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# APPENDIX 11.9.2 ECOLOGICAL BASELINE ASSESSMENT

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## 1.0 INTRODUCTION

### 1.1 Background

The proposed low level waste repository (LLWR) site (Site) is located in the Southern High Plains region portion of the central Great Plains. Vegetation cover is primarily a sparse seasonal cover of grasses and forbs with an overstory of mesquite. Small playas occur across the Site and surrounding area, and various anthropogenic disturbances (e.g., cattle grazing, ranch roads) have occurred throughout the region.

The requirements of the WCS ecological monitoring program are described in the Application for License to Authorize Near-surface Land Disposal of Low-level Radioactive Waste (Section 11: Environmental Report and Alternative Management Techniques) and the Ecological Monitoring Plan (Appendix 11.9.1) to the application. This program was developed to address the monitoring of terrestrial plant and animal communities to supplement the monitoring activities associated with the current Radiological Environmental Monitoring Program (REMP). The REMP was developed to address potential contamination with respect to existing facility operations, as well as the operations associated with the proposed LLRW disposal facilities.

The initial focus of the Ecological Monitoring Plan (EcoMP) is to establish potentially affected and ecological reference areas and the sampling and analysis requirements for incorporation into the REMP, including the approach and development of the “Tier 1” monitoring program. This interim report contains the first season of results for the pre-operational baseline established for terrestrial resources at the Site. Because of unusually dry conditions during summer sampling, results may not be typical of normal years; however, sampling at reference and potentially affected sites should be comparable. Habitat Equivalency Analysis (HEA) methodology will be employed as an additional tool to evaluate baseline conditions at the Site.

The development and implementation of this EcoMP are consistent with the procedures and methodologies outlined in the REMP, as applicable. Information currently available for the Site, including data previous collected in support of the existing REMP, was used to support and refine the data requirements for establishing the current ecological conditions, establishing the potentially affected and reference areas, and developing the conceptual model for the EcoMP. Generally, the approach follows a comprehensive and systematic, value-based, and ecological risk-based approach to ensure that the required data quality objectives (DQOs) are achieved and that data collected are of the necessary type and quality to confirm that baseline conditions have not been substantially altered due to facility operations.

### 1.2 Purpose and Objectives

This investigation was performed to establish baseline ecological conditions at the proposed Site. The purpose was to conduct qualitative and quantitative surveys of selected taxa representing ecological values to be protected at potentially affected (P) and reference (R) locations. These included plants and animals that were sampled in order to establish baseline conditions and determine the comparability of randomly selected sampling plots (reference and potentially affected groups). Most data were collected during June and September surveys in 2006 to

characterize current conditions that might be affected by Site operations and accidental releases at the Site in the future. Specific objectives of this investigation included:

- Establishing a basic sampling design of three survey transects at each of the six plots (three potentially affected and three reference),
- Surveying plot locations to determine plant species richness, identify species present, and assess plot conditions (e.g., presence of invasive weeds, bare ground),
- Conducting small mammal trapping at each plot location and note presence or general abundance of mammal species in each plot and elsewhere on the Site,
- Conducting spring (breeding) and winter (winter visitor) surveys and note presence of bird species in plots and elsewhere on the Site,
- Conducting qualitative amphibian and reptile surveys, noting habitat and location of species in plots and elsewhere on the Site, and
- Conducting qualitative surveys of invertebrates at each plot location.

### **1.3 Conceptual Approach**

Environmental management involves decision-making, whether it is for the location of a new facility, its operation, or mitigation measures to be taken in the event of a negative environmental impact. This report is based on the premise that environmental decisions are based on values (U.S. Environmental Protection Agency 1998, Reagan 2006). The approach used to determine these values is to establish an ecological monitoring program and perform the baseline ecological surveys of the Site.

The framework for identifying values in the USEPA's ecological risk assessment (ERA) guidance (U.S. Environmental Protection Agency 1998) involves identification of assessment endpoints. An assessment is "an explicit expression of the environmental *value* that is to be protected, operationally defined as an ecological entity and its attributes."

The identification of values in ERA and in environmental impact assessments (EIAs) is necessary to focus information gathering and analysis. Environmental management activities (e.g., management of national wildlife refuges or other protected natural resources) frequently involve the stewardship of subsets or components of the broader ecosystem. The framework for values identification acknowledges the growing awareness that scientific understanding needs to be integrated with other stakeholder values.

Comprehensive and systematic values identification begins with the recognition that all environmental values can be grouped into two categories:

- *Ecological values* – Those understood as necessary for maintaining a healthy sustainable ecosystem and the attributes thereof; and
- *Human values* – The full range of human values (i.e., products and services in the broadest sense) of environmental resources.

*Identifying Ecological Values.* The systematic identification of ecological values proceeds using a hierarchical approach that recognizes the sustainability of a healthy ecosystem as the ultimate

value to be protected, restored, or otherwise managed (Figure 1). Because the functions and entities that provide values are linked in an ecosystem, the full suite of ecological services can only be derived from intact and fully functional ecosystems.

While there is no generally accepted definition of what constitutes a healthy ecosystem, an operational framework that defines health in terms of structure and components, patterns of organization, and process rates captures the essential features of these complex ecosystems. This framework can be easily communicated to all stakeholders. Embedded in these categories are concepts such as biodiversity, connectivity, food webs, decomposition, and primary productivity, all of which can be measured and analyzed, as appropriate.

Proceeding to the next lowest level in the hierarchy (Figure 1), ecosystems can be represented in terms of their functional components. In broad terms, the essential functional components of an ecosystem are:

- *Physical (abiotic) resources* - such as water, air, minerals, and soil;
- *Producers* – organisms that fix energy through the processes of photosynthesis or chemosynthesis and make it available to other organisms;
- *Consumers* – organisms that feed on the producers and their byproducts or on each other; and
- *Decomposers* – organisms that reduce dead organic matter to simple chemicals.

All organisms in an ecosystem are components of the food web of that ecosystem, some of which are fundamental to all ecosystems and others of which are characteristic of the particular ecosystem. For particular ecosystems of management interest, these components are categorized into functional groups that feed in a particular way or in a particular location (e.g., arboreal carnivores, and terrestrial herbivores).

The baseline ecological characterization addresses all levels of ecological organization from community biodiversity to presence of particular species of interests (e.g., game or protected species). The combined values at the community to species level of discrimination comprise the possible set of values (i.e., natural resource services) for the Site. From these, the values potentially affected by the proposed disposal facility are identified as the basis for establishing comparisons and for incorporation into the ecological monitoring program.

## **2.0 METHODS**

Survey and sampling methods for ecological baseline surveys were designed to collect information of the appropriate quality to characterize the Site. Data collection and analytical methods addressed specific goals and objectives (section 2.1). Baseline ecological survey results will provide an appropriate basis for future ecological monitoring and quantification of any ecological impacts of operation of the proposed disposal facility.

### **2.1 Data Quality Objectives**

The DQOs for the EcoMP have been developed following the guidance by the USEPA (U.S. Environmental Protection Agency 2000). Data collected will be used to achieve the following goals:

- Establish baseline conditions at the Site in reference and potentially affected areas,
- Characterize ecological conditions at the Site prior to construction and operation as a starting point for monitoring changes in key aspects of the environment including:
  - potential adverse changes in populations of various taxa of biota,
  - changes in habitat and ecosystem characteristics indicative of environmental health (e.g., cover), and
  - changes in other environmental conditions that could be related to proposed disposal facility operations or the releases of contaminants.

The steps in the DQO process are discussed briefly below. The conceptual framework for ecological monitoring presented in Figure 11.9.2-1 of the 2004 LA is a modified version of the approach for decision-making presented in the U.S. EPA's guidance document on DQOs (EPA, 2000). This EcoMP has been developed following Steps 1 through 7 outlined below.

- ◆ Step 1. Defining monitoring goals and objectives. This step is analogous to “stating the problem” in the U.S. EPA DQOs. The goals are detailed above for the EcoMP. These goals focus on monitoring the appropriate reference areas and other environmental parameters to determine if operations from proposed disposal facility may have impacted ecological systems.
- ◆ Step 2. Develop framework of values. The “values” are equivalent to the assessment endpoints for ecological risk assessment defined by U.S. EPA as the specific “environmental values to be protected.”

The EcoMP focuses the “value” assessment on the health of terrestrial plant and animal ecosystems as a whole, as well on the most sensitive plant and animal species that might be impacted by proposed disposal facility operations at the Site.

- ◆ Step 3. Determine management decisions. This step identifies specific decisions to be made based on the results of the analysis of monitoring data, including decisions regarding additional actions, as necessary. For example, actions required when a specific parameter, analytical result, or productivity observation indicates a potential or demonstrated impact may be detailed. Management decisions may include increased monitoring or measurement frequency, continuation of existing monitoring, or direct action.

It should be noted that the existing REMP was developed and is currently being implemented with the intent of addressing “early warning” of a potential contamination event. The existing environmental monitoring program is, therefore, intended to alert facility operators of the potential problem prior to significant contamination of the environment.

- ◆ Step 4. Determine data needs and establish decision criteria. This step is equivalent to the basic approach used in the EPA's DQO guidance for the development of a monitoring program that meets the required goals and objectives. This step identifies the specific data requirements for the ecological monitoring program including the type, number of samples, and specific analytical requirements for each media evaluated. The rational and

methodology used to develop these data needs is discussed in this step. Decision criteria for interpretation and use of the data collected are defined in this step.

- ◆ Step 5. Collect relevant information. This step addresses the sampling design, data quality, and actual collection of monitoring data, including data at reference areas and potentially affected areas, if applicable. Criteria used to define the data collection requirements and data applicability are included in this step.
- ◆ Step 6. Analysis of data. The data collected will be analyzed and compared with the previously established decision criteria to determine a course of action (e.g., modifications to the monitoring program). The data results will enable the decision criteria requiring action to be evaluated. If data do not require action, more specific information can be collected (return to Step 5), or immediate remedial action can be taken to resolve the identified problem (Step 7).
- ◆ Step 7. Make decision or take required action. The completion of the previous steps allows for the specific decision or action to be made concerning the monitoring program. If data meet the decision criteria, the appropriate decision or action can be made. For example, selected parameters measured with their acceptable range indicate that no changes to the monitoring program are required. Conversely, if there are measured changes in selected parameters within a given timeframe (e.g., increase of more than 20% over two consecutive monitoring periods), then modifications to the monitoring program may be instituted.

The primary decision to be made during baseline sampling concerns the comparability of the six sampling plots, three of which are potentially affected, and three of which are classified as reference areas. Data necessary to support this decision include the assessment of variability among locations of sampling plots with respect to plant cover, species composition, and general plot conditions. These data collection efforts will establish present pre-operational conditions as the basis for detecting changes over time at the established sampling plots.

Data Needs:

1. Characterization of the ecology (plants and animals) of the Site, areas of impact, area of potential impact from a release, and reference areas. Characterization will include disturbance conditions and causes (e.g., overgrazing, invasive weeds, and surface disturbance such as cleared areas and roads not associated with Site operations).
2. Quantitative measures characteristics related to ecological endpoints and community characteristics (e.g., biodiversity, cover)
3. Measurements of vegetation of sufficient quantitative rigor to detect changes or define trends
4. Baseline characterization sufficient to estimate a starting value in terms of percent reduction from hypothetical “ideal conditions.” This value will be considered the baseline value for site characterization. “Ideal conditions” are achievable by restoration/enhancement, including estimates of rates of natural recovery (e.g., after weed removal, planting, etc.).

## 2.2 Sampling Design

The sampling program was designed to obtain information to fulfill the data needs identified in section 2.1.

### 2.2.1 Rationale

The objective of plot surveys was to characterize significant aspects of each site in order to determine if the plots represented expected variability in site characteristics and were generally all representative of the ecological environment of the Site. The sampling design consisted of designating two “sites,” each with three permanent locations for sampling plants, small mammals, and terrestrial invertebrates. The potentially affected site, designated “P,” was downwind (based on prevailing SE winds) of the proposed facility; the reference site, designated “R,” was upwind of the proposed disposal facility. The three permanent sampling plots at R and P locations were permanently marked with steel rods placed at the SW corner of small mammal trapping grids (hereafter “Plots”). Coordinates for the SW corner of each plot and starting points of vegetation sampling transects are listed in Table 1.

### 2.2.2 Plot Locations

The EcoMP sampling design is based on the establishment and monitoring of Site (i.e., potentially impacted) and reference areas. The establishment of these plots will rely heavily on the previous work conducted by the Texas Tech Ecology Group (Ortega et al. 1997) and Reagan (2004a, 2004b) as presented in Appendix 2.9.11 of the *2005 Application for License to Authorize Near-surface Land disposal of Low-level Radioactive Waste*. These areas will provide a basis for assessing potential ecological effects to soil and biota based on the DQO approach described in Section 2.2 of Appendix 11.9.1 Ecological Monitoring Plan. Criteria to establish reference areas include population characteristics of important species (e.g., keystone species) and habitat and ecosystem characteristics (e.g., biodiversity, plant cover, productivity). Criteria for monitoring plots and reference area selection follow basic principles for comparing conditions at areas potentially affected by site actions or releases (monitoring plots) with areas similar to potentially affected areas but that are unlikely to be impacted by facility operations (reference areas). Criteria for selecting reference locations also include the typical range of physical, chemical, and biological conditions representative of the potentially impacted areas. These include soil type, habitat or vegetation cover, wildlife species normally present, and conditions of disturbance (e.g., grazing).

A total of three potentially affected (Site-related) and three reference areas were selected for the EcoMP as shown on Figure 2. Areas were selected based on criteria indicated in the previous paragraph. These include characteristics similar to potentially impacted areas, such as soil type, habitat/vegetation association, and orientation from the site. Because airborne deposition is considered to be the primary potential for exposure, reference plots are located at sufficient distances and appropriate directions from the site to ensure isolation from potential Site-related effects. These parameters were selected to address potential pathways of exposure, including sources and transport mechanisms in relation to relevant ecological endpoints.

Vegetation cover at the Site is typical of the High Plains region as modified by human past and current human land uses. Because of varying soil types, past disturbances, and varying land use, the area is a mosaic of grassland and low shrub distributed over a large area of relatively low

topographic relief. Invasive weeds and overgrazing indicator species are common in many areas. Much of the WCS property occurs on a soil type that does not support shinnery oak and sand sage, which are common off site. Small playas occur on the Site, but no permanent water occurs within a 5km radius of the Site.

The grassland and shrub areas are comprised of different densities of the single mesquite grassland habitat that creates a fine-grained mosaic over the potentially impacted areas. Although some species prefer selected areas within this high plains habitat, animals such as the deer mouse, kangaroo rat, coyote, mule deer, quail, and hawks forage over the broader area and use both areas of grassland and shrubs for foraging, nesting, and protection. Because of this uniformity, Site-related and reference plots were selected on the basis of similarities in dominant vegetation present and existing conditions as described above.

Because the primary potential release and transport mechanism for site-related contamination is the airborne pathway, three site-related monitoring plots (P-1 through P-3) were selected in the prevailing wind direction (NNW) at varying distances from the site based on data collected from the on-Site (WCS) monitoring station included in Appendix 2.3.1 to the 2005 license application. Three primary reference plots (R-1 through R-3) were located in the opposite direction (southeast) of the site at varying distances and at a distance from the site sufficient to preclude the likelihood of potential site-related contamination.

The distances and direction involved for selecting the locations of sampling plots were determined on the basis of air modeling and the results of the performance assessment completed for the Site as part of the *Application for License to Authorize Near-Surface Land Disposal of Low-Level Radioactive Waste* developed by WCS in 2005 (WCS, 2005). The of potentially affected areas and reference areas are entirely within the Blakeney and Conger soil association. Three reference area locations were selected by locating similar habitat and soil type in locations south and east of the Site, well away from potential contaminant impact areas related to operations and on WCS property where its long term protection could be ensured. Similar methods, in the opposite direction, were used for selecting the three potentially affected plot locations. Plot locations were determined by walking through an area of relatively uniform vegetation-type and blindly tossing a stake in a random direction. The location was then identified as the center point of a plot as shown in Figure 1. This location was staked and the GPS location recorded. Each plot was also photographed. Photographs of each plot and reference area are included as Figures 4 through 9.

Proposed plot selection was performed on 9 May 2005. Plot locations were visited by Larry Champagne of the Texas Commission on Environmental Quality on 21 June 2005, who gave initial verbal approval to sampling design and sampling locations, with the understanding that Plot P-3 would be moved farther east to provide more representative coverage in the event of a potential release from the Site.

Each of the six plots was surveyed qualitatively to note the dominant vegetation present. Mesquite was the dominant shrub, though cholla cactus was present at some locations. Composites (plants of the family Compositae), other forbs, and a variety of grasses dominated the cover on each of the plots.

Because of the unusually dry spring conditions, initial sampling was delayed until June 2006. At that time, the following necessary plot location changes were made:

- Because of the proximity to radioactive materials temporarily stored above-ground following initial plot establishment, radiation levels at the stake placed at location P-2 were slightly above those requiring radioactive monitoring badges for work at that location. A decision was made to designate a spot approximately 10m east of this stake as the southwest corner of plot P-2. A metal rod was placed at this location, and the slightly relocated plot location recorded (Table 1).
- As agreed, plot P-3 was located farther east (P03-1). This was accomplished by pacing 100m east, and throwing a stake in a random direction, as had been done for establishing the other plots. The soil type and appearance of the vegetation appeared similar to the original P-3 plot.
- Plot R-2, which had been located outside of the Site fenceline, showed evidence of grazing disturbance. The stake was knocked over, and forbs showed evidence of recent grazing. On learning that the area was now being leased for cattle grazing, the plot was moved to a location with similar soil and vegetation characteristics to the other five plots, but within the Site boundary (R02-1). Coordinates are provided in Table 1.

Figure 2 shows the locations of all ecological sampling plots established and surveyed

## **2.3 Plant Surveys**

In an attempt to sample at seasons of maximum flowering, plot surveys were conducted during late spring and late summer (19 - 20 June and 15 – 19 September) 2006. A survey of playas on the Site was conducted on 9 November, and wintering birds were surveyed on 6-7 December 2006.

In order to compare vegetation characteristics among sites, we utilized a consistent line transect sampling strategy at each of the six sample plots (Figure 3). Plant species or other ground cover (e.g., bare ground, rock) was determined every 1 m along three 100 m transects extending off three corners of each small mammal grid (plot) for a total of 300 observations per plot.

Conditions during spring surveys were hot and dry after several months of drought. Heavy rains during July and August produced a lush bloom of vegetation over the Site during late summer surveys. Plants were identified to species either in the field or by the use of voucher specimens in the herbarium at Texas Tech University. In many cases (particularly in the June sampling), identification of plant species was made on the basis of vegetative characteristics only. Some species could not be identified because of the lack of distinguishing characteristics due to the time of year and drought conditions at the site. In those cases, plants were recorded as unknown forb or grass. Other plant species observed on Site but not recorded during transect sampling were identified to develop a general Site species list.

### **2.3.1 Vegetation Analysis**

Aspects of both species richness and species diversity were used as descriptors of the plant community. Species richness is simply the number of species observed, whereas, species diversity is a metric that incorporates species richness as well as a measure of the distribution of individuals across species (i.e., evenness). The Shannon diversity index was used to quantify species diversity. In addition, the number of “hits” along the 3 transects at each plot was used as

a measure of abundance for each species at each sampling location. The percentage of hits belonging to a species was used as a measure of the percent cover of that species.

Analysis of Similarity (i.e., ANOSIM) provides a way to statistically test if there is a significant difference between two groups of samples. The test can be based on species composition (i.e., the identities of species within the samples), or on species composition and abundance (i.e., the identities of species within the samples as well as a measure of the abundance of those species). ANOSIM was used to compare the R and P sites within each of the sampling times.

## **2.4 Animal Surveys**

Because of the mobility of species, most animal surveys were not confined to plot or transect locations. Surveys were conducted at times of day when animals were expected to be most active and, therefore, most visible. These included early morning bird surveys and night surveys for all vertebrate groups.

### **2.4.1 *Terrestrial Invertebrates***

The goal of invertebrate sampling was to characterize the species composition of each sampling location using consistent sampling effort. Therefore, invertebrates were sampled using pitfall traps and sweep nets and were identified to family where possible. Pitfall traps consisted of PVC caps (15.9 cm ID by 7.6 cm depth) buried flush with the soil surface. Four pitfall traps were placed 2 m away from each sampling plot in the four cardinal directions (Figure 3). Traps were cleaned out thoroughly on the evening of 21 June, and then representatives of all the invertebrates in each pitfall trap were collected on the morning of 22 June and 19 September 2006. All of the insects collected from individual pitfall traps were pooled and stored in glass vials with alcohol and labeled by plot number and pitfall number.

Invertebrates on each plot were also sampled by taking sweep net samples on 22 June and 19 September 2006. Fifty sweeps were taken from each of four transects equally spaced across each plot (total of 200 sweep net passes). All captures were pooled by plot and stored in glass jars filled with alcohol.

### **2.4.2 *Amphibians and Reptiles***

Because of prolonged drought conditions and lack of permanent surface water at the Site, spring surveys focused on reptiles. Temporary surface waters resulting from releases of runoff water from detention facilities on Site were visited during night surveys in June.

Reptile surveys were conducted in each of the six plots and at other locations within the Site boundary during spring and late summer surveys. Plot surveys were conducted during morning and late afternoon. One night survey was conducted around the perimeter of the Site between 21:20 and 23:25 h on 18 June 2006.

### **2.4.3 *Birds***

Bird observations were performed throughout areas surrounding Sites R and P during morning and afternoon periods on 20, 22, and 23 of June, 2006. Bird sightings also were recorded during all other periods while on the Site, regardless of proximity to R and P sites.

A winter bird census was conducted 6 - 7 December 2006. Observations were made during early morning and throughout the day to document presence and site use.

#### **2.4.4 Mammals**

Small mammals were trapped using standard mark-recapture methods on each of the six plots. At each plot, a mark-recapture grid was established (Figure 3). Each grid consisted of a 7 by 7 array of Sherman live traps spaced at 10 m intervals. Grid points were marked with survey flags and one trap was placed roughly within 3 m of each flag. All traps were placed under existing vegetation in an effort to shade the trap and thus minimize heat stress of captured animals. Traps were baited with crushed oats mixed with a small amount of peanut butter and then opened each evening between approximately 1600 and 1800 h. Traps were checked the following morning beginning at approximately 0630 h and ending by about 1000 h.

Captured small mammals were identified to species and weighed using a Pesola spring scale. Sex and reproductive condition were determined, and the middle toe on the back right foot was clipped to allow recaptures to be distinguished from new captures. Animals were then released at the capture location. All traps sprung by non-target animals and unknown causes were recorded as sprung. All traps were closed during the day. Grids on plots R1, R2, and R3 were trapped on four consecutive days beginning 21 June 2006. Grids on plots P1, P2, and P3 were trapped four times with day 1 on 18 June 2006 and days 2 through 4 running consecutively beginning 21 June 2006. In the late summer sampling, all plots were trapped on four consecutive days beginning 16 September 2006.

### **3.0 RESULTS AND DISCUSSION**

#### **3.1 Plants**

Conditions at the Site were extremely dry, and most grasses and forbs were not flowering during June surveys. Without flowering parts, it was extremely difficult to distinguish many grass and forb species. As a result, some species from the same genus may have been lumped together (e.g., *Muhlenbergia* spp.) and species richness estimates likely underestimate true species richness. If late summer rains did occur in the area, data collection and analysis for fall sampling should reduce such uncertainties and, as a result, overall plant cover was significantly higher in September (see Figure 6). In addition, identification of grass and forb species in September was facilitated by the presence of flowering parts.

A total of three potentially affected (Site-related) and three reference plots were selected for the EcoMP as shown on Figure 2. The sample plots were statistically combined into a potentially affected area (Area P) and a reference area (Area R).

In June, although both sampling areas had similar plant species richness, Area R had 11 grass and 6 forb species, whereas, Area P had 7 grass and 12 forb species (Table 2, Figure 4). Nevertheless, both areas had similar Shannon diversity (Table 4). Analysis of Similarity (i.e., ANOSIM) provides a way to statistically test if there is a significant difference between two groups of samples. The test can be based on species composition (i.e., the identities of species within the samples), or on species composition and abundance (i.e., the identities of species within the samples as well as a measure of the abundance of those species). ANOSIM indicated

that Areas R and P were similar with respect to both the identities of species within the samples (ANOSIM R statistic = -0.222,  $p > 0.9$ ) and the identity and abundance of species within samples (ANOSIM R statistic = -0.074,  $p = 0.685$ ). The actual differences observed in these data are no different than that which would be expected given random chance. Percent composition of grasses, forbs, and shrubs also was similar among the areas; however, R plots did have a slightly higher percent composition of forbs based on cover (despite having fewer species of forbs, Figure 4).

In September, total species richness in Area R increased to 24 (including 11 grasses and 9 forbs), whereas Site P remained at 22 (including 9 grasses and 10 forbs). In addition, Shannon diversity at Area R increased slightly (Table 5). Nevertheless, ANOSIM results indicate that the areas remained similar with respect to identity of species (ANOSIM R statistic = 0.260,  $p > 0.096$ ) as well as with respect to identity and abundances of species (ANOSIM R statistic = 0.259,  $p = 0.087$ ). Percent composition of grasses, forbs, and shrubs was even more similar between the areas than in June.

Data on the presence and relative abundance of plant species in two playa areas on the proposed site are presented in Table 3. Neither of these areas occurred within randomly located plots. Additional information on playas on the Site is presented in Appendix A-1.

Overall cover by all plant species in June was 63.4% at Area R and 61.6% at Area P. In both areas, the five most common species were mesquite (*Prosopis glandulosa*), two grasses (Slim tridens, *Tridens muticus* and Black gramma, *Bouteloua eriopoda*) and two forbs (Snakeweed, *Gutierrezia sarothrae* and Spiny daisy, *Machaeranthera pinnatifida*) (Table 6). Together, these five species accounted for 74.1 and 87.5 % of all plant cover at Areas R and P, respectively. Differences in vegetation cover between June and September surveys at plot P-03-1 are shown in Figure 5.

The most striking change in both areas between seasons was an increase in overall cover by all species combined. Cover in Area R increased to 80.2%, whereas, cover in Area P increased to 85.4%. This increase in cover is due partly to an increase in the abundance of some of the less common species. As a result, only 65.2% of total cover in Area R and 78.3% of total cover in Area P was due to the five common species mentioned above. This is reflected in slightly higher Shannon diversity values (Table 5).

The dominant plant species on the Site are native. However, several native species are considered invasive from a range/livestock perspective. These include honey mesquite, prickly pear, and snakeweed. Snakeweed is also poisonous to livestock. There are several exotic forb species on the Site, such as Russian thistle, but they were absent or rarely occurred on the plant transects. These exotic forbs are generally associated with locations where the soil surface has been disturbed and would not likely invade the native grassland locations where transects are located unless that soil had been disturbed. Plant transect data are presented in Appendix A-2.

### **3.2 Animals**

Species found on the Site and in sampling plots during baseline surveys are typical of those found in similar habitats throughout the region. No endangered or Federally threatened species were observed during surveys.

### **3.2.1 Terrestrial Invertebrates**

A total of 38 families of insects were collected from the Site; 27 at Area R and 32 at Area P (Table 7). During the June survey, 20 families of insects were collected from Area R and 19 families were collected from Area P. During the September survey, 18 families of insects were collected from Area R and 19 Families were collected from Area P. Crab spiders (*Salticidae*) were collected from both sites, and large numbers of velvet mites (*Trombidiidae*) emerged in both sites after a brief rain event. In addition, individuals from 5 Orders (*Araneida* [spiders], *Solifugae* [wind scorpions], *Coleoptera* [beetles], *Hymenoptera* [wasps, ants, and bees], and *Hemiptera* [true bugs]) were collected from both areas but cannot be identified to family.

### **3.2.2 Amphibians and Reptiles**

One amphibian species, the Texas toad (*Bufo speciosus*) was found active in a small temporary pool and adjacent ditches in water released from the runoff detention facility at the west side of the Site during night surveys. No naturally occurring surface water bodies were present on Site.

Only a few reptile species were observed during the June survey because of hot dry conditions. A yellow mud turtle (*Kinosternon flavescens*) was observed in the runoff water in the ditch at the western border of the Site. The Texas horned lizard (*Phrynosoma cornutum*) is the state reptile of Texas and is listed as state threatened. One specimen was observed near the northwestern corner of the Site during surveys. This species has been observed at other locations throughout the Site on previous surveys.

A list of amphibians and reptiles observed at the Site is provided in Table 8. The final report will contain a combined list of species observed during ecological baseline surveys.

### **3.2.3 Birds**

Thirty and 35 species were observed on the Site during June and December surveys, respectively (Table 9). Of the total of 53 species which were observed on the Site during June and December surveys, only 12 were observed during both seasons. Although bird surveys were qualitative, the data suggest that most species are migratory. Many species migrate to the Site during breeding season, while others that breed farther north feed and roost at the Site during the winter.

No threatened or endangered species were observed during surveys, though some may have passed through the area during spring and fall migrations. Lek surveys for lesser prairie chickens conducted on and near the proposed Site found no active leks (Massey and Dunn 2000, Lyons 2004)

Due to the proximity of the R and P areas, and given the mobility of birds, comparisons between R and P areas were not appropriate.

### **3.2.4 Mammals**

A total of nine small mammal species was captured on study plots during the June and September 2006 sampling periods (Table 10). Wood rats, grasshopper mice, and silky pocket mice were captured on both Areas R and P during both sampling periods. Spotted ground squirrels, although not captured on Area P in June, were captured on Area R in June and both areas in September. However, several spotted ground squirrels were observed in the Area P vicinity in June. Deer mice were captured on both Area R and P, but only in June. The Hispid

cotton rat was captured only on Area P, during both sampling periods, and was the only species captured exclusively on Area P. One house mouse on Area R and one Mexican ground squirrel on Area P were captured in September, and represented the only individuals of those species captured during the study.

The mammal communities at Areas R and P were very similar during both sampling periods, except in September when the minimum number of individual small mammals (MNKA) was about 70% greater on Area P than R (Tables 11 and 12). Nonetheless, Area P consistently demonstrated slightly higher MNKA, catch per unit effort (C/E), species richness (number of species), and diversity (a measure based on number of species and the abundance of each) in both sampling periods. Fewer animals overall were captured in September than June, due mostly to a paucity of silky pocket mice that were relatively abundant in June (Table 11). An apparent consequence of this shift in the small mammal community was an overall increase in community diversity in September (Table 12). For example, silky pocket mice dominated the small mammal community in June, accounting for 52% of the total captures, followed by grasshopper mice at 23% (Table 13). Conversely, silky pocket mice accounted for only about 7% of the total captures in September, with grasshopper mice and woodrats representing the most abundant species at 27 to 30% of the total captures (Table 13).

Lagomorph species (desert cottontail, *Sylvilagus audubonii*, and black-tailed jackrabbit, *Lepus californicus*) were commonly observed on plots and throughout similar habitat elsewhere on the Site. A kangaroo rat (*Dipodomys* sp.) and a wood rat (*Neotoma* sp.) were observed during night surveys in June. Other mammal species documented as occurring on the Site during the baseline survey included mule deer (*Odocoileus hemionus*) and coyotes (*Canis latrans*). A reconnaissance survey offsite near the northwestern corner of WCS property discovered a porcupine (*Erethizon dorsatum*) in mesquite-shinnery oak habitat near small sand dunes.

### **3.2.5 Analysis of Ecological Services**

The impacts of any development project, such as the proposed low level waste repository, can be measured in a variety of ways. Direct impacts on physical, biological, and cultural resources are the easiest to define and measure; however, these are frequently insufficient to address the concerns of stakeholders and decision-makers because they have not been placed in a framework of ecological or human use values. Economic valuation methods have also been used, but these are often based on arbitrary assumptions and are frequently contentious.

Both direct and economic measures of lost resources do not typically consider the values associated with affected resources. Habitat Equivalency Analysis (HEA) provides a mechanism for identifying and quantifying effects on natural resources in terms of the services provided by these resources. The affect on resource services is a measure of resource values, and these values can be quantified in monetary terms (e.g., the cost of quantifying direct impacts and the cost of restoring the resource services provided by the affected resource). The cost for compensating the public for interim lost use of natural resources services can also be calculated using HEA and factored into the total cost of mitigation.

The hierarchical approach to identifying ecosystem values described in section 1.3 provides a comprehensive framework for values identification. For the proposed disposal facility on the Site in Andrews County, Texas, this approach was used to identify values for the Southern Great Plains ecosystem potentially affected by Site development.

The values identified for this prairie ecosystem begins with the most comprehensive value, a **healthy sustainable ecosystem**. Three characteristics define such an ecosystem:

- **Biodiversity** (ecosystem components),
- **Functional integrity** (patterns and interrelationships), and
- **Nutrient and energy dynamics** (rates of processes such as primary production and decomposition)

Data collection to establish baseline considered these as follows:

- Biodiversity was calculated from plant data measured directly along three transects established in each of six plots, three designated as potentially affected (P plots) and three designated as reference (R plots). Qualitative surveys of invertebrates, amphibians, reptiles, birds, and mammals were conducted to identify various taxa and to establish baseline composition of the various functional groups identified for the prairie ecosystem. The basic functional groups are:

- Herbaceous plants – forbs and grasses
- Shrubs – such as mesquite and rabbitbrush
- Fruit and seed eaters – birds and small mammals
- Leaf and twig eaters – deer, some insects
- Nectar feeders – bees, hummingbirds
- Omnivores – coyotes, many bird species
- Intermediate and small predators – spiders, frogs, lizards, birds
- Top predators – hawks, snakes
- Detritivores and scavengers – worms, some invertebrates
- Chemical decomposers – fungi and bacteria

Taxonomic identification provided information for identifying species belonging to different functional groups as well as species valued because they are classified as endangered or threatened. The only species in this category for the site was the Texas horned lizard (*Phrynosoma cornutum*).

Baseline conditions (conditions that would have existed in the absence of a release or other Site-related action) were estimated, based on observations of plants and animals observed during surveys and analyzing data to compare existing with optimal conditions (i.e., those considered characteristic of an ideal undisturbed ecosystem). Invasive weeds (including exotic species and overgrazing indicators), bare ground, and other direct and direct human disturbances were noted.

Surveys and other studies conducted on the Site indicated that all expected functional components for the prairie ecosystem were present. Invasive weeds (e.g., Russian thistle) were present in areas of bare ground disturbed by the construction and use of dirt roads and other physical disturbances. Overgrazing indicators (e.g., snakeweed, prickly pear cactus) reached high densities in some areas, indicating past heavy grazing. Statistical comparisons of potentially affected (P) and reference (R) plots documented their similarity as a basis for future

comparisons. Biodiversity was measured for plants, and cover was measured as an indirect indicator of productivity. More direct measures would be required if a release occurs at the Site.

Subsequent HEA analysis would require apportioning total natural resource values among the defined ecological services and estimating the baseline service values as a percent reduction from the ideal. At this stage, quantification of these values was not appropriate. Measurements of baseline conditions at P and R areas establish a basis for future comparisons, as necessary. However, a baseline services condition of approximately 90% of optimal conditions seems reasonable, considering the presence of exotic species, bare ground, and disproportionate abundance of overgrazing indicator species.

## **4.0 SUMMARY**

This report describes the baseline ecological surveys conducted at the proposed site for Near-surface Land Disposal of Low-level Radioactive Waste during 2006. Surveys were completed successfully. Program rationale, methodology, results, and preliminary results include the following:

- The basic plot design described in the Application for License to Authorize Near-surface Land Disposal of Low-level Radioactive Waste (Section 11: Environmental Report and Alternative Management Techniques) and the Ecological Monitoring Plan (Appendix 11.9.1) to the application.
- Three of the plot locations were altered:
  - Plot P-3 was relocated to an area approximately 100m east of the original location, as agreed to in discussions with Larry Champagne of the TCEQ. To affect a better distribution of plots for monitoring purposes.
  - Plot R-2 was relocated to an area of similar soil type and vegetation cover farther south and within the Site boundaries, to ensure protection from cattle grazing.
  - Plot P-2 was relocated slightly to the east so that sampling could take place without a requirement for radiological monitoring due to proximity to radioactive waste materials placed above ground near the originally selected location.
- Plant surveys were conducted along three 100m transects established at each plot (Figure 4). Species encountered were identified, and specimens of unknown species were collected and identified using voucher specimens at the TTU herbarium.
- Statistical analyses (Analysis of Similarity, ANOSIM) of plant transect survey data indicate no differences between in identity or abundance of species between the P and R areas (groups of plots).
- Invertebrates were sampled using sweep nets and pit traps. Most were identified to family. Invertebrate fauna at R and P areas were generally similar.
- One amphibian, the Texas toad (*Bufo speciosus*), was observed on the Site in surface water areas created by runoff water released onto the surface. There are no permanent surface waters on or within 5km of the Site.

- Eight reptile species were recorded from the Site during 2006 surveys. Texas horned lizards (*Phrynosoma cornutum*) were observed at several locations on and near the Site. This species is listed as threatened in Texas and is the Texas State Reptile.
- Fifty-three species of birds were observed on the Site in the course of baseline ecological surveys. All of these are known to occur in similar habitats throughout the region. Analysis of seasonal data indicated that most were migrants.
- Small mammal trapping was conducted in each of the six plots. Species composition and general abundance were similar at all plots. Other mammal species observed on Site included a kangaroo rat, wood rat, desert cottontail, black-tailed jackrabbit, mule deer, and coyote.
- No federally threatened or endangered species were observed during surveys. The Texas horned lizard, protected by the State of Texas because of shrinking populations due to fire and loss of habitat, was observed at several locations on and around the proposed project site.
- Data from surveys was used to develop a comprehensive list of ecological values for the Site, based on ecological services. It was not appropriate to perform Habitat Equivalency Analysis (HEA) on these data, but it seems reasonable that past direct and indirect human activities on Site have resulted in baseline conditions about 90% of optimal conditions.

## 5.0 REFERENCES

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The table below lists the UTM coordinates of SW corner of plots (e.g., P01) and corresponding starting points for vegetation survey transects on each plot (e.g., P1PLT1) at the Waste Control Specialist study site in Andrews County, Texas. UTM zone equals 13 S.

**Table 11.9.2-1. UTM Coordinates**

<b>Point ID</b>	<b>Northing</b>	<b>Easting</b>
P01	0682160	3592234
P02	0682418	3591814
P03-1	0682682	3591849
P1PLT1	0682167	3592291
P1PLT2	0682221	3592287
P1PLT3	0682214	3592225
P2PLT1	0682432	3591866
P2PLT2	0682491	3591864
P2PLT3	0682481	3591803
P3PLT1	0682693	3591907
P3PLT2	0682753	3591894
P3PLT3	0682743	3591843
R01	0684120	3589913
R02-1	0683825	3590561
R03	0684173	3591068
R1PLT1	0684132	3589969
R1PLT2	0684190	3589963
R1PLT3	0684181	3589903
R2PLT1	0683827	3590617
R2PLT2	0683884	3590608
R2PLT3	0683872	3590552
R3PLT1	0684187	3591117
R3PLT2	0684236	3591114
R3PLT3	0684226	3591062

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The table below lists plant species observed by season and site. Only those species found on a transect were given a species code.

**Table 11.9.2-2. Plant Species Observed By Season and Site**

Species	Code	Common Name	June '06		Sept '06	
			Site R	Site P	Site R	Site P
<b>GRASSES</b>						
		Unknown grass	X	X		
<i>Aristida purpurea</i>	ARIPUR	Purple three awn	X		X	X
<i>Bouteloua eriopoda</i>	BOUERI	Black grama	X	X	X	X
<i>Bouteloua gracilis</i>	BOUGRA	Blue grama	X		X	
<i>Bouteloua hirsute</i>	BOUHIR	Hairy grama	X			
<i>Buchoe dactyloides</i>	BUCDAC	Buffalo grass	X		X	
<i>Cenchrus insertus</i>		Sand bur				
<i>Chloris cucullata</i>	CHLCUC	Hooded windmillgrass	X	X	X	
<i>Digitaria californica</i>		Arizona cottontop				
<i>Eragrostis oxylepis</i>	ERAOPY	Red lovegrass				X
<i>Hilaria mutica</i>		Tobosa grass				
<i>Hymenopappus tenifolius</i>		Old plainsman				
<i>Leptoloma cognatum</i>		Fall witchgrass				
<i>Muhlenbergia arenacea</i>	MUHARENACEA				X	
<i>Muhlenbergia arenicola</i>	MUHARENICOLA	Sand muhly			X	X
<i>Muhlenbergia porteri</i>		Bush muhly				
<i>Muhlenbergia spp.</i>	MUHSPPP	Muhly	X	X		
<i>Panicum hallii</i>	PANHAL	Hall's panicum			X	X

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**Table 11.9.2-2. Plant Species Observed By Season and Site**

Species	Code	Common Name	June '06		Sept '06	
			Site R	Site P	Site R	Site P
<i>Schedonnardus paniculatus</i>		Tumble grass				
<i>Scleropogon brevialius</i>	SCLBRE	Burro grass	X	X	X	X
<i>Setaria leucopila</i>	SETLEU	Plains bristle grass			X	X
<i>Sporobolus cryptandrus</i>	SPOCRY	Sand dropseed	X	X	X	X
<i>Tridens muticus</i>	TRIMUT	Slim tridens	X	X		X
<b>SHRUBS/CACTUS</b>						
<i>Chrysothamnus pulchellus</i>	CHRPUL	Rabbit brush				X
<i>Echinocactus texanus</i>		Horse crippler				
<i>Echinocereus spp.</i>	ECHSPP	Hedgehog cactus	X			
<i>Ephedra spp.</i>		Skeleton bush				
<i>Opuntia imbricata</i>		Cholla				
<i>Opuntia spp.</i>	OPPSPP	Prickly pear	X	X	X	X
<i>Prosopis glandulosa</i>	PROGLA	Honey Mesquite	X	X	X	X
<i>Yucca spp.</i>	YUCSPP	Spannish dagger		X		
<i>Ziziphus obtusifolia</i>	ZIZOBT	Lotebush	X		X	
<b>FORBS</b>						
		Unknown forb	X	X		
<i>Allium drummondii</i>		Wild onion				
<i>Ambrosia psilostachya</i>		Western ragweed				
<i>Asclepias spp.</i>		Milkweed				
<i>Cassia roemeriana</i>		Two leaf senna				
<i>Commelina erecta</i>		Dayflower				
<i>Conyza canadensis</i>		Mare's tail				
<i>Croton dioicus</i>	CRODIO	Grassland Croton	X	X	X	X
<i>Cryptantha minima</i>	CRYMIN	Cryptantha		X	X	X
<i>Gaillardia pulchella</i>		Indian blanket				

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**Table 11.9.2-2. Plant Species Observed By Season and Site**

Species	Code	Common Name	June '06		Sept '06	
			Site R	Site P	Site R	Site P
<i>Gutierrezia sarothrae</i>	GUTSAR	Snakeweed	X	X	X	X
<i>Hoffmannseggia glauca</i>	HOFGLA	Hog potato			X	
<i>Lesquerella gordonii</i>	LESGOR	Bladderpod	X	X		
<i>Leucelene ericoides</i>		Baby white aster				
<i>Machaeranthera pinnatifida</i>	MACPIN	Spiny daisy	X	X	X	X
<i>Machaeranthera tanacetifolia</i>		Tahoka daisy				
<i>Melampodium leucanthum</i>		Blackfoot daisy				
<i>Monarda punctata</i>		Horsemint				
<i>Oenothera spp.</i>		Evening primrose				
<i>Physalis viscosa</i>	PHYVIS	Ground cherry			X	X
<i>Plantago patagonica</i>	PLAPAT	Plantain		X		
<i>Psilotrophe villosa</i>	PSIVIL	Hairy paperflower		X		X
<i>Ratibida columnaris</i>	RATCOL	Prairie coneflower	X	X		
<i>Salsola iberica</i>	SALIBE	Russian thistle		X		
<i>Solanum elaeagnifolium</i>	SOLELA	Silver leaf nightshade			X	X
<i>Sphaeralcea coccinea</i>	SPHCOC	Scarlet globe mallow		X	X	X
<i>Sphaerlcea angustifolia</i>		Narrowleaf globe mallow				
<i>Tidestromia lanuginosa</i>	TIDLAN	Wooly tidestromia				X
<i>Verbena plicata</i>		Vervain				
<i>Xanthocephalum dracunculoides</i>	XANDRA	Annual broomweed	X	X	X	X

X = Species observed on transect within site.

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Table 11.9.2-3 lists the presence and relative abundance of plant species (% occurrence) recorded in two playas on WCS site, Andrews County, Texas, November 9, 2006.

**Table 11.9.2-3. Presence and Relative Abundance of Plant Species**

Species	South Playa		North Playa	
	Presence	Occurrence	Presence	Occurrence
GRASSES				
<i>Bouteloua eriopoda</i>			X	
<i>Bouteloua gracilis</i>	X		X	
<i>Buchloe dactyloides</i>	X	9.0	X	
<i>Digitaria cognata</i>	X			
<i>Elymus canadensis</i>	X			
<i>Muhlenbergia arenacea</i>			X	
<i>Panicum obtusum</i>	X	59.8	X	
<i>Schedonnadrus paniculatus</i>			X	
<i>Schleropogon brevifolius</i>			X	
FORBS				
<i>Amaranthus retroflexus</i>	X	3.0	X	0.3
<i>Ambrosia psilostachya</i>			X	0.3
<i>Aster subulatus</i>			X	
<i>Aster sp.</i>	X			
<i>Coryza canadensis</i>	X	2.5	X	0.3
<i>Croton dioicus</i>			X	2.1
<i>Cucurbita foetidissima</i>			X	
<i>Eriogonum annuum</i>			X	
<i>Grindelia squarrosa</i>	X	0.5	X	0.3
<i>Gutierrezia sarthrae</i>	X		X	0.6

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**Table 11.9.2-3. Presence and Relative Abundance of Plant Species**

Species	South Playa		North Playa	
	Presence	Occurrence	Presence	Occurrence
<i>Helianthus annuus</i>	X			
<i>Hymenopappus flavescens</i>			X	0.3
<i>Kochia scoparia</i>	X			
<i>Machaeranthera pinnatifida</i>			X	
<i>Malvella leprosa</i>	X			
<i>Physalis</i> sp.			X	0.6
<i>Psilostrophe villosa</i>			X	0.3
<i>Ratibida columnifera</i>	X	5.5	X	1.5
<i>Salsola iberica</i>	X		X	
<i>Solanum elaeagnifolium</i>	X	4.5		
<i>Sphaeralcea angustifolia</i>	X		X	1.2
<i>Tidestromia lanuginosa</i>			X	
<i>Verbena bracteata</i>	X	4.0		
<i>Xanthocephalum dracunculoides</i>	X		X	
SHRUBS/CACTUS				
<i>Opuntia imbricata</i>			X	
<i>Opuntia</i> spp.			X	
<i>Prosopis glandulosa</i>	X	1.5	X	2.7
<i>Sapindus saponaria</i>			X	0.3
BARE GROUND		9.5		3.0

**Table 11.9.2-4. Summary Statistics of Plant Communities on  
Six Plots at the WCS Site in Andrews County, Texas, June 2006**

Variable	Plot ID						Site	
	R01	R02-1	R03	P01	P02	P03	Site R	Site P
<sup>1</sup> Richness	12	17	13	14	12	19	21	22
<sup>2</sup> Diversity	1.800	1.931	2.027	1.884	1.829	1.917	2.276	2.082
Percent Composition								
Grasses	20.7	13.0	28.0	28.0	25.7	17.1	20.6	23.7
Forbs	35.0	31.3	22.0	22.7	23.7	31.0	29.4	25.7
Shrubs & Cactus	10.0	14.7	15.7	14.3	11.7	10.5	13.4	12.2
<sup>3</sup> Bare ground	34.3	41.0	34.3	35.0	39.0	41.5	36.6	38.4

<sup>1</sup>Richness = number of plant species observed on each plot.

<sup>2</sup>Diversity = Shannon diversity index.

<sup>3</sup>Dead vegetation and rock (only 1 occurrence in the entire dataset) are also considered bare ground.

**Table 11.9.2-5. Summary Statistics of Plant Communities on Six Plots at the WCS Site  
in Andrews County, Texas, September 2006**

Variable	Plot ID						Site	
	R01	R02-1	R03	P01	P02	P03	Site R	Site P
<sup>1</sup> Richness	11	17	17	17	15	18	24	22
<sup>2</sup> Diversity	1.804	2.255	2.180	1.952	1.863	2.137	2.449	2.091
Percent Composition								
Grasses	53.3	51.7	36.0	45.7	49.5	51.7	47.0	48.9
Forbs	13.0	15.0	31.0	26.3	19.1	17.0	19.7	20.8
Shrubs & Cactus	11.0	15.7	13.7	14.0	15.7	17.3	13.4	15.7
<sup>3</sup> Bare ground	22.7	17.7	19.3	14.0	15.7	14.0	19.8	14.6

<sup>1</sup>Richness = number of plant species observed on each plot.

<sup>2</sup>Diversity = Shannon diversity index.

**Table 11.9.2-6. Percent Cover of the Five Most Abundant Plant Species**

Species	Common Name	June, 2006			September, 2006		
		Total	Site R	Site P	Total	Site R	Site P
<sup>1</sup> Bare ground		37.5	36.6	38.4	17.2	19.9	14.6
<i>Prosopis glandulosa</i>	Honey Mesquite	12.1	12.6	11.6	14.0	12.9	15.1
<i>Tridens muticus</i>	Slim tridens	10.3	9.4	11.2	5.0	5.8	4.2
<i>Bouteloua eriopoda</i>	Black grama	9.8	7.0	12.7	25.1	17.3	32.9
<i>Gutierrezia sarothrae</i>	Snakeweed	9.4	10.9	7.9	6.9	7.6	6.2
<i>Machaeranthera pinnatifida</i>	Spiny daisy	8.8	7.1	10.5	8.5	8.6	8.5
<i>Cumulative</i>		87.9	83.6	92.3	76.7	72.1	81.5

<sup>1</sup>Dead vegetation and rock (only 1 occurrence in the entire dataset) are also considered bare ground.

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Table 11.9.2-7 lists the Order and Families of insects collected using pit traps and sweepnetting at the WCS site in Andrews County, Texas. Spiders and mites are included.

**Table 11.9.2-7. Insect Order and Family**

Group	Common Name	June, 2006		September, 2006	
		Site R	Site P	Site R	Site P
<sup>1</sup> <b>ORDERS</b>					
Coleoptera	Beetles	X	X	X	X
Hymenoptera	Wasps, ants, bees, sawflies	X	X	X	X
<sup>2</sup> Hemiptera	True bugs	X	X	X	X
Araneida	Spiders	X	X	X	X
Solifugae	Wind scorpions	X	X		
<b>INSECT FAMILIES</b>					
Acrididae	Grasshoppers	X	X	X	X
Anthridae	Ant-like beetles	X	X	X	
Asilidae	Robber flies	X	X		
Blattidae	Roaches		X		
Braconidae	Parasitoid wasps			X	
Cantharidae	Soldier beetles	X			X
Carabidae	Ground and tiger beetles				X
Cerambycidae	Long-horned beetles			X	X
Chalcididae	Wasps				X
Chrysomelidae	Leaf beetles	X	X	X	X
Cicadidae	Cicadas		X		X
Coccinellidae	Lady bugs			X	
Coreidae	Squash bugs	X	X		
Curculionidae	Snout beetles	X	X	X	X
Formicidae	Ants	X	X	X	X
Geometridae	Larval moths	X	X	X	X
Gryllidae	Crickets		X		
Ichneumonidae	Wasps				X
Lepidoptera	Moths	X			
Lygaeidae	Milkweed bugs				X
Mantidae	Mantids		X		
Meloidae	Blister beetles			X	
Melyridae	Soft winged flower beetles			X	
Membracidae	Treehoppers	X	X	X	
Monotomidae	Dark beetles	X	X	X	X

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**Table 11.9.2-7. Insect Order and Family**

Group	Common Name	June, 2006		September, 2006	
		Site R	Site P	Site R	Site P
Mutillidae	Velvet ants	X			
Nitidulidae	Sap beetles			X	
Pentatonidae	Stink bugs	X			
Phasmatidae	Walking sticks	X	X	X	X
Proctotrupidae	Wasps	X	X		
Psyllidae	Plant louse				X
Pyrrhocoridae	Red bugs				X
Reduviidae	Assassin bugs	X	X	X	X
Scarabaeidae	June bugs	X		X	
Sphecidae	Wasps	X			
Tenebrionidae	Darkling beetles	X	X		X
Tettigoniidae	Katydids		X	X	X
Vespidae	Paper wasps				
<b>ARACHNID FAMILIES</b>					
Salticidae	Crab spiders (Jumping spiders)	X	X	X	X
Theridiidae	Widow spiders			X	X
Trombidiidae	Velvet mites	X	X		

X = Species observed on site.

<sup>1</sup>Individuals of unknown families.

<sup>2</sup>Includes immatures that cannot be ID'd to Family.

Table 11.9.2-8 lists amphibians and reptiles observed at the WCS Site in Andrews County, Texas during 1996 (Ortega et al. 1997), 2004 (Reagan 2004a, 2004b), and 2006 surveys.

**Table 11.9.2-8. Amphibians and Reptiles**

Common Name	Scientific Name
<b>AMPHIBIANS</b>	
<i>Scaphiopus multiplicatus</i> *	New Mexico spadefoot
<i>Bufo speciosus</i>	Texas Toad
<b>REPTILES</b>	
<i>Phrynosoma cornutum</i>	Texas horned lizard
<i>Cnemidophorus gularis</i>	Texas spotted whiptail
<i>Cnemidophorus inornatus heptagrammus</i> *	Trans-Pecos striped whiptail
<i>Uta stansburiana</i> *	desert side-blotched lizard
<i>Eumeces obsoletus</i>	Great Plains skink
<i>Crotalus viridis viridis</i>	green prairie rattlesnake
<i>Masticophis flagellum</i> *	western coachwhip
<i>Heterodon nasicus nasicus</i>	plains hog-nosed snake
<i>Terrapene ornata</i>	ornate box turtle
<i>Kinosternon flavescens</i>	yellow mud turtle

\* reported from 1996 surveys which include offsite localities (Ortega et al. 1997)

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**Table 11.9.2-9. Birds Observed at the WCS Site in Andrews County, Texas**

Scientific Name	Common Name	June, 2006	December, 2006
<i>Accipiter cooperii</i>	Cooper's hawk		X
<i>Actitis macularia</i>	Spotted sandpiper	X	
<i>Agelaius phoeniceus</i>	Red-winged blackbird	X	
<i>Aimophila cassinii</i>	Cassin's sparrow	X	
<i>Ammodramus savannarum</i>	Grasshopper sparrow	X	
<i>Anas sp.</i>	Duck (mallard hen?)	X	X
<i>Anas strepera</i>	Gadwall		X
<i>Aphelocoma californica</i>	Western scrub jay		X
<i>Ardea herodias</i>	Great blue heron	X	X
<i>Bubo virginianus</i>	Great horned owl		X
<i>Buteo jamaicensis</i>	Red-tailed hawk		X
<i>Callipepla squamata</i>	Scaled quail	X	X
<i>Campylorhynchus brunneicapillus</i>	Cactus wren		X
<i>Cardinalis cardinalis</i>	Northern cardinal	X	
<i>Cardinalis sinuatus</i>	Pyrrhuloxia	X	X
<i>Charadrius vociferus</i>	Killdeer	X	X
<i>Chondestes grammacus</i>	Lark sparrow	X	
<i>Chordeiles minor</i>	Common nighthawk	X	
<i>Circus cyaneus</i>	Northern harrier	X	X
<i>Corvus cryptoleucus</i>	Chihuahuan raven	X	X
<i>Falco mexicanus</i>	Prairie falcon		X
<i>Falco sparverius</i>	American kestrel		X
<i>Geococcyx californianus</i>	Greater roadrunner	X	
<i>Himantopus mexicanus</i>	Black-necked stilt	X	
<i>Hirundo rustica</i>	Barn swallow	X	
<i>Icterus bullockii</i>	Bullock's oriole	X	
<i>Icterus spurius</i>	Orchard oriole	X	
<i>Junco hyemalis</i>	Dark-eyed junco		X
<i>Lanius ludovicianus</i>	Loggerhead shrike		X
<i>Melospiza lincolnii</i>	Lincoln's sparrow		X
<i>Melospiza melodia</i>	Song sparrow		X
<i>Mimus polyglottos</i>	Northern mockingbird	X	
<i>Molothrus ater</i>	Brown-headed cowbird		X
<i>Nycticorax nycticorax</i>	Black crown night heron	X	
<i>Passer domesticus</i>	House sparrow	X	

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**Table 11.9.2-9. Birds Observed at the WCS Site in Andrews County, Texas**

<b>Scientific Name</b>	<b>Common Name</b>	<b>June, 2006</b>	<b>December, 2006</b>
Passerculus sandwichensis	Savannah sparrow		X
Picoides scalaris	Ladder-backed woodpecker		X
Pooecetes gramineus	Vesper sparrow		X
Quiscalus sp.	Grackle	X	X
Regulus calendula	Ruby-crowned kinglet		X
Sayornis saya	Say's phoebe	X	X
Spizella passerine	Chipping sparrow		X
Spizella pusilla	Field sparrow		X
Sturnella magna	Eastern meadowlark	X	
Sturnella neglecta	Western meadowlark		X
Sturnus vulgaris	European starling		X
Thryomanes bewickii	Bewick's wren		X
Toxostoma curvirostre	Curve-billed thrasher	X	X
Tyrannus forficatus	Scissor tail flycatcher	X	
Tyrannus verticalis	Western kingbird	X	
Tyto alba	Barn owl	X	X
Zenaida macroura	Mourning dove	X	X
Zonotrichia leucophrys	White-crowned sparrow		X

**Table 11.9.2-10. Small Mammal Species Captured by Season and Site**

Species=	Code	Common Name	June, 2006		September, 2006	
			Site R	Site P	Site R	Site P
<i>Mus Musculus</i>	MUSMUS	House mouse			X	
<i>Neotoma micropus</i>	NEOMIC	Southern plains wood rat	X	X	X	X
<i>Onychomys leucogaster</i>	ONYLEU	Northern grasshopper mouse	X	X	X	X
<i>Perognathus flavus</i>	PERFLA	Silky pocket mouse	X	X	X	X
<i>Chaetodipus hispidus</i>	PERHIS	Hispid pocket mouse		X	X	X
<i>Peromyscus maniculatus</i>	PERMAN	Deer mouse	X	X		
<i>Sigmodon hispidus</i>	SIGHIS	Hispid cotton rat		X		X
<i>Spermophilus mexicanus</i>	SPEMEX	Mexican ground squirrel				X
<i>Spermophilus spilosoma</i>	SPESPI	Spotted ground squirrel	X		X	X

X = Species captured on site.

**Table 11.9.2-11. Summary Statistics of Small Mammal Trapping on Six Plots at the WCS Site in Andrews County, Texas, June 2006**

Variable	Plot ID						Site	
	R01	R02-1	R03	P01	P02	P03	Site R	Site P
<sup>1</sup> Trap-nights (total)	196	196	196	196	196	196	588	588
<sup>2</sup> Trap-nights (adjusted)	186.5	177.5	173.5	176.5	174.5	182.5	537.5	533.5
<sup>3</sup> MNKA	8	11	8	13	11	7	27	31
<sup>4</sup> C/E	4	6	5	7	6	4	5	6
<sup>5</sup> Richness	2	5	3	3	5	4	5	6
<sup>6</sup> Diversity	0.544	2.118	1.406	1.140	1.868	1.664	1.878	1.898

<sup>1</sup>Total trap-nights = 49 traps x 4 nights.

<sup>2</sup>Adjusted trap-nights = total trap-nights – (traps sprung by all causes/2).

<sup>3</sup>MNKA = Minimum number of individual small mammals known to be alive on each plot.

<sup>4</sup>C/E = Catch per unit effort expressed as number of animals captured per 100 trap-nights (adjusted for sprung traps by all causes).

<sup>5</sup>Richness = number of small mammal species captured on each plot.

<sup>6</sup>Diversity = Shannon diversity index.

**Table 11.9.2-12. Summary Statistics of Small Mammal Trapping on Six Plots at the WCS Site in Andrews County, Texas, September 2006**

Variable	Plot ID						Site	
	R01	R02-1	R03	P01	P02	P03	Site R	Site P
<sup>1</sup> Trap-nights (total)	196	196	196	196	196	196	588	588
<sup>2</sup> Trap-nights (adjusted)	189.5	174	184	192	185.5	181	547.5	558.5
<sup>3</sup> MNKA	1	9	5	4	8	13	15	25
<sup>4</sup> C/E	1	5	3	2	4	7	3	4
<sup>5</sup> Richness	1	5	3	3	3	5	6	7
<sup>6</sup> Diversity	NA	2.059	1.522	1.5	1.5	2.076	2.333	2.432

<sup>1</sup>Total trap-nights = 49 traps x 4 nights.

<sup>2</sup>Adjusted trap-nights = total trap-nights – (traps sprung by all causes/2).

<sup>3</sup>MNKA = Minimum number of individual small mammals known to be alive on each plot.

<sup>4</sup>C/E = Catch per unit effort expressed as number of animals captured per 100 trap-nights (adjusted for sprung traps by all causes).

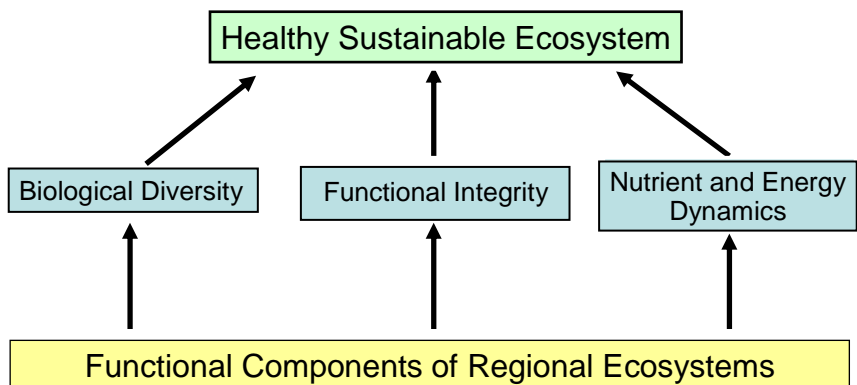
<sup>5</sup>Richness = number of small mammal species captured on each plot.

<sup>6</sup>Diversity = Shannon diversity index.

Table 11.9.2-13 lists the percent of total captures for all small mammal species on Site R and P (plots pooled within Site) at the WCS site in Andrews County, Texas, June and September 2006.

**Table 11.9.2-13. Percent of Total Captures for all Small Mammal Species on Site R and P**

<b>Species</b>	<b>June, 2006</b>	<b>September, 2006</b>
Perognathus flavus	52	7.5
Onychomys leucogaster	23	27.5
Neotoma micropus	12	30
Peromyscus maniculatus	3	NA
Sigmodon hispidus	3	10
Chaetodipus hispidus	2	12.5
Spermophilus pilosoma	5	7.5
Spermophilus mexicanus	NA	2.5
Mus musculus	NA	2.5



**Figure 11.9.2-1. Hierarchy of Ecological Values**

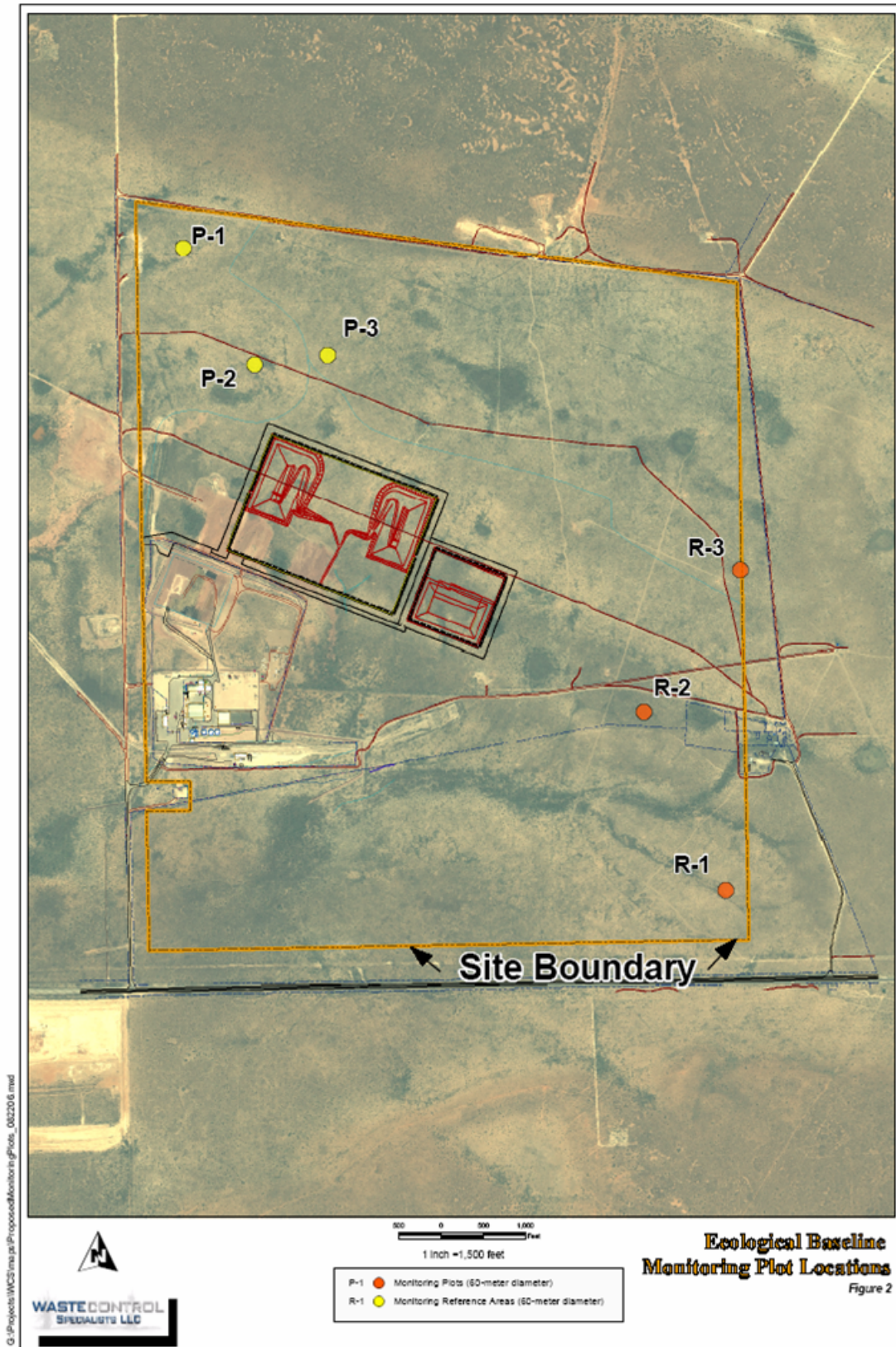


Figure 11.9.2-2. Ecological Baseline Survey Plot Locations

Figure 11.9.2-3 is a diagram of sampling locations for plants, mammals, and invertebrates. Mammal traps were placed 10 m apart in a 7 x 7 grid with the SW corner of the grid being one of the six permanent Sample Plots. Vegetation transects originated at the NW, NE, and SE corners of the mammal trapping grid and extended 100m in a N, NE, or W direction.

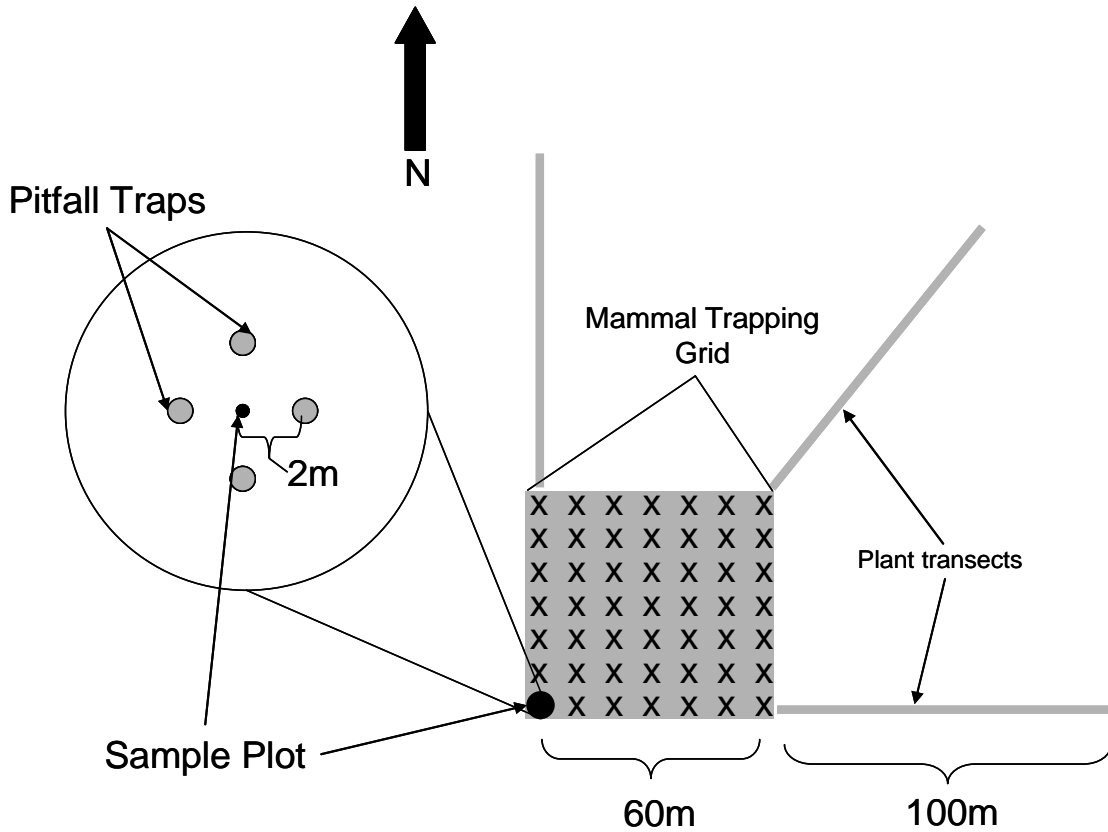
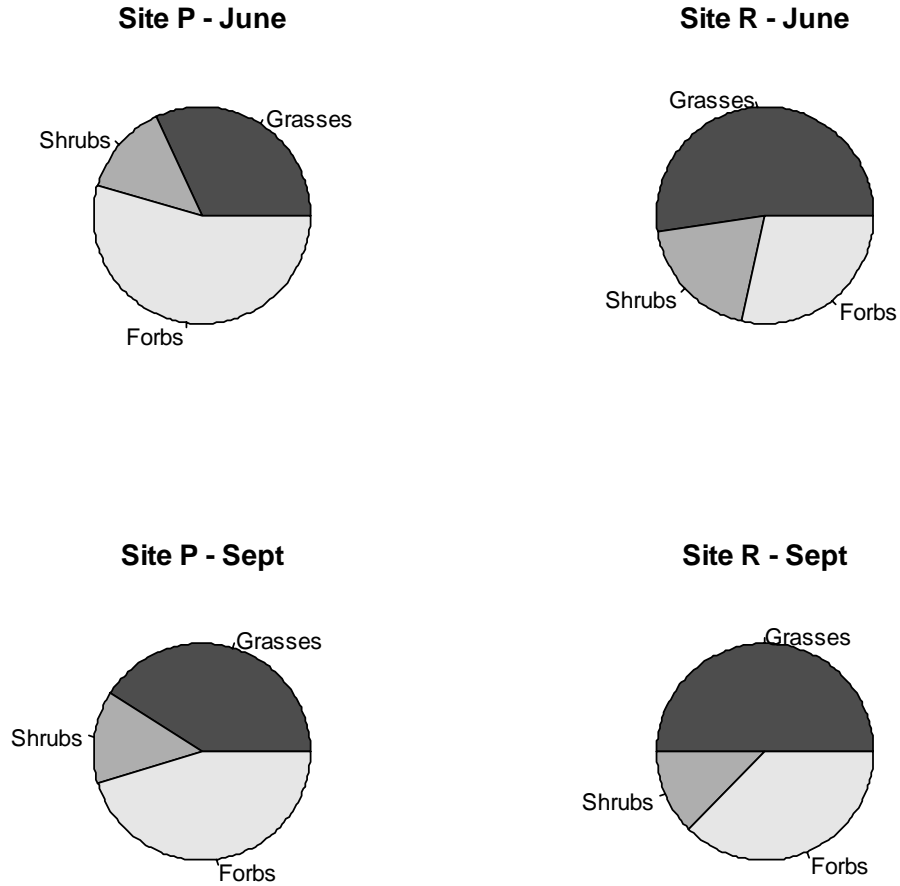


Figure 11.9.2-3. Diagram of Sampling Locations for Plants, Mammals, and Invertebrates

Figure 11.9.2-4 shows plant species composition at the WCS site in Andrews County, Texas, 2006. Site P is downwind (based on prevailing SE winds) of the WCS facility. Site R is upwind of the facility. Pie charts reflect relative proportion of the number of species in each of three growth forms (grasses, shrubs, or forbs).



**Figure 11.9.2-4. Plant Species Composition at the WCS Site in Andrews County, Texas, 2006**

Figure 11.9.2-5 shows Plot P-03-1 in June (top) and September (bottom) 2006 facing southwest. Insect pit traps are barely visible in September due to lush growth of grasses and forbs that developed after heavy summer rains.



**Figure 11.9.2-5. Plot P-03-1**

## **ATTACHMENT A: PLAYA LAKES SURVEY**

WCS Playa Surveys November 2006, L. M. Smith, Lubbock, TX

The purpose of this report is to provide information on plant surveys conducted on two playas at the WCS Site, November 2006. Playas are shallow depressional recharge wetlands each existing in their own catchment. As the term recharge implies playas are the primary sites of focused recharge to the High Plains Aquifer. They are also local sites of biodiversity in this semi-arid landscape. In addition, the report comments on potential regulatory aspects of playa modification and/or hydrological alteration.

Plant Surveys

Plant surveys were conducted on 9 November 2006 when most herbaceous species had either died or were dormant. Surveys consisted of traversing the entire perimeter of each playa and recording species presence. Two transects were also conducted across the entire diameter of each playa. These were step-points where species presence was noted every 1-m step (Smith and Haukos 2002). The edge of the playa was determined by a change in soil color and elevation. Species were identified following Haukos and Smith (1997).

Both playas were in the dry phase and did not contain any surface water. Many of the species were dead or dormant. Species composition reflected dry conditions (Table 3) and are typical species found in native grassland playas (Haukos and Smith 1997, Smith and Haukos 2002). This survey is not a complete list of species occurring in these two playas since turnover of species usually averages about 40% across a year, a result of seasonal changes and hydrologic events driven by precipitation (Smith and Haukos 2002).

Regulatory Considerations

In my view and experience, as a result of the 2001 SWANCC v. United States Corps of Engineers Supreme Court decision, federal regulation of impacts covered by the Clean Water Act has been eliminated for most playas (including those in question in Andrews County, TX) and other isolated wetlands (Haukos and Smith 2003). These include “dredge and fill” impacts.

However, from a legal perspective, I recommend that this opinion be officially verified with the U.S. Army Corps of Engineers in Fort Worth, TX. Next, Texas and local groundwater districts realize the importance of recharge to the High Plains Aquifer (Haukos and Smith 2003). Therefore, runoff and added fill into playas should not contain any contaminated or toxic materials to eliminate potential groundwater contamination. Finally, in my opinion, based on experience, research, and consultation, although important sites of biodiversity the two playas in question do not likely serve as critical habitat for any endangered or threatened species in the U.S. or Texas.

References Cited

- Haukos, D.A., and L.M. Smith, 1997. Common flora of the playa lakes. Texas Tech University Press, Lubbock, TX, USA
- Haukos, D.A., and L.M. Smith, 2003. Past and future impacts of wetland regulations on playa ecology in the Southern Great Plains. *Wetlands* 23:577-589.
- Smith, L.M., and D.A. Haukos. 2002. Floral diversity in relation to playa wetland area and disturbance. *Conservation Biology* 16:964-974.