and safety, nor a disturbance of public peace and welfare.

## 3.8 CULTURAL RESOURCES

### 3.8.1 Historic Resources

The Area of Potential Effects (APE) for direct impacts to historic resources is the project footprint. Taking into consideration the height of the crane that would be required, the height of the potential above-ground facility, and the relatively flat surrounding terrain, the APE for indirect/visual impacts for historic resources is a 1.6 km (1 mi) radius from the proposed project footprint. WCS anticipates that the NRC would issue a Final Environmental Impact Statement and License by April 1, 2019. Therefore, a historic-age date of 1974 (45 years prior to 2019) is proposed. The direct effects APE is contained entirely within the state of Texas, while the indirect effects APE extends into New Mexico.

A search of the Texas Historic Sites Atlas maintained by the THC was conducted for previously identified Official State Historical Markers (OSHM), Recorded Texas Historic Landmarks (RTHL), properties or districts listed on the National Register of Historic Places (NRHP), State Antiquities Landmarks (SALs), cemeteries, or other cultural resources that may have been previously recorded. No such resources were identified within the APE for direct effects. The nearest previously identified resource is the OSHM for Andrews County, located approximately 27 km (17 mi) southeast of the project area.

According to a search of the New Mexico Cultural Resources Information System (NMCRIS), there are no previously-identified non-archeological historic resources located within the APE for direct or indirect impacts. The closest historic resource in New Mexico is “HCPI 37299” (building at 703 Ruth Circle, Eunice, Lea County), located approximately 7.2 km (4.5 mi) from the CISF.

### 3.8.2 Historical and Cultural Resource Analysis

In May 2015, a pedestrian archeological survey was completed in order to inventory and evaluate any archeological resources on private land within the footprint of the proposed spent nuclear fuel the CISF at the existing WCS waste disposal facility in western Andrews County, Texas. Because the project includes a host agreement with Andrews County, a political subdivision of the State of Texas, the project is considered subject to the Antiquities Code of Texas. The project would also be subject to Section 106 of the NHPA, as amended, due to oversight and licensing by the NRC.

Chris Dayton, PhD in Archeology and a Registered Professional Archeologist and Steven Schooler, MA in Anthropology/Archeology of CMEC carried out the survey on behalf of the County and WCS under Texas Antiquities Permit 7277.

### 3.8.3 Previous Investigations and Previously Identified Archeological Resources

A data search of the Texas Archeological Sites Atlas maintained by the THC and the Texas Archeological Research Laboratory (TARL) was conducted in order to identify any previously recorded cemeteries, historical markers, NRHP properties or districts, SALs, archeological sites, and previous surveys in the archeological APE, which consisted of the footprint of the proposed expansion, and within 1.6 km or 1 mi (THC, 2015) of the APE. No records of previously documented resources were found.

The closest known resources, five prehistoric sites, are all located in New Mexico, just outside the 1.6 km (1 mi) study buffer. Sites LA140701, LA140702, LA140703, LA140704, and LA140705 are all surface and near-surface scatters of fire-cracked rock, flaking debris, and ground stone recorded in an aeolian dune field by Western Cultural Resource Management during a 2003 survey for the New Mexico State Land Office (NMDCA, 2015). These sites were excavated prior to destruction of the dune field by the construction of the NEF, a uranium processing plant run by URENCO USA. One of the sites, LA140704, contained four hearths from which radiocarbon samples were gathered, yielding occupation dates in the Late Archaic/Early Ceramic period (later centuries B.C./early centuries A.D.) (NMDCA, 2015).

### 3.8.4 Physical Extent of Survey

The physical extent of the survey was along the Texas/New Mexico state line, immediately north of an existing WCS site on the north side of Texas State Highway 176 and 8 km (5 mi) east of

Eunice, New Mexico. The footprint of the planned CISF, and therefore the archeological APE, covers an area of approximately 87.7 ha (216.6 acres).

### 3.8.5 Description of Survey Techniques

CMEC personnel conducted a survey of the 87.7 ha (216.6 acre) APE in May 2015. Field methods were guided by THC/Council of Texas Archeologists (CTA) standards. Due to high ground surface visibility, extensive previous mechanical clearing, and thin soils over the local caliche cap (fragments of which were ubiquitous), no locations for productive shovel testing were found, and the survey consisted of examination of the surface via pedestrian transects. Because the investigation took place on private land, a non-collection policy (i.e., field documentation only) was in place during the survey, but proved to be moot due to the lack of finds. Per 13 Texas Admission Code §26.16 -17, field forms and other project records will be curated at the Center for Archaeological Studies at Texas State University in San Marcos. No historic or prehistoric artifacts or features were found during the survey.

## 3.9 VISUAL AND SCENIC RESOURCES

According to the U.S. Department of the Interior (DOI) and BLM, visual resources consist of landscape or visual character, and visual sensitivity and exposure. A study area's landscape features include landform, vegetation, water resource features, color, adjacent scenery, scarcity, and cultural modifications (that either add to or detract from visual quality). The overall impression of an area, composed of the elements above, is referred to as the "visual character." For this analysis, the visual character of the area is focused on the perspective of residents living in close proximity to the proposed CISF who would be affected by the continued operations, and the perspective of the driving public (along roads within the visual resources study area). However, since the closest residence is approximately 6.1 km (3.8 mi) away from the CISF, the majority of the analysis is geared toward the driving public.

The environmental team analyzed whether the following features exist or are likely to exist within 24 km (15 mi) of the CISF:

- landforms (elevated views, hilltops, vegetation, woodlands)
- water (stream crossings, bridges, wetlands, pastoral scenes, wildlife viewing potential)
- scarcity (known scarcity of wildlife habitat, vegetation, or cultural resource)

- cultural modifications (urbanized areas, historic structures, visual detractors)

In accordance with DOI and BLM guidance, a photo inventory of the scenic qualities of the CISF was conducted on April 7 and 8, 2015. This study included views from as far as 24 km (15 mi) from the WCS project. Views were captured to illustrate several zones: foreground, middle ground, background, and seldom-seen. This inventory replicated photos taken for the WCS licensing efforts in 2007 and 2008 for the LLRW disposal license. The study team was interested in learning what has changed in the landscape over the last seven years.

In the SIA (Appendix A), each photo (1-14) in Appendix C, WCS Scenic Resources Photo Inventory Figures C-1 and C-2, is labeled with the direction in relation to the CISF, whether it represents foreground, middle ground, background, or seldom-seen views, and approximate distance from the center point of the proposed CISF on the WCS controlled property.

The WCS CISF site was evaluated November 9, 2015 to November 10, 2015 by WCS using the BLM visual resource inventory process to determine the scenic quality of the site. The WCS site received a "C" rating and falls into Class IV. Refer to Table 4.9-1, Scenic Quality Inventory and Evaluation Chart.

The foreground and middle ground views are taken from locations less than 4.8 to 8 km (3 to 5 mi) from the CISF, with several mid-ground range photos just beyond the 8 km (5 mi) radius. This zone includes the road cut for Texas State Highway 176, which creates berms that intermittently obscure views beyond the roadway and then open up views to the various landfills in the vicinity and to the sole urbanized area of Eunice, approximately 8 km (5 mi) to the west of the CISF.

The background zone includes views from locations between 8 km (5 mi) and 16 km (10 mi) away (see photos 11 and 13 in Appendix C of Appendix A). These views are from generally flatter terrain allowing broader views across the landscape. These broader views take in oil-extraction structures (pump jacks, tanks, and fence lines) in the foreground and a combination of constructed landscape forms (e.g., landfill and extraction facility earth mound(s)) and naturally occurring swales). The seldom-seen views were from locations that are farther than 16 km (10 mi) away or otherwise hidden from view (see Photo 12 in Appendix C of Appendix A). The CISF is barely seen from this distance, with the most prominent features of the CISF (the red bed soil piles) hardly registering as more than an undulation in the horizon.

The local landscape is typified by cattle ranch land with gently undulating, brushy grassland broken by sporadic brush covered sand dunes that extend for many miles in all directions. The Mescalero escarpment, Monument Draw, Texas and Monument Draw, New Mexico are the only persistent geographic features in the area. The scenic quality is rather uniform topographically with few trees and topographic relief. Caliche service roads crisscross the landscape at random intervals. The Interstate electric transmission lines extend to the horizon to the north and the south while the local distribution lines service the industrial and cattle ranch infrastructure in the area. Within view of the facility, there is significant evidence of human development including a stone quarry, a hazardous waste and low-level radioactive waste landfill, a large power transmission substation, a county landfill, a uranium enrichment plant, and an aboveground oilfield waste disposal land farm.

Adjacent to the CISF to the west in New Mexico is a large uranium enrichment plant called the NEF, operated by URENCO. This facility was developed and constructed since the last visual resources inventory was conducted. This facility is the most substantial new structure on the visual landscape. The relationship of WCS to URENCO is shown in Figure C-1 in Appendix A. Photo locations are shown in Appendix A, Figure C-2 along with an 8 km (5 mi) radius and a 16 km (10 mi) radius around the CISF. The proposed CISF activities would take place beyond the existing railroad spur on the WCS property, farthest from Texas State Highway 176 compared to other current activities at the CISF.

It was determined that the visual resources study area does not contain notable representations of any of the landscape features listed above, although the relative lack of visual obstructions to a vast view of this section of the west Texas/east New Mexico landscape could be considered the "visual character" of the area. With the exception of a roadside picnic area and historical marker, no recreational resources are identified in the immediate area of the site. Overall, the entire study area can be considered to have modest scenic quality that is pleasant to regard for its rural, undeveloped nature, but not dramatic, unique, or rare. Facilities geared towards resources extraction (the Lea County Landfill and oil well pump jacks) exist in the project area, in addition to the URENCO facility, all of which have an equal or higher impact on the visual landscape compared to the proposed CISF.

### 3.10 SOCIOECONOMICS

This section describes the current social and economic characteristics of the ROI surrounding the WCS complex. Information is provided on population, including minority and low-income areas, economic trends, housing, and community services in the areas of education, health, public safety, and transportation.

The primary labor markets for the operation of the processing and storage facility will be Andrews County, Texas, and Lea County, New Mexico. The Andrews County seat is located in the City of Andrews, about 48 km (30 mi) east-southeast of the CISF. There are no population centers in Andrews County closer to the processing and storage facility. The surrounding area is very rural and semi-arid, with commerce in livestock production, agriculture (cotton, sorghum), and substantial oil and gas production, which represents most of the county's wealth and income. Andrews County ranked sixth in oil producing counties in Texas in April 2014 (Railroad Commission of Texas 2015: http://www.rrc.state.tx.us/oil-gas/research-and-statistics/ ). Andrews County covers 3888 square km (1,501 square mi) and in 2010 its population density was 3.8 persons per square km (9.9 persons per square mi); this compares 37.2 persons per square km (96.3 persons per square mi) for Texas as a whole). Population projections are available from the Texas Water Development Board for Texas counties from 2020 to 2070. In this 50-year timeframe, all Texas counties in the area of interest are expected to grow by varying degrees. Andrews is projected to grow by 107.3 percent, while Gaines is expected to grow by 120 percent (CMEC, 2015)

The City of Andrews has been in a period of large economic activity triggered by major industry investments, which have brought in hundreds of high-paying jobs and additional construction activity. Recent examples of new infrastructure and investments include (among others): the Performance Center, two new elementary schools, the City of Andrews Business and Technology Center, a Senior Citizens Activity Center, a new 90-bed Residential Care Facility, two new business parks (energy industry driven), the County Special Events Center, Andrews downtown streetscape improvements, and a new campus for the Permian Regional Medical Center. One library, two banks, three credit unions, and a biweekly newspaper serve the city of Andrews. Fraternal and civil organizations include the Lions Club, Rotary Club, United Way of Andrews, Knights of Columbus, and Girl Scouts of America. Local facilities serving the community of Andrews include 39 churches, a municipal swimming pool, a golf course, tennis courts, youth club/center/parks, and athletic fields.

The current socioeconomic conditions for Lea County are similar in most respects to Andrews County. Lea County is relatively large, covering 11,373 square km (4,391 square mi) in southeastern New Mexico. The county population density is 5.8 persons per square km (14.7

persons per square mi); this compares to 6.6 persons per square km (17 persons per square mi) for New Mexico as a whole. The Lea County community was initially agriculturally based, but the discovery of oil and gas in the mid-1920s has had a significant impact on the region. Today the county's agricultural heritage continues to have underlying influences on the county's development with farming and ranching. The oil and gas industry still has a strong effect on the local economy, in addition to a growing manufacturing sector. Five libraries, nine financial institutions, and two daily newspapers serve Lea County. Cities in Lea County that are within the ROI include Hobbs, Eunice, and Jal. In Lea County, there are five public school districts and four private schools. The closest school district is in Eunice, located 9.7 km (6 mi) to the west, with the other districts located in Hobbs, Jal, Lovington, and Tatum. The main campus of the University of the Southwest (USW) and New Mexico Junior College (NMJC) are located in and near Hobbs, New Mexico. NMJC's Training and Outreach Facility provides workforce training, online courses, and a center for legal studies.

There are two hospitals in Lea County, New Mexico. The Lea Regional Medical Center is located in Hobbs, New Mexico, about 32 km (20 mi) north of the CISF. In Lovington, New Mexico, 63 km (39 mi) north-northwest of the CISF, Covenant Medical Systems manages Nor-Lea Hospital, a 25-bed Medicare-certified Critical Access Hospital serving southeastern New Mexico.

Andrews County had a tax base (total certified net taxable value) in 2014 of over $7.2 billion dollars, a general fund tax rate of 0.2936 per $100, and a road and bridge tax rate of 0.0477 per $100 (Andrews County Appraisal District 2015). The county tax levy in 2014 for all funds amounted to almost $21,177,205. Total tax rates (per $100) in 2014 for jurisdictions within Andrews County Appraisal District include: Andrews Independent School District – a combined rate of $1.17000; City of Andrews - $0.18900; Andrews County - $0.2936; and, Andrews Hospital District - $0.29612 (CMEC, 2015).

Additional information on socioeconomics can be found in the SIA provided in Appendix A (CMEC, 2015).

## 3.11 PUBLIC AND OCCUPATIONAL HEALTH

This section describes existing public and occupational health issues that relate to the location and operations at the CISF. It begins with a description of the general radiological environment in the U.S., followed by a discussion of background levels and sources of radiation and historic exposures near the CISF. This section also presents public and occupational dose limits applicable to WCS, and summarizes health effects studies related to the radiation exposure.

### 3.11.1 Radiological Environment

All members of the public are exposed to sources of ionizing radiation that occur naturally in the environment and as a result of human activities. Relative concentrations of radionuclides in different environmental media around the U.S. (e.g., air, soil, ground water) vary by geographic location.

Naturally occurring radionuclides in the environment are from two general sources, cosmogenic and primordial. Cosmogenic radionuclides are produced by interactions of cosmic radiation with atoms in the atmosphere or in the earth and include $^{3}$H, $^{7}$Be, $^{14}$C, and $^{22}$Na. Also, external radiation from space consists of solar energetic particles and cosmic rays (NCRP, 2009). Primordial radionuclides are radionuclides that are found in the earth's soils and rocks and have been present since formation of the earth. Primordial radionuclides include those found in the decay series headed by $^{238}$U (uranium series), $^{232}$Th (thorium series), and $^{235}$U (actinium series) (NCRP, 2009). Radionuclides that are part of these series include $^{238}$U, $^{234}$Th, $^{234m}$Pa, $^{234}$U, $^{230}$Th, $^{226}$Ra, $^{222}$Rn, $^{218}$Po, $^{214}$Pb, $^{214}$Bi, $^{214}$Po, $^{210}$Pb, $^{210}$Bi, $^{210}$Po, and $^{206}$Pb (uranium series); $^{232}$Th, $^{228}$Ra, $^{228}$Ac, $^{220}$Ra, $^{216}$Po, $^{212}$Pb, $^{212}$Bi, $^{212}$Po, $^{208}$Th, and $^{208}$Pb (thorium series); and $^{235}$U (actinium series). Potassium-40 is a primordial radionuclide that is not part of a decay series.

Anthropogenic radionuclides (i.e., those resulting from human activities) occur in the environment as a result of atmospheric weapons testing, operations supporting the production of nuclear weapons, the nuclear fuel cycle for electricity generation, nuclear reactor accidents, and radionuclides used in medicine or research (NCRP, 2009). Some important anthropogenic radionuclides are $^{137}$Cs, $^{90}$Sr, $^{60}$Co, $^{99}$Tc, $^{129}$I, $^{131}$I, $^{239}$Pu, and $^{3}$H.

Figure 3.11-1 shows the relative contributions of different classes of naturally occurring and anthropogenic radionuclides to the arithmetic mean total annual effective dose (ED) of 3.11 mSv (311 mrem) to the U.S. population (NCRP, 2009). Isotopes of radon (primarily $^{222}$Rn but also $^{220}$Rn) contribute the largest percentage of the total dose, followed by primordial radionuclides, external radiation from space, and other sources (anthropogenic radionuclides).

**Table 3.11-1, Detected concentrations of background radionuclides in samples collected in the vicinity of WCS during 2010 and 2011.**

| Sample type | Radionuclide | Min | Max | Mean | SD | Units | # samples |
|---|---|---|---|---|---|---|---|
| Air | Cs-137 | 2.45E-04 | 1.19E-03 | 4.94E-04 | 2.07E-04 | pCi/m3 | 18 |
| Air | GROSSA | 4.36E-04 | 7.80E-03 | 1.68E-03 | 9.37E-04 | pCi/m3 | 583 |
| Air | GROSSB | 4.81E-04 | 3.67E-02 | 7.95E-03 | 3.33E-03 | pCi/m3 | 624 |
| Air | K-40 | 1.78E-03 | 6.92E-03 | 3.64E-03 | 1.07E-03 | pCi/m3 | 80 |
| Air | Pb-210 | 7.42E-04 | 1.23E-01 | 6.80E-03 | 6.21E-03 | pCi/m3 | 759 |
| Air | Ra-226 | 2.44E-05 | 3.42E-03 | 1.47E-04 | 1.82E-04 | pCi/m3 | 415 |
| Air | Ra-228 | 6.03E-05 | 4.93E-03 | 2.63E-04 | 4.46E-04 | pCi/m3 | 270 |
| Air | Th-228 | 1.40E-05 | 2.43E-04 | 6.95E-05 | 2.96E-05 | pCi/m3 | 265 |
| Air | Th-230 | 6.01E-06 | 2.93E-04 | 7.02E-05 | 3.23E-05 | pCi/m3 | 354 |
| Air | Th-232 | 9.39E-06 | 2.51E-04 | 5.61E-05 | 2.67E-05 | pCi/m3 | 325 |
| Air | Th-234 | 7.50E-03 | 9.53E-03 | 8.76E-03 | 1.10E-03 | pCi/m3 | 3 |
| Air | U-233/234 | 5.49E-05 | 1.41E-03 | 1.54E-04 | 9.10E-05 | pCi/m3 | 604 |
| Air | U-235/236 | 3.71E-06 | 7.29E-05 | 1.63E-05 | 1.04E-05 | pCi/m3 | 135 |
| Air | U-238 | 3.84E-05 | 9.53E-03 | 1.94E-04 | 6.15E-04 | pCi/m3 | 604 |
| Ground Water | GROSSA | 1.36E+00 | 6.16E+01 | 1.15E+01 | 8.03E+00 | pCi/L | 677 |
| Ground Water | GROSSB | 1.75E+00 | 1.12E+02 | 1.17E+01 | 1.02E+01 | pCi/L | 617 |

| Sample type | Radionuclide | Min | Max | Mean | SD | Units | # samples |
|---|---|---|---|---|---|---|---|
| Ground Water | K-40 | 4.08E+01 | 1.39E+02 | 8.56E+01 | 2.91E+01 | pCi/L | 9 |
| Ground Water | Pb-210 | 1.79E+00 | 6.42E+02 | 2.24E+01 | 9.45E+01 | pCi/L | 58 |
| Ground Water | Ra-226 | 1.25E-01 | 7.71E+00 | 5.93E-01 | 5.26E-01 | pCi/L | 567 |
| Ground Water | Ra-228 | 4.01E-01 | 4.16E+00 | 1.29E+00 | 6.28E-01 | pCi/L | 544 |
| Ground Water | Th-228 | 2.75E-02 | 2.03E-01 | 8.17E-02 | 3.89E-02 | pCi/L | 103 |
| Ground Water | Th-230 | 1.76E-02 | 3.07E-01 | 7.46E-02 | 4.35E-02 | pCi/L | 174 |
| Ground Water | Th-232 | 1.74E-02 | 1.36E-01 | 4.15E-02 | 2.45E-02 | pCi/L | 20 |
| Ground Water | Th-234 | 1.82E+02 | 1.82E+02 | 1.82E+02 | NULL | pCi/L | 1 |
| Ground Water | U-233/234 | 7.43E-02 | 3.73E+01 | 8.91E+00 | 6.95E+00 | pCi/L | 689 |
| Ground Water | U-235/236 | 4.23E-02 | 1.79E+00 | 2.97E-01 | 2.49E-01 | pCi/L | 415 |
| Ground Water | U-238 | 7.84E-02 | 1.82E+02 | 2.86E+00 | 7.43E+00 | pCi/L | 685 |
| Soil | Cs-137 | 1.29E-02 | 7.55E-01 | 1.07E-01 | 9.68E-02 | pCi/g | 441 |
| Soil | GROSSA | 2.78E+00 | 2.27E+01 | 7.76E+00 | 2.90E+00 | pCi/g | 462 |
| Soil | GROSSB | 3.14E+00 | 4.60E+01 | 1.28E+01 | 5.35E+00 | pCi/g | 489 |
| Soil | K-40 | 1.68E+00 | 1.89E+01 | 8.88E+00 | 3.24E+00 | pCi/g | 529 |
| Soil | Pb-210 | 1.92E-01 | 5.56E+00 | 1.17E+00 | 7.13E-01 | pCi/g | 355 |
| Soil | Ra-226 | 1.21E-01 | 1.29E+00 | 5.54E-01 | 1.79E-01 | pCi/g | 580 |

| Sample type | Radionuclide | Min | Max | Mean | SD | Units | # samples |
|---|---|---|---|---|---|---|---|
| Soil | Ra-228 | 1.07E-01 | 3.11E+00 | 6.35E-01 | 3.08E-01 | pCi/g | 628 |
| Soil | Th-228 | 2.06E-01 | 2.04E+00 | 6.85E-01 | 2.65E-01 | pCi/g | 293 |
| Soil | Th-230 | 1.21E-01 | 3.01E+00 | 6.72E-01 | 2.67E-01 | pCi/g | 890 |
| Soil | Th-232 | 1.73E-01 | 2.52E+00 | 6.53E-01 | 2.80E-01 | pCi/g | 376 |
| Soil | Th-234 | 1.48E-01 | 2.50E+00 | 7.49E-01 | 3.17E-01 | pCi/g | 275 |
| Soil | U-233/234 | 5.52E-02 | 1.09E+00 | 4.35E-01 | 1.64E-01 | pCi/g | 472 |
| Soil | U-235/236 | 1.63E-02 | 1.00E-01 | 4.55E-02 | 1.71E-02 | pCi/g | 133 |
| Soil | U-238 | 7.85E-02 | 2.50E+00 | 5.59E-01 | 2.73E-01 | pCi/g | 750 |

#### 3.11.1.1 Background Levels of Radiation at WCS

WCS conducted pre-operational monitoring of the environment in 2010 and 2011 to develop a data set that could be used to characterize baseline levels of radiation and radioactivity prior to any LLRW disposal site operations, which began in 2012 (WCS, 2011). Pre-operational data, along with all subsequently collected data, are available through the RACER application. Available data for samples collected in 2010 and 2011 were obtained from the RACER database and are summarized in Table 3.11-1 to provide an indication of baseline radiological conditions in the vicinity of the WCS disposal facility. Table 3.11-1 shows the range of detected concentrations (min and max), along with the mean and standard deviation, for the background radionuclides expected to contribute most to radiation exposure in the WCS area. The WCS area is characterized as having relatively lower radon concentrations, consistent with other areas of Texas and the southwest U.S. and the levels of uranium and radium in the soil shown in Table 3.11-1 (NCRP, 2009).

#### 3.11.1.2 Current Radiation Sources and Exposure Levels at WCS

Radiation sources at WCS include the naturally occurring background radiation and the LLRW and uranium byproduct material waste that is received by the facility and prepared and stabilized for disposal. Natural background levels were discussed in the previous section. The CWF will accept only stabilized LLRW of Classes A, B, or C from commercial waste generators. Waste shipments are received in a variety of sealed containers such as 55-gallon drums, rectangular steel boxes, and shipping casks. Waste is stabilized before disposal in the facility using concrete containers and grout. The FWF also accepts Classes A, B, and C LLRW. The FWF allows for two different disposal methods, containerized waste and non-containerized waste in the In-Cell Non-Containerized Disposal Unit (IC NCDU). The containerized section of the FWF, similar to the CWF, grouts containerized waste in concrete canisters. The IC NCDU accepts federal Class A waste in larger volumes of bulk soil or soil-like debris, rubble, or a single uniform piece qualified for disposal under the facility’s license. Waste packaging and stability requirements limit the amount of radionuclide particulates or gasses that may be suspended into the air during waste handling, including unloading of shipments, repackaging, and containerizing of waste for disposal. Thus, inhalation is not a large contributor to worker dose. WCS accepts remotely handled waste with exposure rates of up to 10 mR $hr^{-1}$ at 2 m., workers in close proximity to this waste will incur external doses (Table 3.11-2).

**Table 3.11-2, Summary of occupational exposures at WCS based on OSL measurements (mrem $y^{-1}$)***

| Year | Min[a] | | Max | | Mean | |
|---|---|---|---|---|---|---|
| | with zeroes | w/o zeroes | with zeroes | w/o zeroes | with zeroes | w/o zeroes |
| 2010 | 0 | 1 | 22 | 22 | 1.8 | 5.5 |
| 2011 | 0 | 1 | 16 | 16 | 1.5 | 4.6 |
| 2012 | 0 | 0.2 | 393 | 393 | 50.6 | 66.2 |
| 2013 | 0 | 0.2 | 347 | 347 | 44.5 | 58.6 |
| 2014 | 0 | 0.1 | 884 | 884 | 58.3 | 78 |

[a] With zeroes = min and mean calculated using non-detect results (assumed to be zero), and w/o zeroes = min and mean calculated not using non-detect results.
*1mrem = 0.01mSv

Analysis of gross alpha and gross beta measurements for 2014 in ambient air environmental monitoring samplers showed that 13% of the gross alpha measurements and 28% of the gross beta measurements exceeded the pre-operational upper confidence level of 0.155 mBq $m^{-3}$ (4.2 fCi $m^{-3}$) and 0.518 mBq (14 fCi $m^{-3}$), respectively. Of the samples that exceeded the preoperational levels, 1.6% of the gross alpha and 15% of the gross beta exceeded the background concentration measured at the same time at Station 9 (one of the background stations). Isotopic analysis indicated that most of the increase in activity concentration was from naturally occurring radionuclides presumably found in dust that was suspended during excavation activities. There was only one analytical result for an anthropogenic radionuclide ($^{60}Co$, 0.936 fCi $m^{-3}$), and that value exceeded the REMP investigation level of 0.266 fCi $m^{-3}$. This measurement occurred for the November 2014 monitoring period at Sampler 1, which is located south of the waste receiving facilities. However, subsequent data validation determined that this analytical result was a false positive, and not indicative of an IL exceedance.

External exposure to gamma rays and neutrons is the most significant pathway of exposure to workers. External dose to persons working onsite in 2014 as measured by OSLs ranged from 0 to 8.839 mSv (0 to 883.9 mrem) with the average of 0.5826 mSv (58.26 mrem) when OSLDs with zeros are included in the average, or 0.7799 mSv (77.99 mrem) when zeros are excluded from the average. Of the 166 OSLDs issued, 42 had readings of zero mSv. Because of distance and shielding, external exposure is not an important pathway of exposure to the public.

### 3.11.1.3 Historical Exposure to Radioactive Materials at WCS

Both occupational and public external exposures at and around the WCS for the past five years are summarized in this section. These exposures are based on quarterly readings obtained from the thermoluminescent dosimeters (TLDs) and optically stimulated luminescent dosimeters (OSLs) worn by site personnel and placed at various locations in the environment around the CISF. Table 3.11-2 summarizes occupational exposures for the past five years. Personnel exposures increased after operations began in 2012 because radioactive waste shipments for disposal commenced.

Table 3.11-3 summarizes environmental TLD and OSL measurements and calculated doses to the public for the past five years. Background corrected doses are also shown based on subtraction of the pre-operational background dose as assumed by WCS as part of its annual REMP reporting (10 mrem). Averages including zero values (i.e., nondetects or values <= 0 after background subtraction) and excluding zero values are both shown. Doses measured during the pre-operational period of 2010–2011 are consistent with those measured during 2012–2014, and there is no evidence of an increase in external radiation exposure to the public after operations began in 2012. External radiation is not expected to be a significant source of exposure to members of the public due to distance and shielding from the materials managed at WCS.

**Table 3.11-3, Summary of environmental exposures at WCS based on TLD and OSL measurements (mean mrem $y^{-1}$)[c]**

| Type | Year | Before background subtraction | | | | | | After background subtraction | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Annual total | | Public dose (bounding) | | Public dose (site-specific) | | Annual total | | Public dose (bounding) | | Public dose (site-specific) | |
| | | a | b | a | b | a | b | a | b | a | b | a | b |
| OSLD | 2010 | 8.7 | 8.7 | 2.0 | 2.0 | 0.4 | 0.4 | 2.1 | 7.1 | 0.5 | 1.6 | 0.1 | 0.4 |
| OSLD | 2011 | 7.7 | 8.7 | 1.8 | 2.0 | 0.4 | 0.4 | 1.9 | 8.1 | 0.4 | 1.9 | 0.1 | 0.4 |
| OSLD | 2012 | 6.7 | 9.1 | 1.5 | 2.1 | 0.3 | 0.5 | 2.0 | 8.6 | 0.5 | 2.0 | 0.1 | 0.4 |
| OSLD | 2013 | 8.1 | 8.1 | 1.8 | 1.8 | 0.4 | 0.4 | 1.0 | 4.3 | 0.2 | 1.0 | 0.1 | 0.2 |
| OSLD | 2014 | 7.3 | 11.3 | 1.7 | 2.6 | 0.4 | 0.6 | 2.4 | 9.2 | 0.5 | 2.1 | 0.1 | 0.5 |
| TLD | 2010 | 16.8 | 16.8 | 3.8 | 3.8 | 0.8 | 0.8 | 7.2 | 9.0 | 1.6 | 2.1 | 0.4 | 0.5 |
| TLD | 2011 | 16.3 | 16.3 | 3.7 | 3.7 | 0.8 | 0.8 | 6.9 | 8.6 | 1.6 | 2.0 | 0.3 | 0.4 |
| TLD | 2012 | 12.2 | 12.2 | 2.8 | 2.8 | 0.6 | 0.6 | 4.2 | 7.9 | 1.0 | 1.8 | 0.2 | 0.4 |
| TLD | 2013 | 6.1 | 6.1 | 1.4 | 1.4 | 0.3 | 0.3 | 1.0 | 3.8 | 0.2 | 0.9 | 0.0 | 0.2 |
| TLD | 2014 | 14.7 | 14.7 | 3.4 | 3.4 | 0.7 | 0.7 | 7.4 | 12.1 | 1.7 | 2.8 | 0.4 | 0.6 |

a = with zero values included b = without zero values included c = 1mrem = 0.01mSv

WCS also estimates inhalation and immersion doses based on radionuclide releases from the Mixed Waste Treatment Facility stacks, the CWF Sampling Room Stack, and the FWF Sampling Room Stack and from meteorological information from the Midland/Odessa Airport. The maximum calculated effective dose equivalent[1] was $5.82\times10^{-4}$, $1.03\times10^{-4}$, and $1.74\times10^{-5}$ mrem $y^{-1}$ in 2012, 2013, and 2014, respectively (WCS, 2013) (WCS, 2014) (WCS, 2015).

### 3.11.2 Public and Occupational Dose Limits

This section provides the radiation standards and dose limits applicable to WCS, describes occupational injury and fatality rates related to WCS and summarizes health effects studies related to radiation exposure.

#### 3.11.2.1 Applicable Standards and Dose Constraints

Radiation exposure limits for the workers and general public have been established by the NRC in 10 CFR Part 20 and by the EPA in 40 CFR Part 190. The NRC regulates the disposal of LLRW according to the rules in 10 CFR Part 61.

According to 10 CFR Part 20, the total effective dose equivalent (TEDE) to an individual member of the public from all licensed operations is not to exceed 1 mSv $y^{-1}$ (100 mrem $y^{-1}$), excluding background radiation and medical exposure. The dose rate in any unrestricted area from external sources of radiation (excluding medical treatments) is not to exceed 0.02 mSv (2 mrem) in any one hour.

EPA standards for nuclear power generation (40 CFR Part 190) and treatment and management of spent nuclear fuel (40 CFR Part 191) are 0.25 mSv $y^{-1}$ (25 mrem $y^{-1}$) dose equivalent to the whole body or any organ, and 0.75 mSv $y^{-1}$ (75 mrem $y^{-1}$) to the thyroid.

Annual worker radiation dose standards in 10 CFR Part 20 are 50 mSv (5 rem) total effective dose equivalent, 0.5 Sv (50 rem) committed dose equivalent (CDE) to any organ, 0.15 Sv (15 rem) to the lens of the eye, 0.5 Sv (50 rem) to the skin, and 0.5 Sv (50 rem) to any extremity.

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[1] The effective dose equivalent includes the 50-year committed effective dose equivalent (CEDE).

Annual public dose limits as given in 10 CFR Part 61 for the disposal of LLRW are 0.25 mSv (25 mrem) dose equivalent to the whole body, 0.75 mSv (75 mrem) dose equivalent to the thyroid, and 0.25 mSv (25 mrem) to any other organ. Radiation protection standards are summarized in Table 3.11-4.

Note that the units of the standards are different and reflect changes in the methods and terminology used to quantify radiation doses (Table 3.11-5). Radiation protection standards were originally written in terms of the terminology and quantities provided in the International Commission on Radiation Protection (ICRP) report 2 (ICRP, 1959). Dose limits were based on the relative biological effect (RBE) dose to the whole body or critical organ. The RBE dose (termed dose or dose equivalent) is the absorbed dose (energy imparted per unit mass) times the RBE for radiation types. (RBE = 1 for gamma and beta emission, 20 for alpha particles, and 20 for recoil electrons). This dosimetry system is reflected in National Bureau of Standards Handbook (NBS) 69 (NBS, 1959) that forms the basis for the current radionuclide drinking water standards in 40 CFR Part 191.

**Table 3.11-4, Summary of radiation protection standards**

| Individual | Annual dose limit | Reference |
|---|---|---|
| Worker | 50 mSv TEDE | 10 CFR 20 |
| | 0.5 Sv CDE to any organ | 10 CFR 20 |
| | 0.15 Sv DE lens of eye | 10 CFR 20 |
| | 0.5 Sv DE skin | 10 CFR 20 |
| | 0.5 Sv DE extremity | 10 CFR 20 |
| General Public | 1 mSv TEDE all man-made sources | 10 CFR 20 |
| | 0.02 mSv EDE in any 1-hour period | 10 CFR 20 |
| | 0.25 mSv CDE whole body | 40 CFR 190 and 10 CFR 61 |
| | 0.25 mSv CDE any organ | 40 CFR 190 and 10 CFR 61 |
| | 0.75 mSv CDE thyroid | 40 CFR 190 and 10 CFR 61 |
| | 0.25 mSv ED | Proposed 10 CFR 61 using current ICRP methodology and terminology |

**Table 3.11-5, Radiation dose quantities and terminology**

| Dose quantity | Reference documents |
|---|---|
| Dose equivalent (DE), whole body dose, critical organ dose | ICRP 2 (ICRP 1959), NBS Handbook 69 (NBS 1959) |
| Effective dose equivalent (EDE), committed effective dose equivalent (CEDE), committed dose equivalent (CDE), total effective dose equivalent (TEDE) | ICRP 30 (ICRP 1979, 1980, 1981), Federal Guidance Report 11 (EPA 1988), Federal Guidance Report 12 (EPA 1993) |
| Absorbed dose (D), Equivalent dose (H), Effective dose (ED) | ICRP 60 (1991) ICRP 72 (1996) |

The ICRP revised and refined its dosimetry system in ICRP 26 and 30 and introduced the quantity *Effective Dose Equivalent* (EDE) and *Committed Effective Dose Equivalent* (CEDE) to replace the whole body and critical organ concept in ICRP 2 (ICRP, 1979) (ICRP, 1980) (ICRP, 1981). The EDE is the sum of the organ dose equivalent from external sources times an organ-weighting factor. The CEDE is the sum of the organ dose equivalent from an intake of a radionuclide integrated out to 50 years times an organ-weighting factor. The total (EDE + CEDE) is termed the *Total Effective Dose Equivalent* (TEDE).

In ICRP 60 and 72, the terminology again changed (ICRP, 1991) (ICRP, 1996). The TEDE is represented by the term *Effective Dose* (ED). Tissue and radiation weighting factors were also updated from ICRP 26/30.

WCS is regulated by TCEQ using the ICRP 26/30 methodology as implemented in Federal Guidance Report 11 (EPA, 1988) and Federal Guidance Report 12 (EPA, 1993). Thus, the terms EDE, CEDE, and TEDE will be used to describe radiation doses.

### 3.11.2.2 Occupational Injury and Fatality Rates

Potential health impacts to workers during the construction and operation of the proposed CISF would be those normally associated with construction and industrial activities. The U.S. Bureau of Labor compiles annual data on nonfatal and fatal occupational injuries in various industries. Incidence rates of nonfatal occupational injuries in Texas are presented in Table 3.11-6 for 2009–2013 (DOL , 2013) and fatal occupational injuries rates by industry in Texas are shown in Table 3.11-7.

A six-year safety summary for nonfatal injuries for WCS is presented in Table 3.11-8. When these rates are compared with other industries in Texas (Table 3.11-6), it is clear that WCS has a low incidence rate of nonfatal injuries. The days away from work rate (DART) at WCS in 2014 was 1.04 and 0.58 in 2013. For all industries in Texas in 2013, the DART was 1.4 (Table 3.11-6). WCS has had a good safety record since its operations began in 2012.

The Illness and Injury Surveillance Program, operated by the Oak Ridge Institute for Science and Education (ORISE) from 1990 through 2009, examined and analyzed the occupational health records of more than 125,000 workers at 14 participating DOE facilities (DOE, 2012). These analyses allowed DOE to assess the health of its workforce and identify groups that may be at increased risk of illness or injury. Injuries (those not the result of an occupational accident) were a leading cause of absence. Contractor service workers, line operators, and security and fire fighters had the highest rates of absence due to injuries.

The nonfatal occupational rate of injuries and illnesses among state and local government workers remains significantly higher than the private industry rate (Figure 3.11-2) (DOL , 2013).

**Table 3.11-6, Incidence rates of nonfatal occupational injuries by industry in Texas[a]**

| Industry | 2013 | 2012 | 2011 | 2010 | 2009 |
|---|---|---|---|---|---|
| All industries | 1.4 | 1.5 | 1.6 | 1.7 | 1.7 |
| Agriculture-crop production | 2.1 | 1.8 | 1.9 | 3.8 | 1.7 |
| Agriculture-animal production | 2.9 | 2.3 | 3.6 | 3.0 | 1.5 |
| Construction | 1.6 | 1.4 | 1.9 | 1.6 | 1.7 |
| Mining (except oil & gas) | 1.1[b] | 1.2 | 1.3 | 0.9 | 1.3 |
| Drilling (oil & gas) | 1.0 | 0.8 | 0.6[c] | 1.2 | [d] |

[a] Incidence rates represent the number of injuries and illnesses per 100 fulltime workers (working 40 hours per week, 50 weeks per year) reported as cases with days away from work, job transfer, or restriction rate (DART) (DOL 2013).

[b] Data for mining (Sector 21 in the *North American Industry Classification System*-U.S., 2007) include establishments not governed by the Mine Safety and Health Administration rules and reporting, such as those in oil and gas extraction and related support activities. Independent mining contractors are excluded. These data do not reflect the changes the Occupational Safety

and Health Administration made to its recordkeeping requirements effective January 1, 2002; therefore, estimates for these industries are not comparable to estimates in other industries.

[c] Oil and gas extraction.

[d] Not reported.

**Table 3.11-7, Fatal occupational injuries rates by industry in Texas[a]**

| Industry | 2013 | 2012 | 2011 | 2010 | 2009 |
|---|---|---|---|---|---|
| All industries | 4.4 | 4.8 | 4.0 | 4.4 | 4.6 |
| Agriculture, forestry, fishing, and hunting | 11.6 | 14.8 | 12.5 | 15.9 | 11.2 |
| Construction | 13.3 | 12.8 | 9.7 | 10.7 | 16.7 |
| Mining | 11.2 | 16.6 | 14.3 | 16.4 | 11.9 |
| Manufacturing | 2.3 | 2.1 | 2.6 | 2.6 | 2.8 |
| Transportation and utilities | 12.6 | 15.2 | 12.6 | 15.3 | 12.6 |

[a] From the U.S. DOL Bureau of Labor Statistics, in cooperation with state and federal agencies, Census of Fatal Occupational Injuries (http://www.bls.gov/iif/oshstate.htm#TX). The rate represents the number of fatal occupational injuries per 100,000 full-time equivalent workers and can be used to compare the risk among worker groups with varying employment levels.

**Table 3.11-8, WCS worker safety statistics**

| Statistic | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 |
|---|---|---|---|---|---|---|
| Hours worked | 383,343 | 347,712 | 381,964 | 326,478 | 274,294 | 340,311 |
| Recordable incidents | 2 | 1 | 2 | 0 | 3 | 5 |
| Days away / job transfer incidents | 2 | 1 | 0 | 0 | 3 | 1 |
| Total days away / job transfer days | 132 | 35 | 66 | 0 | 114 | 1 |
| Total recordable case rate (TRC) | 1.04 | 0.58 | 1.05 | 0 | 2.19 | 2.94 |
| Experience modifier rate (EMR)[a] | 0.66 | 0.74 | 0.81 | 0.91 | 0.92 | 0.99 |
| Days away from work rate (DART) | 1.04 | 0.58 | 0 | 0 | 2.19 | 0.59 |

[a] Experience modifier rate (EMR) is a number used most commonly by insurance carriers to determine past and future risks. The lower the EMR, the lower the workers compensation premium; the higher the EMR, the higher the workers compensation premium.

### 3.11.3 Health Effects Studies

Knowledge of the effects of ionizing radiation comes primarily from studying groups of people who have received high doses. The risks associated with large doses of ionizing radiation like X-ray and gamma radiation are relatively well established and have been reported in numerous publications by national and international organizations (NAS, 1999) (NRC, 2006) (UNSCEAR, 2008) (UNSCEAR, 2013). Epidemiology is the study of the distribution and causes of disease in humans. Some of the key epidemiological studies linking high doses of radiation with human cancer cover a long period beginning with Roentgen's discovery of X-rays in 1895 to the survivors of the atomic bombing of Hiroshima and Nagasaki, involving a population of 86,611 directly exposed at levels ranging up to more than 5,000 mSv (500 rem). From these data, ICRP and others estimate the fatal cancer risk as 5% per Sv exposure for a population of all ages—so one person in 100 exposed to 200 mSv (20 rem) could be expected to develop a fatal cancer some years later.

There are several studies of occupationally exposed persons, who generally receive low doses of ionizing radiation at low dose rates. For example, in the International Agency Research for Cancer 15-country study, average cumulative doses were 19.4 mSv (1940 mrem), and fewer than 5% of workers received cumulative doses exceeding 100 mSv (10 rem) (Boice, Nakamura, Niwa, Nakamura, Yoshida, & Hendry, 2010). Radiation is a weak carcinogen, but undue exposure can certainly increase health risks. Radiation protection standards assume that any dose of radiation, no matter how small, involves a possible risk to human health. In 1990, the National Cancer Institute found no evidence of any increase in cancer mortality among people living near 62 major nuclear facilities (Jablon, Hrubec, Boice Jr, & Stone, 1990). The overall relative risk of leukemia was higher before than after facilities began operating (Jablon, Hrubec, & Boice Jr, 1991). An updated study of populations around nuclear facilities is currently being designed (NCI, 2012).

Radiation epidemiology has provided clear insights into radiation exposures and risks (UNSCEAR, 2008). A single radiation exposure can increase cancer risk for life and the young are more susceptible than the elderly. In utero, susceptibility to radiation-induced cancer is no greater than in early childhood, and females are more susceptible than males. Radiation cancer risks differ by organ and tissue and some sites have not seen a convincing increase after exposure. Radiation epidemiology is highly uncertain about low dose and low-dose rate risks. However, available scientific evidence does not indicate any cancer risk or immediate effects at doses below 100 mSv (10 rem) per year. At low levels of exposure, the body's natural mechanisms repair radiation damage to cells soon after it occurs.

In the U.S., about 25% of the population dies from cancers each year from all causes, with smoking, dietary factors, genetic factors, and strong sunlight being among the main causes (ACS, 2014). The American Cancer Society reports that an estimated 115,730 new cancer cases were expected for the state of Texas in 2014, and more than 1.6 million new cases were expected for the entire U.S. during that time (ACS, 2014). Table 3.11-9 shows the cancer incidence rate for Texas and surrounding states for the period 2006–2010 for selected cancer sites.

The Texas Cancer Registry (TCR) is a statewide population-based registry that is the primary source of Texas cancer data. Texas Health Service Region 9 (HSR9) includes WCS and Andrews County, Texas. In 2014, the TCR estimated there would be 2,891 new cancer cases and 1,053 cancer deaths (TDSHS, 2014). A comparison of HSR9 and Texas for the period 2007–2011 shows similar cancer rates for the three leading body sites (Table 3.11-10).

**Table 3.11-9, Incidence rates for selected cancers by state, 2006–2010[a]**

| All sites | | | Lung | | Breast | Prostate | Non-Hodgkins lymphoma | |
|---|---|---|---|---|---|---|---|---|
| State | Male | Female | Male | Female | Female | Male | Male | Female |
| Texas | 513.9 | 389.9 | 78.2 | 49.0 | 114.4 | 133.2 | 22.2 | 15.9 |
| New Mexico | 461.9 | 362.5 | 52.9 | 38.1 | 108.8 | 134.1 | 18.2 | 13.8 |
| Oklahoma | 552.2 | 422.0 | 96.1 | 62.7 | 121.7 | 148.4 | 22.4 | 17.1 |
| Louisiana | 603.4 | 413.6 | 99.6 | 57.7 | 119.7 | 169.3 | 24.5 | 16.5 |
| Colorado | 483.1 | 396.4 | 56.1 | 44.2 | 125.3 | 142.7 | 22.5 | 15.9 |

[a] From ACS 2014. Incidence rate per 100,000 age-adjusted to the 2000 U.S. standard population.

**Table 3.11-10, Incidence Rates of Cancer in Andrews County Region (HSR9) and Texas 2007–2011**

| Rate per 100,000 | | | Rate per 100,000 | | |
|---|---|---|---|---|---|
| Males | Region | State | Females | Region | State |
| All sites | 497.1 | 504.6 | All sites | 378.9 | 387.1 |
| Prostate | 112.9 | 126.9 | Breast | 104.8 | 113.6 |
| Lung | 79.7 | 75.6 | Lung | 49.5 | 47.4 |
| Colorectal | 51.2 | 49.7 | Colorectal | 36.2 | 34.6 |

## 3.12 WASTE MANAGEMENT

Waste management for the CISF is divided into gaseous and liquid effluent, as well as solid waste. Descriptions of the sources and effluent systems for each of these waste streams are discussed in this section. Disposal plans, waste minimization practices, and related environmental impacts are discussed in Section 4.13 of this report and Chapter 6 of the SAR.

### 3.12.1 Effluent Systems

Effluent systems are used to manage gaseous and liquid effluents to ensure that potential radiation doses to workers are compliant with the discharge limits specified in 10 CFR Part 20, maintain ALARA, and consistent with the philosophy of waste minimization, the term “waste” as used in this section refers to waste generated during operations at the CISF, and does not include SNF waste materials handled at the CISF.

These systems are described in more detail in Chapters 4 and 6 of the SAR.

#### 3.12.1.1 Gaseous Effluents

Non-radiological air emissions would be generated primarily from diesel generators and engines used to provide electrical power and move equipment, including SNF, at the CISF. Non-radiological emissions would be controlled in accordance with air quality standards and permits issued by the TCEQ.

Discrete or containerized gaseous wastes are not generated at the CISF. However, airborne particulate radioactivity may potentially be generated in the Transfer Facility. The potential emission sources include suspended radionuclide particulates attributable to contamination that could be present on the transportation casks received at the Transfer Facility and from potential leakage as a result of a failed seal. Only very low levels of airborne radioactivity are anticipated to be generated at CISF. Off-gas treatment and ventilation systems consisting of conventional HVAC in the Transfer Facility and a cask sampling system would be employed at the CISF. These systems would be employed to ensure that radiological air emissions from the CISF are well below the regulatory limits specified in 10 CFR 20, Appendix B and maintained ALARA.

These systems are described in detail in Chapters 4 and 6 of the SAR.

#### 3.12.1.2 Liquid Effluents

There is the potential for non-radioactive wastewater effluents at the proposed CISF. There are no radioactive effluent releases associated with the proposed CISF.

##### 3.12.1.2.1 Non-Radioactive Waste Water

Non-radioactive or conventional wastewater may potentially be generated at the CISF. Fire protection operations, building and equipment leakage, fuel tank leakage, equipment and floor washing, and general cleaning and equipment maintenance would generate wastewater. This wastewater may contain some or all of the following constituents.

- Suspended solids
- Dissolved solids
- Nutrients
- Acids and alkalis
- Heavy metals
- Fuel, oil, and grease

Only very low levels of the above constituents are expected in CISF conventional wastewater. The non-reactive liquid waste streams shall be managed and would potentially be released to the environment at the CISF only in accordance with federal and state requirements (e.g., a TPDES Permit issued by the TCEQ).

#### 3.12.1.2.2 Sanitary Wastes

Sanitary wastes generated at the CISF include the effluents from facility drinking water fountains, water closets, lavatories, mop sinks, and other similar fixtures. Sanitary waste generated at the CISF would be transferred to aboveground holding tanks, prior to discharge in a permitted POTW.

#### 3.12.1.3 Solid Wastes

Solid LLRW and non-radioactive solid waste may be generated at the CISF. Mixed and hazardous waste is not expected to be generated at the CISF.

#### 3.12.1.3.1 Solid Low-Level Radioactive Waste

The CISF would be designed, and procedures developed, to minimize the volumes of solid LLRW generated at the CISF in accordance with 10 CFR 20.1406, *Minimization of Contamination*, and 10 CFR 72.130, *Criteria for Decommissioning*.

Solid radioactive wastes may be generated at the CISF as a result of cask contamination surveillance and decontamination activities. These wastes generally consist of paper or cloth swipes, paper towels, protective clothing, and other job control wastes contaminated with low levels of radioactivity. Expended HEPA filters from the transfer facility ventilation system along with job control waste associated with filter change-out, also may contribute to the generation of solid radioactive waste. Job control waste generated during filter change-out is collected and monitored along with other low-level wastes for off-site processing.

Solid radioactive wastes would be collected in containers and temporarily stored in the transfer facility. Small volumes of solid radioactive wastes are anticipated. These low activity wastes would be disposed of at WCS' permitted or licensed disposal facility.

#### 3.12.1.3.2 Non-Radioactive Solid Waste

Solid non-radioactive waste may also be generated at the CISF. The majority of the solid non-radioactive waste is expected to be generated during fabrication of some of the SNF storage systems. Approximately 3,200 storage systems would be fabricated to store 40,000 MTUs of SNF *and related GTCC waste* over 20 years. However, some storage systems would be fabricated offsite, but assembled at the CISF.

Other non-radioactive solid wastes are expected to be generated as a result of routine maintenance, operations, and administrative support functions at the CISF. Prior to releasing solid materials for unrestricted release, radiological surveys would be conducted to ensure that any potential levels of radioactivity are below the limits specified in Regulatory Guide 1.86, *Termination of Operating Licenses for Nuclear Reactors.*

Non-radiological solid waste would be disposed of at a solid waste municipal landfill.

#### 3.12.1.3.3 Hazardous and Mixed Waste

Hazardous or mixed waste is not expected to be generated at the CISF.