

**Potential for radionuclide redistribution due to biotic intrusion: Aboveground biomass study at the Los Alamos National Laboratory for the closure of Material Disposal Area G - 8502**

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**ABSTRACT**

Low-level radioactive waste generated at the Los Alamos National Laboratories (LANL) is disposed of at Technical Area (TA) 54, Material Disposal Area (MDA) G. The ability of MDA G to safely contain radioactive waste was evaluated in the facility's performance assessment (PA) and composite analysis (CA). The PA and CA project that, due to uptake and incorporation of radionuclides into aboveground plant material, plant roots penetrating into buried waste may lead to releases of radionuclides to the accessible environment and potentially lead to the exposure to members of the public. The potential amount of contamination deposited on the ground surface, due to plant intrusion into buried waste, is a function of the quantity of litter generated by plants, as well as radionuclide concentrations within the litter. Radionuclide concentrations in plant litter is dependent on the distribution of root mass with depth and the efficiency with which radionuclides are extracted from contaminated soils by the plants roots. In order to reduce uncertainties associated with the PA and CA for MDA G, aboveground biomass surveys, plant litter production rates, and root mass with depth analyses for the four prominent vegetation types (grasses, forbs, shrubs and trees) are being conducted. Sampling occurred during the months of August and September of 2007 which measured aboveground biomass for the types of grasses and forbs that may become established at MDA G after the disposal facility undergoes final closure. Biomass data are representative of the future potential for the amount of contaminated plant litter fall, which could act as a latent conduit for radionuclide transport from the closed disposal area. Follow on work will be conducted to evaluate frequency and coverage of all growth forms, litter production rates will be measured, and root mass with depth for grasses, forbs, shrubs, and trees will be analyzed. Together, data collected are expected to reduce uncertainties associated with the PA and CA for MDA G and ultimately aid in the prevention of radionuclide transport within the environment from the closed disposal area and exposure to the public.

## **INTRODUCTION**

Low-level radioactive waste generated at the Los Alamos National Laboratory (LANL) is disposed of at Technical Area (TA) 54, Material Disposal Area (MDA) G (Fig. 1). The ability of MDA G to safely contain the radioactive waste is evaluated in the facility's performance assessment (PA) and composite analysis (CA) [1]. The PA and CA project that plant roots and animal burrows penetrating into the buried waste may lead to releases of radionuclides to the accessible environment and, ultimately, exposures of members of the public. Radionuclides disposed of at MDA G may be transported to the surface of the disposal facility by plants and animals intruding into the waste. Recognizing that uncertainties exist in the models, data, and assumptions used to conduct the PA and CA, a more comprehensive evaluation of the potential impacts of biotic intrusion is being undertaken as part of the PA and CA Maintenance Program Plan [2].

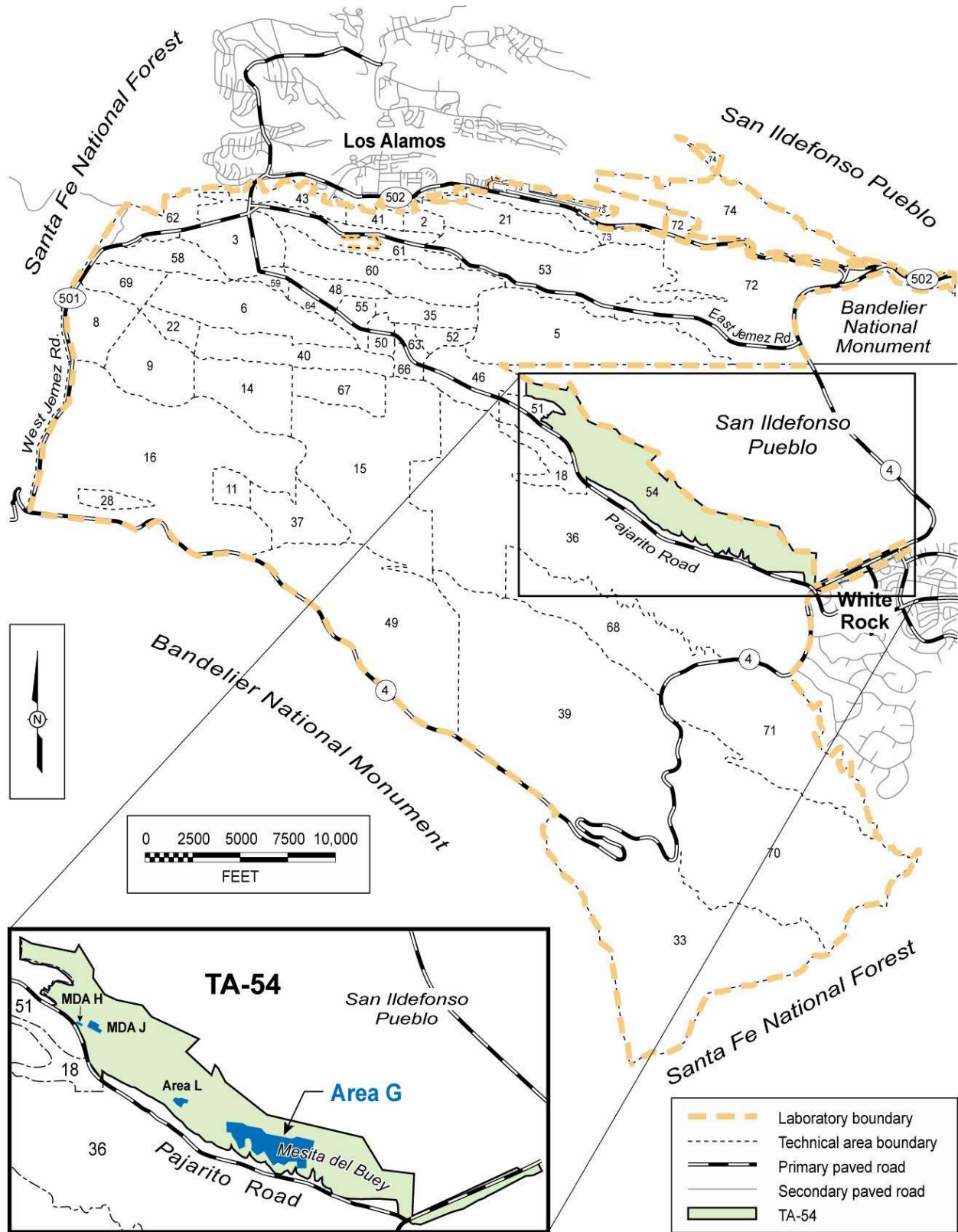
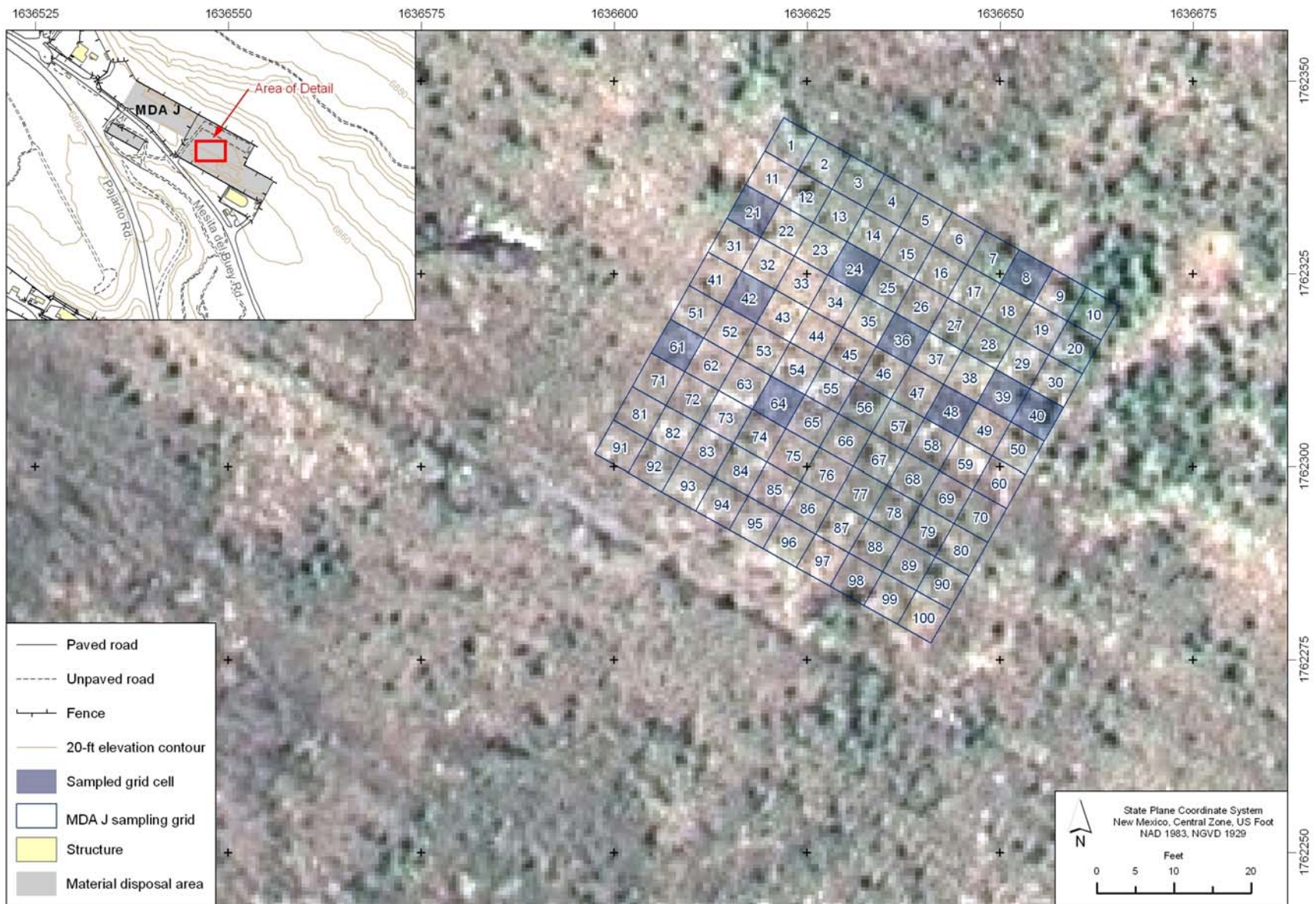


Fig. 1. Area G at Technical Area 54, Los Alamos National Laboratory.

The biotic sampling event that occurred during August and September of 2007 provides information on the site-specific aboveground biomass for grasses and forbs within MDA J and Zone 4 at TA-54. MDA J, a waste disposal area that has achieved a relatively uniform grassland cover, exhibits conditions expected to exist at MDA G shortly after closure in the beginning successional stages of plant growth. Zone 4, which is a well-established Piñon-Juniper woodland, represents the later successional stage of plant growth expected long after MDA G closure. Figures 2 and 3 present biotic sampling locations within MDA J and Zone 4, respectively, at TA-54.

Updated biotic intrusion modeling, to be conducted with data from this study, will help refine release rate estimates and contribute to a better understanding of the potential impacts to the downwind receptors. This information will be used to reduce the uncertainty in the biotic intrusion modeling and, therefore, in the doses projected for receptors living in the vicinity of the disposal facility.



**Fig. 2. Biomass Sampling Locations at Los Alamos National Laboratory TA-54, MDA-J.**

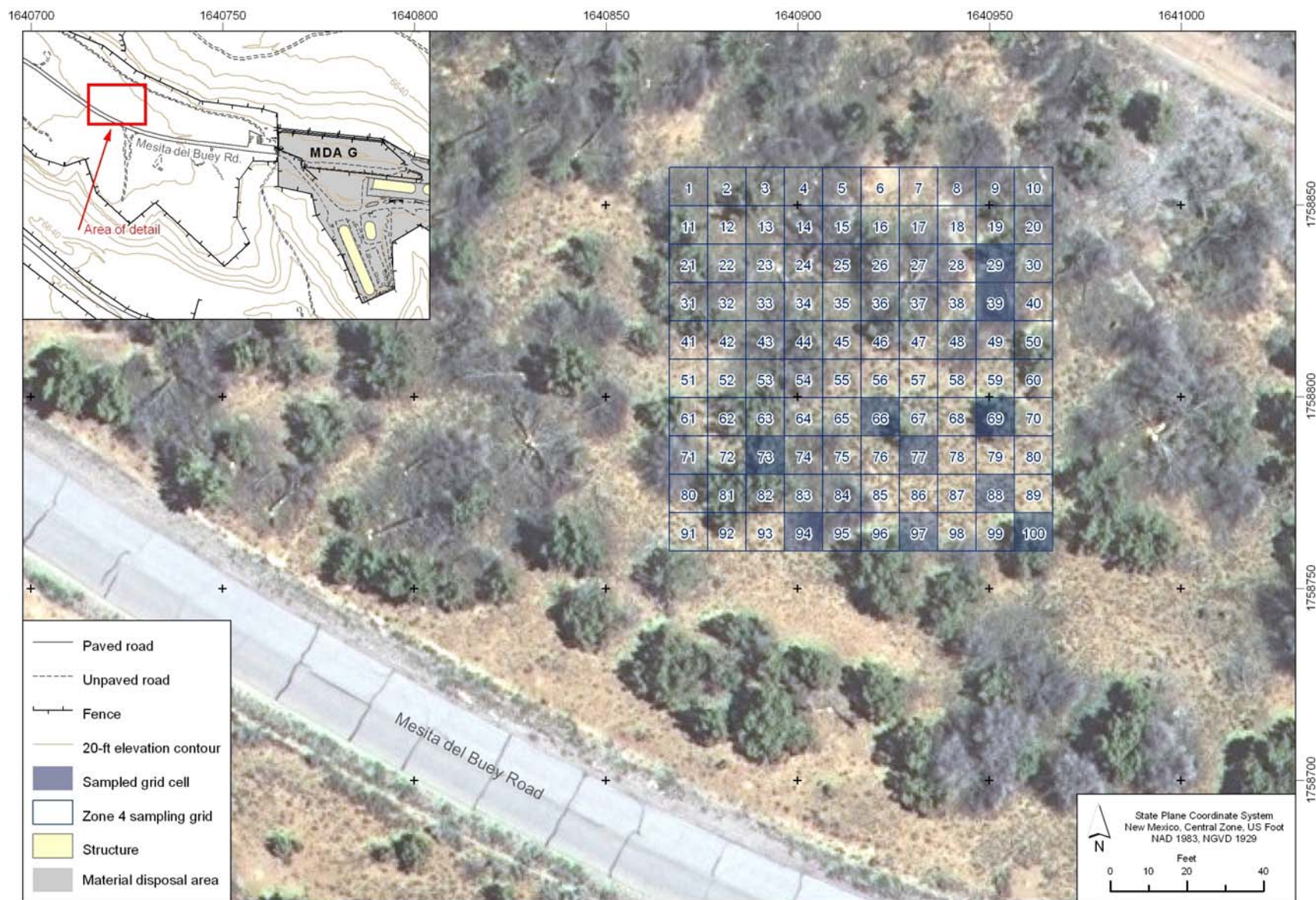


Fig. 3. Biomass Sampling Locations at Los Alamos National Laboratory TA-54, MDA G, Zone 4.

## **PURPOSE**

Measurement of aboveground biomass for grasses and forbs will provide data to reduce uncertainties associated with the MDA G PA and CA biotic intrusion modeling. Previous estimates of understory biomass for the early successional stages at MDA G have been based on data reviews from sites outside the Laboratory, including Piñon-Juniper woodlands that have been disturbed by fire or other physical means, Piñon-Juniper grasslands, and areas adjacent to mature woodlands. These data have provided estimates of conditions similar to MDA G disposal sites, but do not provide actual site-specific information.

## **SAMPLING AND SURVEYING ACTIVITIES**

The following activities were performed to determine aboveground biomass at TA-54 within the grassland area of MDA J, and within the Piñon-Juniper woodland of MDA G, Zone 4.

### **Aboveground Biomass Sampling Within MDA J**

MDA J is a solid waste landfill located at TA-54. Landfill closure activities were completed June 27, 2002. MDA J was established as a solid waste landfill in 1961 at TA-54 in order to maintain long-term institutional control over selected non-hazardous, non-radioactive wastes for security and safety reasons. New Mexico special wastes were disposed of at MDA J. Liquid, hazardous, and radiologically contaminated wastes were prohibited. MDA J consisted of six waste disposal pits and four shafts that were situated on 13,000m<sup>2</sup> (3.3 acres). This site was reseeded with native grasses upon closure, and currently the revegetation at the site consists of a mixture of native grasses and common weeds (forbs). The weeds resulted from the presence of non-native weed seeds in the topsoil used during closure activities [3]. There are currently no shrubs or trees present within the portion of MDA J selected for biomass sampling.

A uniform grid was located within the north central portion of MDA J. A 15.24 m by 15.24 m (50 ft by 50 ft) square grid was established with 100 grid cells spaced at 1.5 m (5 ft) intervals. Each cell was numbered, and a random number generator was used to select 10 cells for biomass sampling. Grid cells selected were 8, 21, 24, 36, 39, 40, 42, 48, 61, and 64. The following field procedures were performed:

- All vegetation within the grid cell was clipped at the base of the ground, sorted by growth form (i.e., grass and forbs) and packaged into brown paper bags;
- Paper bags were labeled with the grid cell number, the date, time of collection, and the plant growth form identification;
- Biomass samples were air or oven dried; and
- All biomass samples were dry-weighed using a calibrated scale.

Plants were weighed by growth form (i.e., grass and forbs) and the results were documented in a field log notebook. Two grid cells were randomly selected for oven drying. Material from these cells was weighed prior to and after being dried for 48 hours in an oven at 49° C. The scale used to perform the weight measurements was an Ohaus Scout Pro Balance. This scale was tared prior to each use to ensure measurement accuracy.

### **Aboveground Biomass Sampling Within Zone 4**

Zone 4 is located in Area G, north of the Mesita del Buey road, and is approximately 487 m by 76 m (1600 ft by 250 ft) as bounded by the northern fenceline road. Boreholes and monitoring wells exist throughout this entire northern portion of Zone 4, and other land-disturbing activities such as tree cutting and off-road vehicle travel has occurred. There is one large archeological site located on the western end of Zone 4, and is adjacent to the MDA L fenceline. The north-central portion of Zone 4, however, consists of well-established and relatively undisturbed Piñon-Juniper woodland.

A uniform grid was located within the north central portion of Zone 4 at Area G. A 30.48 m by 30.48 m (100 ft by 100 ft) grid was established with 100 grid cells spaced at 3.04 m (10 ft) intervals. Each cell was numbered, and a random number generator was used to select 10 cells for biomass sampling. Grid cells selected were 29, 39, 66, 69, 73, 77, 88, 94, 97, and 100. The following field procedures were performed:

- All vegetation within the grid cell was clipped at the base of the ground, sorted by growth form (i.e., grass and forbs) and packaged into brown paper bags;
- Paper bags were labeled with the grid cell number, the date, time of collection, and the plant growth form identification;
- Biomass samples were air or oven dried; and
- All biomass samples were dry-weighed using a calibrated scale.

Plants were weighed by growth form (i.e., grass and forbs) and the results were documented in a field log notebook. Two grid cells were randomly selected for oven drying. Material from these cells was weighed prior to and after being dried for 48 hours in an oven at 49° C. The scale used to perform the weight measurements was an Ohaus Scout Pro Balance. This scale was tared prior to each use to ensure measurement accuracy.

### **BIOMASS DATA**

#### **Material Disposal Area J**

Aboveground biomass for the ten plots surveyed at MDA J was measured to be 1469.7 g for grasses and 1220.8 g. for forbs. The majority of the grasses and forbs collected from MDA J were air dried over several weeks. Two grid cells (8 and 48) were selected for oven drying of grasses and forbs to determine the contribution of relative humidity on moisture content. The plant material was weighed prior to oven drying, and weighed again after a minimum of 48 hours in the oven. Oven temperature was set at 49° C. Table II presents results for MDA J. Material that was oven dried was also weighed again several weeks later in order to establish whether relative humidity reabsorbing into plant material causes a measurable weight change, therefore creating a higher error associated with air versus oven drying methodology. Results, also presented in Table I, show that with more plant material sampled, more weight gain will occur post oven drying. Reabsorbtion reflects equilibrium of the plant material with the environment, at its driest state and the significance of this will be evaluated during further study



Table I. Aboveground Biomass within MDA J at TA-54

Grid Cell #	Grass Dry Mass (g)	Forbs Dry Mass (g)	Standing Dead Matter (Forbs) (g)
8 <sup>a</sup>	188.8 <sup>a</sup>	18.5 <sup>a</sup>	NA
8 <sup>b</sup>	181.9 <sup>b</sup>	17.3 <sup>b</sup>	NA
8 <sup>c</sup>	182.3 <sup>c</sup>	17.3 <sup>c</sup>	NA
21	253.0	49.2	NA
24	135.4	27.0	NA
36	223.0	45.3	NA
39	143.5	192.1	NA
40	232.5	274.1	NA
42	48.7	10.3	NA
48 <sup>a</sup>	188.6 <sup>a</sup>	643.1 <sup>a</sup>	NA
48 <sup>b</sup>	176.1 <sup>b</sup>	405.5 <sup>b</sup>	NA
48 <sup>c</sup>	184.6 <sup>c</sup>	416.0 <sup>c</sup>	NA
61	29.6	39.2	NA
64	46.0	160.7	NA

<sup>a</sup> Pre-oven dry weight.

<sup>b</sup> Oven dried at 49° C for 48 hours.

<sup>c</sup> Post-oven dry weight.

NA = not applicable; not collected.

#### Zone 4

Aboveground biomass for the ten plots surveyed in Zone 4 was measured to be 1819.6 g for grasses and 10,536.2 g for forbs. The majority of the grasses and forbs collected from Zone 4 were air dried over several weeks. Two grid cells (39 and 73) were selected for oven drying of grasses and forbs. The plant material was weighed prior to oven drying, and weighed again after a minimum of 48 hours in the oven. Oven temperature was set at 49° C. Table II presents the results for Zone 4. Material which was oven dried was also weighed again several weeks later, as done for MDA J material. Results, also presented in Table II, indicate that more weight gain will occur post oven drying relative to how much plant material was collected for that cell.

Table II. Aboveground Biomass within Zone 4 at TA-54

Grid Cell #	Grass Dry Mass (g)	Forbs Dry Mass (g)	Standing Dead Matter (Forbs) (g)
29	770.3	169.2	NA
39 <sup>a</sup>	267.6 <sup>a</sup>	578.1 <sup>a</sup>	NA
39 <sup>b</sup>	249.5 <sup>b</sup>	476.1 <sup>b</sup>	NA
39 <sup>c</sup>	261.7 <sup>c</sup>	496.8 <sup>c</sup>	NA
66	112.5	1997.5	31.6
69	193.6	1256.2	35.1
73 <sup>a</sup>	101.8 <sup>a</sup>	537.2 <sup>a</sup>	58.5 <sup>a</sup>
73 <sup>b</sup>	91.9 <sup>b</sup>	504.5 <sup>b</sup>	51.5 <sup>b</sup>
73 <sup>c</sup>	97.7 <sup>c</sup>	522.9 <sup>c</sup>	55.9 <sup>c</sup>
77	134.5	1598.7	NA
88	22.4	1209.1	NA
94	213.8	1064.2	NA
97	26.8	1310.5	NA
100	5.3	950.2	70.2

<sup>a</sup> Pre-oven dry weight.

<sup>b</sup> Oven dried at 49° C for 48 hours.

<sup>c</sup> Post-oven dry weight.

NA = not applicable; not collected.

## SUMMARY AND FURTHER RECOMMENDATIONS

Collection of aboveground grasses and forbs at TA-54 resulted in dry-weight biomass data for two of the four growth forms of interest for the MDA G PA and CA. Shrubs were not encountered in any of the grid cells selected for sampling. Trees were not encountered within MDA J. Mature trees (Juniper) were located in five grid cell locations at Zone 4. Dead and down trees (Piñon) were located in two of the grid cells at Zone 4.

The grid size at MDA J was reduced to 15.2 m by 15.2 m (50 ft by 50 ft) because of the anticipated mass to be collected. MDA J has achieved a relatively uniform grass and forbs coverage, and due to time constraints the size was reduced by half.

Material that was originally oven dried was weighed again after several weeks. Data from post oven drying reports weight gain, indicating a higher error associated with air versus oven drying methodology. The drying methods will be explored in greater depth with future studies. Future surveys will include measurement of aboveground biomass of shrubs and trees, measurement of litter production rates; root mass with depth for grasses, forbs, shrubs, and trees; and frequency and coverage surveys to determine the percent coverage of each growth form. The collection of this additional data will provide further site-specific information regarding the growth of grasses, forbs, shrubs, and trees within the expected successional growth stages expected at MDA G. These data will be incorporated into the biotic intrusion modeling for the MDA G PA and CA.

## **REFERENCES**

1. LANL (Los Alamos National Laboratory), "Performance Assessment and Composite Analysis for Los Alamos National Laboratory Material Disposal Area G, Revision 3", Los Alamos National Laboratory (2005).
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3. LANL (Los Alamos National Laboratory), "TA-54 Area J Closure Certification Report", Los Alamos National Laboratory Document LA-UR-02-6548 (2002).