APPENDIX J

REVEGETATION BASELINE MONITORING PLAN

CEDAR CREEK ASSOCIATES, INC.

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United Nuclear Corporation (UNC)

Northeast Church Rock Mine

EAST DRAINAGE VEGETATION BASELINE SAMPLING METHODOLOGY

1.0 INTRODUCTION

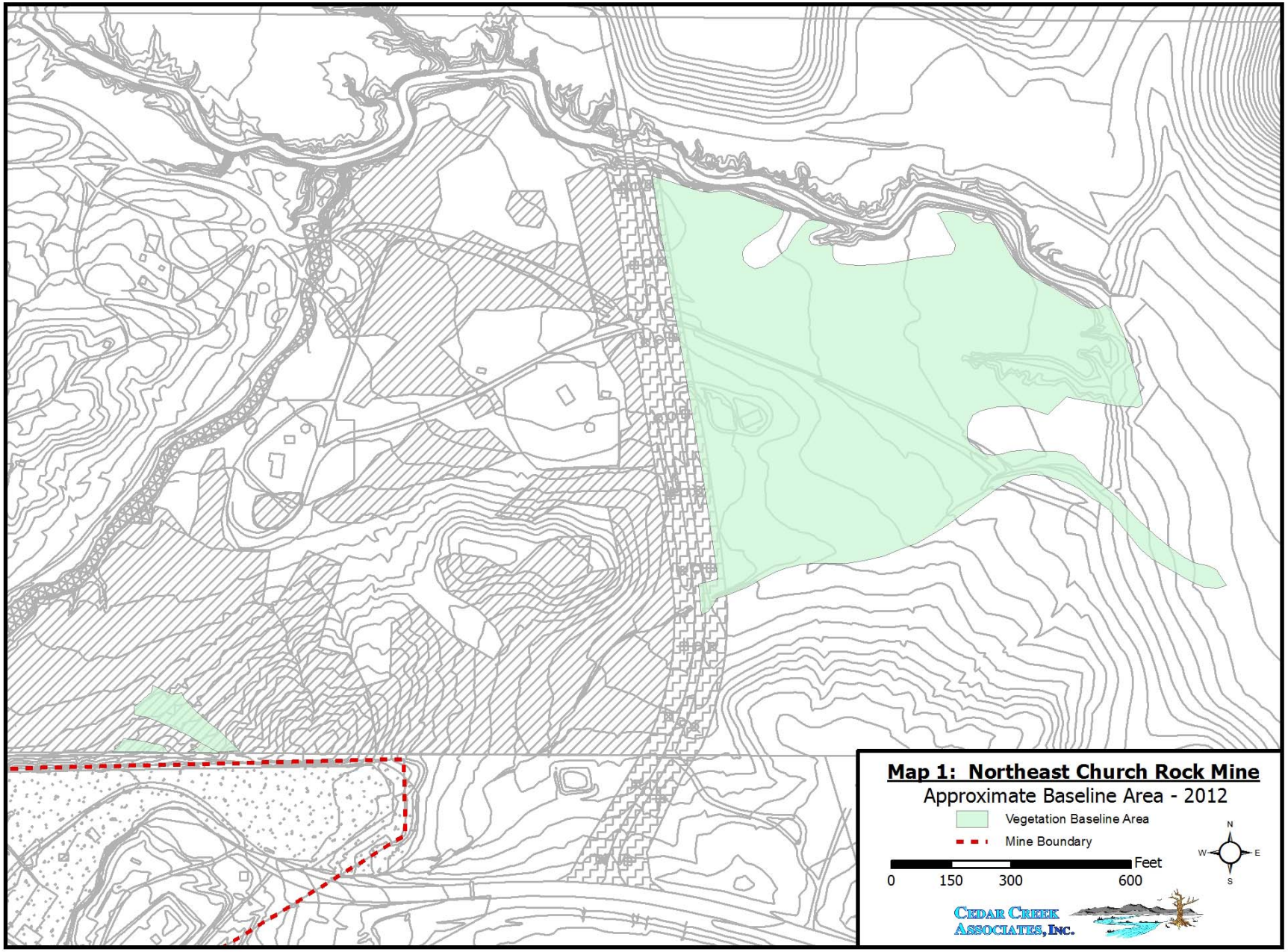
1.1 General

Cedar Creek Associates, Inc. (Cedar Creek) has been contracted in 2012 to implement a work plan specific to development of a baseline vegetation evaluation in support of the East Drainage Removal Action (RA) for United Nuclear Corporation's (UNC) Northeast Church Rock Mine (NECR). This work plan requires identification of methods and protocols for vegetation evaluations responsive to the removalaction pursuant to mandates of the US Environmental Protection Agency (EPA) – Region 9. In addition to baseline evaluation of the project area, establishment of an additional (site-appropriate) vegetation reference area may be necessary to provide a suitable comparison for eventual reclamation and revegetation of East Drainage. Therefore, the purpose of the effort documented herein is presentation of a methodology designed to facilitate a determination of current floral conditions extant in the vicinity of the project area.

Floral surveys are to be conducted in August prior to the start of removal activities. The results will be used to develop a revegetation plan. These surveys are to be conducted by or under the direct supervision of Cedar Creek's Ecologist Mr. Jesse H. Dillon. Mr. Dillon will also serve as the Project Manager for Cedar Creek.

1.2 Site Description

NECR is located approximately 16 miles northeast of Gallup, New Mexico at an elevation ranging between 7,000 and 7,200 feet above mean sea level. East Drainage Project Area is immediately east of the Step Out Area across Red Water Pond road. This RA also includes small areas to the west of Red Water Pond road and north of the mine boundary (Map 1). Based on field reconnaissance by Cedar Creek biologists, there is one distinct vegetation community within the project area, Saltbush-steppe. Saltbush-steppe is dominated by saltbush species in the shrub stratum with an herbaceous understory of perennial sod-forming "short" grasses and occasional forbs that can sometimes be seasonally dominant.


Map 1: Northeast Church Rock Mine
Approximate Baseline Area - 2012
Vegetation Baseline Area
Mine Boundary
Feet
0
150
300
600
N
W
E
S
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2.0 REFERENCE AREA SELECTION

The reference area(s) to be used for final revegetation success comparison will be selected from undisturbed areas in the vicinity of the project area. Preferred reference areas can be characterized as "ecologically and topographically similar" to the rehabilitated landform, surrounding areas, and/or areas representing the desired post mining land use (PMLU), and are based on five main considerations, as follows:

1. The reference area(s) is representative of the desired PMLU or vegetation community supporting the PMLU (grazing land in the case of NECR East Drainage).

2. The reference area(s) occupy topography and aspects that are representative of the majority of reclaimed areas, especially with regard to slopes that may be subject to erosion.

3. The reference area(s) exhibit similar physical soil conditions as reclaimed areas and therefore, should be an "approximate ecological equivalent".

4. Excepting managed pasturelands and/or occasional invasive weeds, the reference area(s) support native tree/shrub/grass plant communities similar in structure to what can be obtained on reclaimed areas in the short term.

5. The plant communities selected for comparison provide an appropriate and logical target for reclamation efforts.

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3.0 SAMPLING METHODS

Cedar Creek's vegetation sampling protocols involve an emphasis upon ground cover* to facilitate repeatable future statistical comparisons among evaluation areas as well as a multitude of additional reasons. In brief, concentration on a single variable of plant ecology facilitates improved comprehension and comparability over time and among treatment scenarios. Second, ground cover data, especially when determined using a very precise method such as the point-intercept procedure, provides some of the most important information regarding community variability that ecologists can evaluate. Such data facilitate the determination of true species composition, relative health (condition), and successional status of the sampled area. Furthermore, the same data can be utilized to develop the "sister" variables of frequency and species composition if desired. Third, strong inferences can be developed with other reasonably correlated variables such as production when species composition is factored into the analysis. Fourth, ground cover is a preferred variable for revegetation monitoring because cover data can be readily obtained in a statistically adequate and cost-effective manner (using the proper procedures), has broad application for evaluation (including erosion control modeling), precisely reflects species' dominance of a given area, and when collected using bias-free techniques such as the point-intercept procedure is one of the most repeatable variables among independent observers.

In addition to ground cover evaluations, Cedar Creek recommends evaluation of woody plant density and current annual vegetative production to facilitate a broader analysis. In this regard, it was determined most appropriate to document woody plant populations (for wildlife habitat considerations) by utilizing long quadrats or belts as detailed below. The most appropriate method for measuring current annual herbaceous production is use of long rectangular quadrats. Since sampling adequacy is not required (nor recommended) for woody plant density or vegetative production samples, one density belt and one production quadrat will be co-located with each ground cover transect evaluated. Resulting data are then considered reasonable for the evaluation purposes intended.

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* To avoid confusion, the term "ground cover" is utilized to indicate the variable of <u>non-overlapping foliar cover</u> (the percent of the ground occupied by all above ground plant material) in addition to the ground surface covered by litter or rock. Non-overlapping means that only that cover which would be wetted by a light mist would be counted as opposed to that plant material which would not get wet due to overshadowing plant material. In this manner, <u>total ground cover</u> cannot exceed 100%. Other forms of "cover" would include: basal cover (the percent of the ground surface occupied by the living base of plants), crown or canopy cover (the percent of the ground occupied by the canopies of plants), or overlapping foliar cover (the percent of the ground occupied by <u>all</u> plant material allowing for overlapping vegetation - i.e., such cover can exceed 100%). Non-overlapping foliar cover is preferred because of its inherent repeatability among observers, resulting data are directly applicable to erosion control modeling efforts, and significant precedent has already been set in the mining industry. In contrast, the determination of the live portion of the base of a plant (as necessary for basal cover) becomes increasingly difficult and subjective given life forms such as certain bunch grasses and sod-formers.

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3.1 Sample Site Selection / Location

The primary field effort for vegetation calls for sampling of undisturbed portions of East Drainage and the establishment and sampling of a corresponding reference area. The reference area is to be selected and established during floral evaluations in August. The systematic procedure for determination of sample locations occurs in the following stepwise manner. First, a fixed point of reference is selected for the entire area to facilitate location of the systematic grid in the field. Second, a systematic grid of appropriate dimensions (i.e., 150′ X 150′) is selected by Cedar Creek to provide a minimum number of coordinate intersections (~30 in the baseline area and ~30 in the reference area) within the vegetative unit that could then be used for the initial set of sample sites. Third, a scaled representation of the grid is overlain on field maps extending parallel to major compass points to facilitate field location. Fourth, unbiased placement of this grid is controlled by selection of two random numbers between 0 and 150 (used as coordinates). Fifth, utilizing a handheld compass and pacing techniques or a GPS, all 30 of the initial sample points are located in the field. If the initial 30 systematic samples are not sufficient to provide an adequate ground cover sample, an "intergrid" would be selected to provide additional systematically determined sample points.

3.2 Determination of Ground Cover

Ground cover at each sampling site is determined utilizing the point-intercept methodology (Bonham 1989) as illustrated on Figure 1. This methodology has been utilized for range studies for over eighty (80) years, however, Cedar Creek utilizes state-of-the-art instrumentation that it has pioneered to facilitate much more rapid and accurate collection of data. Implementation of the technique for the sampling effort occurs as follows: First, a transect of 10 meters length is extended from the starting point of each sample site toward the direction of the next site to be sampled. Then, at each one-meter interval along the transect, a "laser point bar" is situated vertically above the ground surface, and a set of 10 readings recorded as to hits on vegetation (by species), litter, rock (>2mm), or bare soil. Hits are determined at each meter interval by activating a battery of 10 specialized lasers situated along the bar at 10 centimeter intervals and recording the variable intercepted by each of the narrow (0.02") focused beams (see Figure 1). In this manner, a total of 100 intercepts per transect are recorded resulting in 1 percent cover per intercept. This methodology and instrumentation facilitates the collection of the most unbiased, repeatable, precise, and cost-effective ground cover data possible. Furthermore, the point-intercept procedure has been widely accepted in the scientific community as the protocol of choice for vegetation monitoring and is frequently used within the mining industry..

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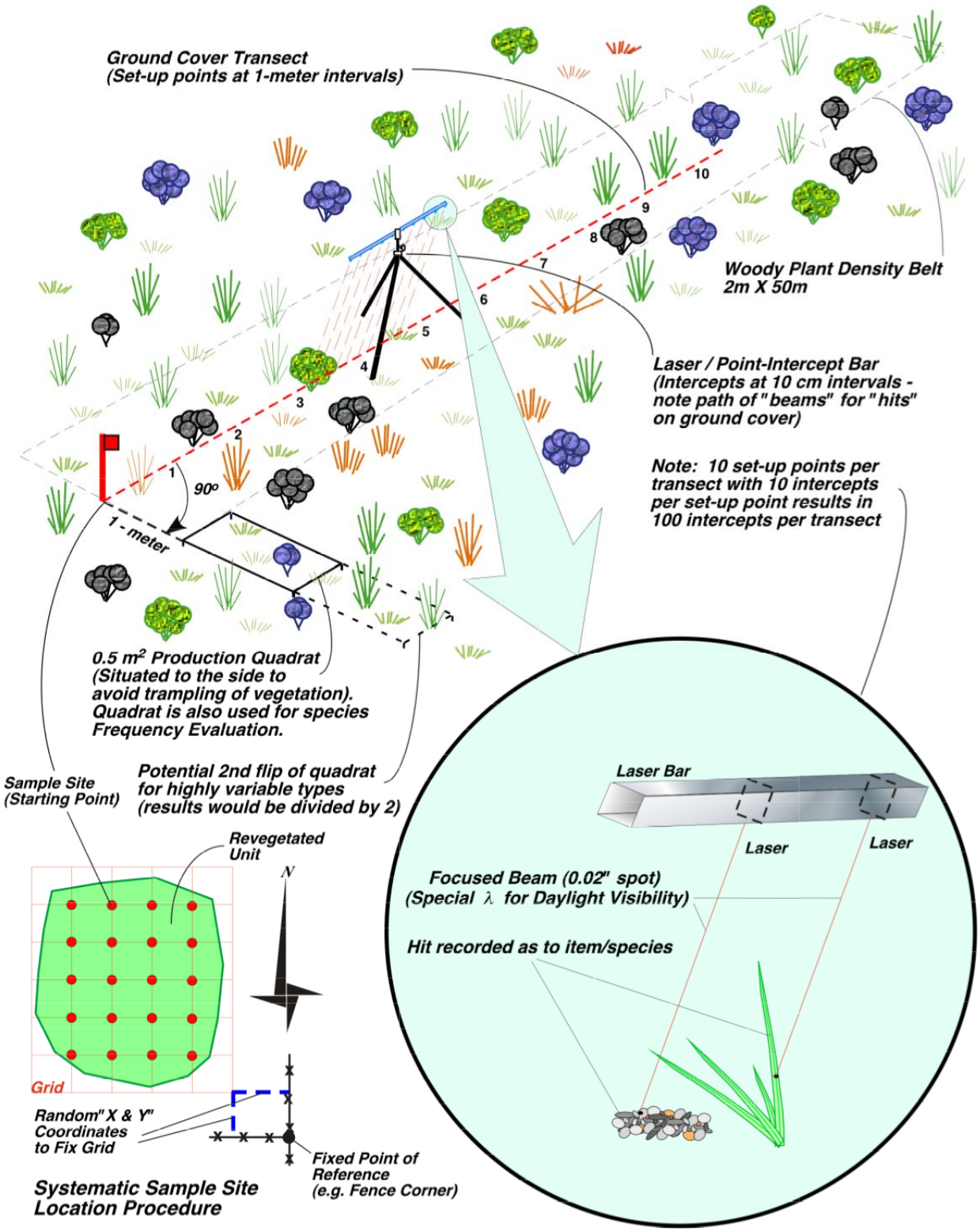

Figure - 1

Sampling Procedure at a Systematic Sample Site Location

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3.3 Determination of Woody Plant Density

Woody plant density at each sampling site is determined using fixed length / width belt transects oriented parallel to, and co-located with, each ground cover transect. Each belt is 2 meters in width and extended from the beginning of the sample point for a distance of 50 meters (see Figure 1). All shrubs, succulents, and trees rooted within the boundaries of these belts are counted and classified according to species (sub-shrubs are not counted). Entire plants rather than stems are counted to provide a more accurate representation of actual woody plant density.

3.4 Determination of Vegetative Production

At each sample site, current annual production is collected from a $^1/_2$ m^2 quadrat frame flipped once (end to end – see Figure 1) to facilitate less variable data, therefore sampling a total of 1 m^2 at each sampling location. The quadrat is initially placed one meter and 90° to the right (clockwise) of the ground cover transect to avoid vegetation trampled by investigators during sample site location (see Figure 1). From within each quadrat, all above ground current annual vegetation within the vertical boundaries of the frame is clipped and bagged separately by life form as follows:

Native Perennial Grass
Introduced Perennial Grass
Annual Grass
Sub-Shrub
Shrub
Native Perennial Forb
Annual / Biennial Forb
Introduced Perennial Forb
Noxious Weed

All production samples are returned to the lab for drying and weighing. Drying will occur at 105° C until a stable weight is achieved (24 hours). Samples are then re-weighed to the nearest 0.1 gram.

3.5 Sample Adequacy Determination

Ground cover sampling is conducted to a minimum of 30 initial ground cover transects for the baseline area and a minimum of 30 initial ground cover transects for the reference area. Production and woody plant density samples are co-located with each ground cover transect but are not subject to a determination of sampling adequacy. From these preliminary efforts for ground cover, a sample mean and standard deviation for total non-overlapping vegetation ground cover is calculated. These parameters are calculated in the field to insure collection of an adequate sample and once again by computer during final data analyses for each area. Sampling continues until an adequate ground cover sample, $\mathbf{n_{min}}$, has been collected in accordance with the Cochran formula (below) for determining sample adequacy, whereby the population would be estimated to within 10% of the true mean (μ) with 90% confidence. Sampling to these limits facilitates a very strong estimate of target populations.

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When the inequality ($\mathbf{n_{min}} \leq \mathbf{n}$) is true, sampling is adequate and $\mathbf{n_{min}}$ is determined as follows:

$$\mathbf{n_{min} = (t^2 s^2) \ / \ (0.1 \ \bar{x} \ )^2}$$

where: n = the number of actual samples collected (initial size = 30)

t = the value from the one-tailed t distribution for 90% confidence with n-1 degrees of freedom;

s^2 = the variance of the estimate as calculated from the initial samples;

$\bar{x}$ = the mean of the estimate as calculated from the initial samples.

If the initial 30 ground cover samples from each area does not provide a suitable estimate of the mean (i.e., the inequality is false), additional samples would be collected until the inequality ($\mathbf{n_{min}} \leq \mathbf{n}$) becomes true.

3.6 Threatened, Endangered, and Rare Plant Species

A list of rare and endangered plant and animal species that are known to occur within McKinley County and the Saltbush Steppe ecotype, which contains the study area, will be developed from several sources including New Mexico Natural Heritage Program, New Mexico Rare Plant Website, and Navajo Nation EPA before baseline evaluation.

Prior to implementation of fieldwork, taxonomic descriptions and botanical drawings of these target species are to be compiled into a field guide. Actual fieldwork will involve search patterns in all portions of appropriate habitat within the project area. Search procedures involves slow implementation of qualitative pedestrian transects and careful visual scanning of the ground surface for any of the target plant species. The compiled field guide will be used to determine whether encountered plants are species of concern.

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4.0 LITERATURE CITED

Bonham, Charles D. 1989. Measurements for Terrestrial Vegetation. John Wiley & Sons. 338 pp.