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LEGACY COMPLIANCE FINAL REPORT:

RESULTS OF THE NAVY/ENCAPCO

SOIL STABILIZATION STUDY AT THE NEVADA TEST SITE

NYE COUNTY, NEVADA

Prepared for

National Nuclear Security Administration

Prepared by

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EXECUTIVE SUMMARY

Historic atmospheric testing of nuclear devices at the Nevada Test Site (NTS) has resulted in large areas of plutonium-contaminated surface soils. The potential transport of these contaminated soils to onsite and offsite receptors is a concern to the land steward and local stakeholders. The primary transport pathways of interest at the NTS are sediment entrained in surface water runoff and windblown dust.

This project was initially funded by the U.S. Navy and subsequently funded by the U.S. Department of Energy Stockpile Stewardship Program. Field tests were conducted over a 20.5 month period to evaluate the efficacy of an organic-based, surface applied emulsion to reduce sediment transport from plutonium-contaminated soils. The patented emulsion was provided by Encapco Technologies LLC. Field tests were conducted within the SMOKY radioactive contamination area (CA). The SMOKY above ground nuclear test was conducted on August 31, 1957, with a reported yield of 44 kilotons and was located at N 37° 10.5' latitude and W 116° 04.5' longitude. Three "safety tests" were also conducted within approximately 1,500 meters (5,000 feet) of the SMOKY ground zero in 1958. Safety tests are designed to test the response of a nuclear device to an unplanned external force (e.g., nearby detonation of conventional explosives). These three safety tests (CERES, OBERON, and TITANIA) resulted in dispersal of plutonium over a wide area (Bechtel Nevada, 2002).

Ten 3 x 4.6 meter test plots were constructed within the SMOKY CA to conduct rainfall-runoff simulations. Six of the ten test plots were treated with the emulsion at the manufacturer recommended loading of 1.08 gallons per square meter, and four plots were held untreated as experimental controls. Separate areas were also treated to assess impacts to native vegetation and surface infiltration rate.

Field tests were conducted at approximately 6, 13, and 20.5 months post emulsion treatment. Field tests consisted of rainfall-runoff simulations and double ring infiltrometer measurements. Plant vigor assessments were conducted during peak production time, approximately seven months post treatment.

Rainfall was simulated at the approximate 5 minute intensity of a 50-year storm (5.1 inches per hour) for durations of four to five minutes. All runoff generated from each test plot was collected noting the time for each liter of volume. Five gallon carboys containing the runoff water and sediment were shipped to Clemson Environmental Technologies Laboratory for analysis. The samples were separated into liquid and solid fractions. Liquid and solid fractions were weighed and analyzed for Americium-241 (Am-241) by gamma spectrometry. Quality control measures used at the laboratory indicate the analytical data are accurate and reproducible.

A weather station was deployed to the field site to take basic meteorological measurements including air temperature, incoming solar radiation, wind speed, wind direction, barometric pressure, relative humidity, precipitation, and volumetric soil moisture content. Meteorological monitoring data indicate the climate over the test period was hot and dry with 41 days having measurable precipitation. The total precipitation for the study period was 12.5 centimeters, 37% of the long-term average. For the 20.5 month test period, 64 freeze-thaw cycles occurred.

Vegetation assessments indicate the emulsion treatment did not negatively impact existing vegetation. The three rounds of double ring infiltration tests on treated surfaces indicate the infiltration rate was relatively constant over time and not significantly different from measurements taken on untreated surfaces.

Significant differences were observed in the amount of runoff and sediment collected from treated and untreated plots for the first two but not the third round of rainfall-runoff simulations, indicating significant emulsion degradation after 20.5 months of exposure. Treated plots had higher total runoff volumes and sediment loads as compared to untreated plots for the first two rounds of simulations. These data indicate the treatment caused the treated surfaces to repel more of the simulated rainfall than the untreated plots but did not increase the cohesion between soil particles to resist soil particle detachment and transport with the runoff water. Am-241 concentration in collected sediments varied as a function of proximity to the safety test locations, not as a function of surface treatment.

The results from field testing the Encapco emulsion indicate it is not a viable long-term option for the stabilization of radionuclide impacted surface soils at the Nevada Test Site in its current formulation. Dust suppression studies conducted by Etyemezian et al. (2006) at an uncontaminated location near the SMOKY site indicate the emulsion significantly reduced dust emissions for at least four months post application, indicating the emulsion may be useful for short-term applications.

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ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
Am-241	Americium-241
CA	contamination area
cm	centimeter
cm/hr	centimeter(s) per hour
DOE	U. S. Department of Energy
ft	foot
g	gram
gal	gallon
in.	inch
in./hr	inch(es) per hour
km	kilometer
L	liter
L/min	liter(s) per minute
m/s	meter(s) per second
m	meter
mi	mile
min	minute
mm	millimeter
mph	mile(s) per hour
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NTS	Nevada Test Site
pCi/g	picocurie(s) per gram
PPE	personal protective equipment
psi	pounds per square inch
RCT	radiological control technician
RWP	radioactive work permit
TDR	time-domain reflectometer
yd	yard

1 Introduction

Historic atmospheric testing of nuclear devices at the Nevada Test Site (NTS) has resulted in large areas of plutonium-contaminated surface soils. The potential transport of these contaminated soils to onsite and offsite receptors is a concern to the land steward and local stakeholders. The primary transport pathways of interest at the NTS are sediment entrained in surface water runoff and windblown dust. The U.S. Department of Energy (DOE) has funded multiple studies to evaluate techniques to reduce the volume of these contaminated soils (e.g., Papelis et al., 1996). Typical techniques involve soil excavation and subsequent physical and chemical separation of plutonium from the soil. These techniques are costly and have had varying degrees of success. An alternative to the excavate-and-treat approach is in situ stabilization. In situ stabilization of contaminants can provide a cost-effective alternative to excavation for some contaminated sites. This project, initially funded by the U.S. Navy and subsequently funded by the DOE Stockpile Stewardship Program, evaluates the efficacy of a patented surface applied emulsion to reduce sediment transport via surface water runoff from plutonium-contaminated soils over a 20.5-month period.

This report summarizes the field tests conducted within the SMOKY radioactive contamination area (CA). The SMOKY above ground nuclear test was conducted on August 31, 1957, with a reported yield of 44 kilotons and was located at N 37° 10.5' latitude and W 116° 04.5' longitude (U.S. Department of Energy, Nevada Operations Office, 2000). Three "safety tests" were conducted within approximately 1,500 meters (m) (5,000 feet [ft]) of the SMOKY ground zero in 1958. Safety tests are designed to test the response of a nuclear device to an unplanned external force (e.g., nearby detonation of conventional explosives). These three safety tests (CERES, OBERON, and TITANIA) resulted in the dispersal of plutonium over a wide area (Bechtel Nevada, 2002).

The field site is located on a sandy, gravelly alluvial fan near the north end of Yucca Flat. The Smoky Hills, about 1 kilometer (km) (0.62 mile [mi]) north of the site, expose bedded limestone and dolomite of the Cambrian Windfall Formation and the Ordovician Goodwin Limestone (Barnes et al., 1963). The alluvium at the site is about 90 m (300 ft) thick, based on extrapolation between thicknesses of alluvium in borehole U10b-6, approximately 366 m (1,200 ft) to the north and borehole U10b, approximately 549 m (1,800 ft) to the south (Fernald et al., 1968). The alluvium of the fan is composed primarily of argillite, conglomerate, and quartzite clasts derived from the Mississippian to Pennsylvanian Eleana Formation exposed in Quartzite Ridge to the northwest (Barnes et al., 1963) with lesser amounts of volcanic clasts. Drainage from the site is toward the southeast. The predominant fan surface within the testing area is mapped as S4. Near the western and southern edges of the testing area, an S5a surface fills a broad channel inset slightly into the S4 surface (Bechtel Nevada, 2002). S4 surfaces in the area are smooth (no bar and swale) with moderately well developed desert pavement and weakly developed desert varnish, and are thought to be of Late Pleistocene age (10,000 to 128,000 years). S5a surfaces are also smooth with only a very incipient desert pavement (a gravel lag) and no desert varnish. S5a surfaces are thought to be of Middle Holocene to Late Pleistocene age (3,000 to 10,000 years) (Snyder et al., 1995).

2 Methods

2.1 Site Selection

The SMOKY site is located within Area 8 of the Nevada Test Site (NTS), which is located 105 km (65 mi) northwest of Las Vegas (see Figure 2-1) The NTS is a DOE facility approximately 3,500 km^2 (1,375 mi^2) in area, which was used as the continental proving ground for nuclear weapons testing from 1951 to 1992. Current NTS activities include hazardous chemical spill testing, emergency response training, waste management, and nuclear stockpile stewardship.

The SMOKY site (see Figure 2-2) was selected to conduct field testing of the soil stabilizing emulsion from among several other candidate sites based on the following characteristics:

- The site had been characterized previously, and had known elevated concentrations of plutonium in the surface soils
- The plutonium concentrations are relatively homogenous
- The soil surface is relatively active to ensure the potential for surface erosion during the rainfall-runoff tests
- There is sufficient surface slope to promote water runoff
- The site is accessible
- The site has minimal desert pavement and minimal plant cover

Once the site was selected, several activities were conducted prior to the start of field testing.

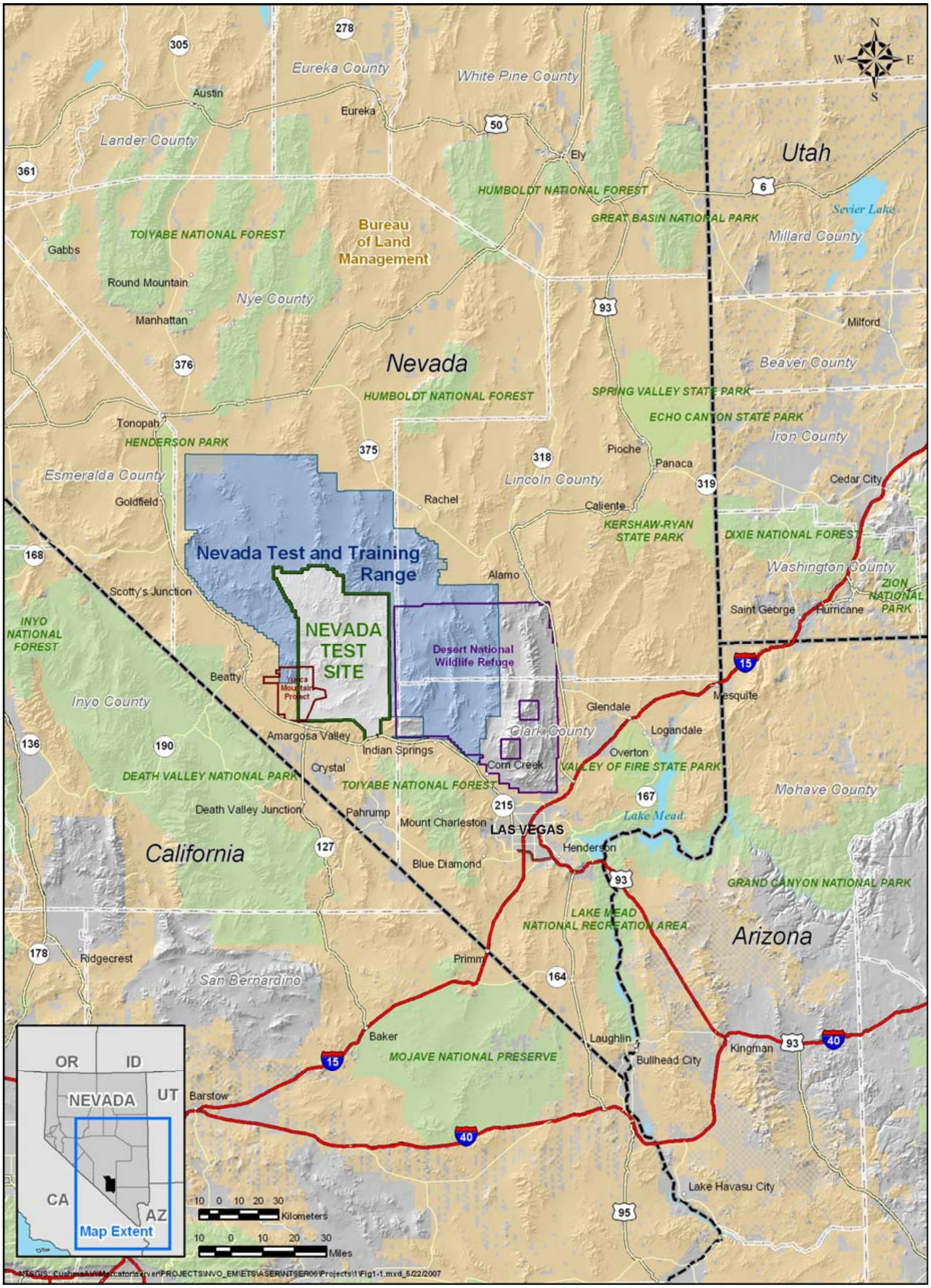

Figure 2-1. Location of the Nevada Test Site

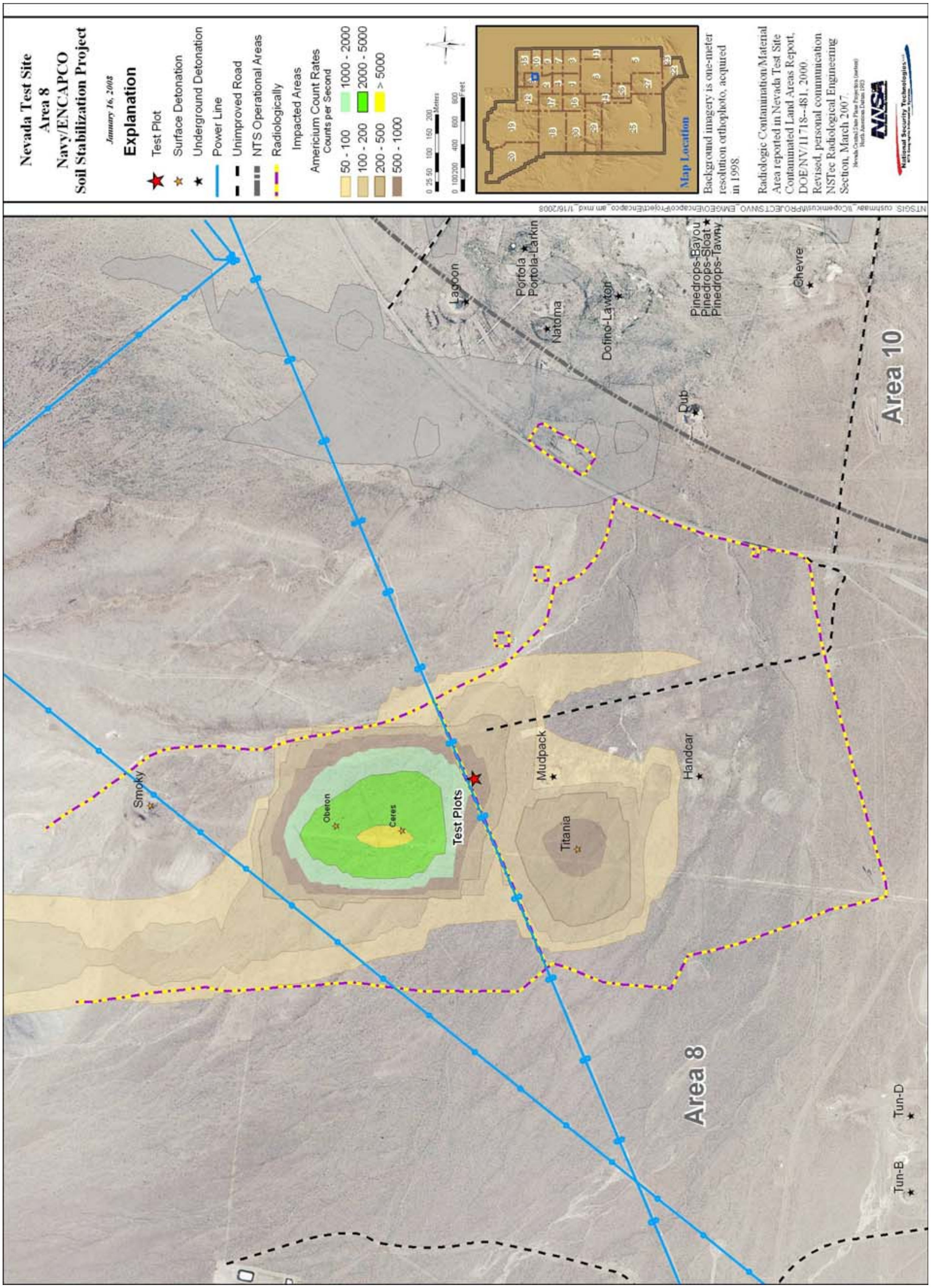

Figure 2-2. Location of the SMOKY Site within the NTS

2.2 Causeway Construction

To gain access to the SMOKY Site and provide an uncontaminated staging location to access the testing areas, a clean causeway was constructed. After construction, the causeway was fenced and surveyed to ensure the area was clean. Figures 2-3 and 2-4 show the causeway before and after construction, respectively.

2.3 Preliminary Emulsion Evaluation

The Encapco Technologies LLC Tall Oil Pitch emulsion used in the field experiments has been laboratory tested and is a non-hazardous material. To design the optimal emulsion formulation for field application at the SMOKY site, laboratory emulsion penetration tests were conducted in 2003. Soil from an uncontaminated area adjacent to the SMOKY site was packed into columns and pre-wetted. Various dilutions of the emulsion were applied to the soil column surfaces with a spray bottle. Observations of the soil columns after drying indicate the emulsion did not penetrate deeply into the soil as desired (Figure 2-5) (Bechtel Nevada, 2006). The laboratory results prompted a field test of the emulsion penetration.

Eight field penetration tests were conducted at an uncontaminated area adjacent to the SMOKY site. The tests were conducted by driving a metal ring into the soil surface and ponding different emulsion dilutions inside the rings. The test areas were excavated 24 hours later to evaluate the emulsion penetration and soil particle cohesion (see Figure 2-6). The results were compiled and discussed with the emulsion manufacturer (Encapco Technologies LLC). After discussion, a 4:1 mix (four parts water to one part emulsion) was selected for field application at the SMOKY site test area.

Figure 2-3. Causeway Location Prior to Construction

Figure 2-4. Causeway after Construction

Figure 2-5. Laboratory Emulsion Penetration Test

Figure 2-6. Field Emulsion Penetration Test

2.4 Working in the SMOKY Contaminated Area

All work in the SMOKY CA was performed under a radioactive work permit (RWP) developed by a health physicist assigned to the project. The RWP delineated the levels of contamination at the work location and specified the required work controls and personal protective equipment (PPE). Access to the site was controlled by radiological control technicians (RCTs). Personnel entering the CA were required to have radiation worker training, wear a dosimeter and PPE including anti-contamination suits, rubber boots, and rubber gloves (see Figure 2-7). RCTs were present during all operations conducted inside the CA to ensure the scope of work authorized by the RWP was not exceeded and to survey personnel as they exited the CA. CAs at the NTS are typically delineated with three-strand yellow wire fence with contamination area signs approximately every 300 m (1,000 ft).

PPE and equipment that could not be decontaminated was containerized in steel drums (a total of 13), characterized, and shipped to the Area 5 Radioactive Waste Management Site located on the NTS for disposal.

Figure 2-7. Personnel Donning PPE Prior to Entering CA

2.5 Test Plot Installation

Ten rainfall-runoff test plots each 3 x 4.6 m (10 x 15 ft) were installed at the SMOKY site. Plots were located in areas with minimal vegetation to minimize differences between test plot surfaces. Prior to each test any standing vegetation was either pulled up or clip to ground level. Plot borders were constructed by driving 1.5 m (5 ft) long metal strips (7.5 centimeter [cm] [3 inches (in.)] wide, 0.6 cm [0.25 in.] thick) into the soil surface. A fabricated sheet-metal collection plate was installed at the end of each plot to funnel runoff water into the collection container. The interface between the soil test plot and collection plate was sealed using silicon caulk (see Figure 2-8). A cover was placed over the collection plate to ensure that only runoff from the test plot surfaces (not the collection plate) was collected. A schematic of the test plot design is shown as Figure 2-9.

The soil surface (~top 2.5 cm [1 in.]) of the five plots on the south side of the causeway were raked simulate a disturbed area. The five plots on the north side of the causeway were undisturbed (Table 2-1). The ten test plots were surveyed to compute surface slopes. Figure 2-10 shows the locations of the test plots at the SMOKY site.

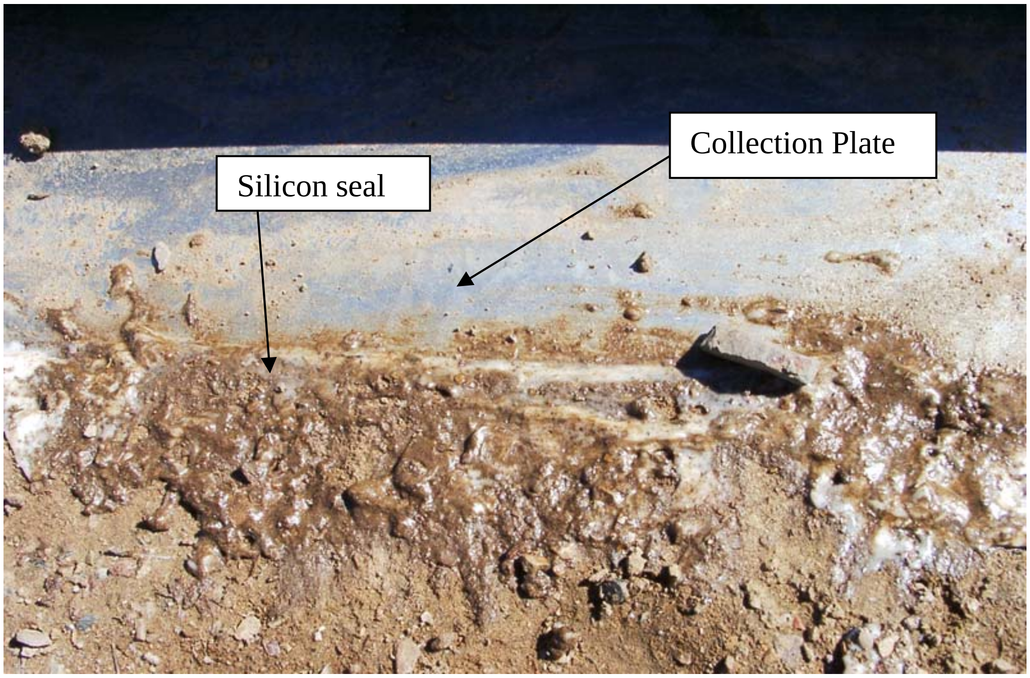

Figure 2-8. Test Plot Collection Plate Interface

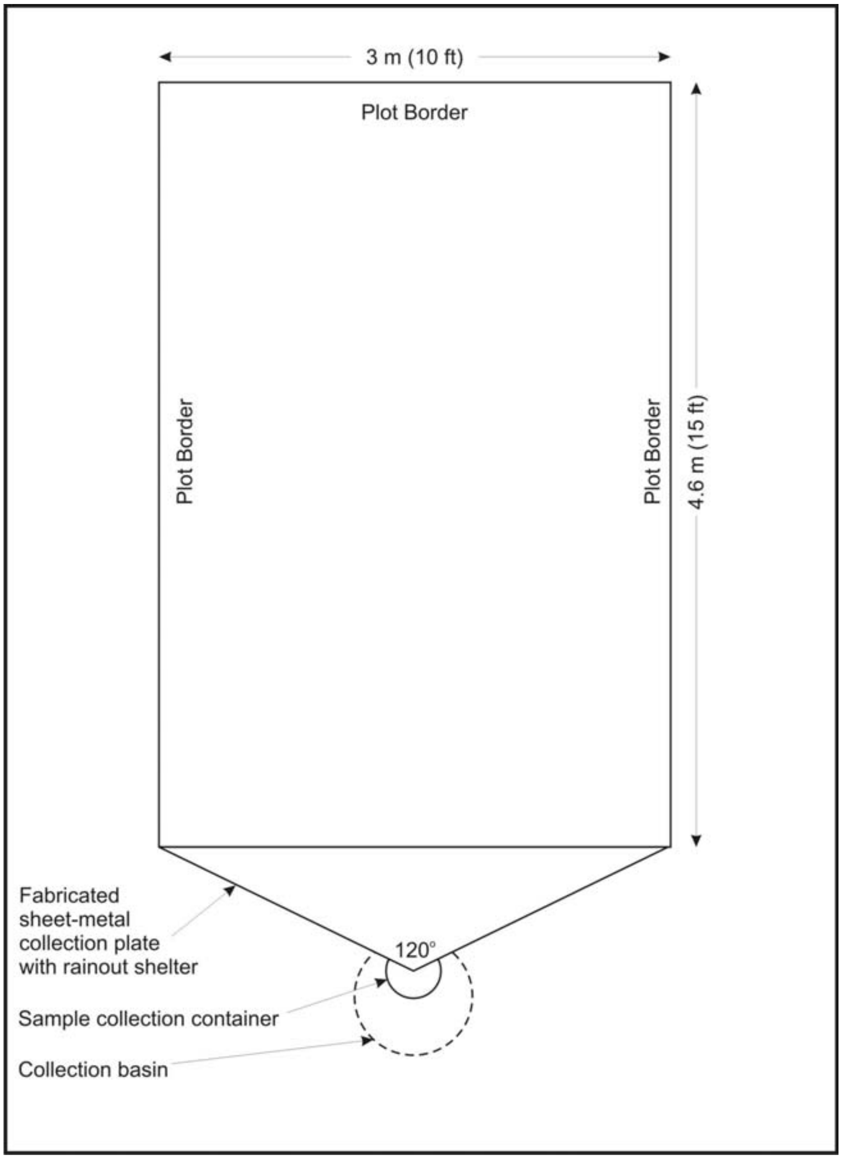

Figure 2-9. Schematic of Rainfall-Runoff Test Plots

Table 2-1. Test Plot Summary Data

Plot	Treated/Untreated	Disturbed/Undisturbed	Slope (%)
1 (T)	treated	undisturbed	5.4
3 (T)	treated	undisturbed	5.4
5 (T)	treated	undisturbed	8.6
7 (T)	treated	disturbed	5.1
9 (T)	treated	disturbed	4.1
10 (T)	treated	disturbed	4.5
2 (U)	untreated	undisturbed	2.9
4 (U)	untreated	undisturbed	4.9
6 (U)	untreated	disturbed	4.0
8 (U)	untreated	disturbed	2.5

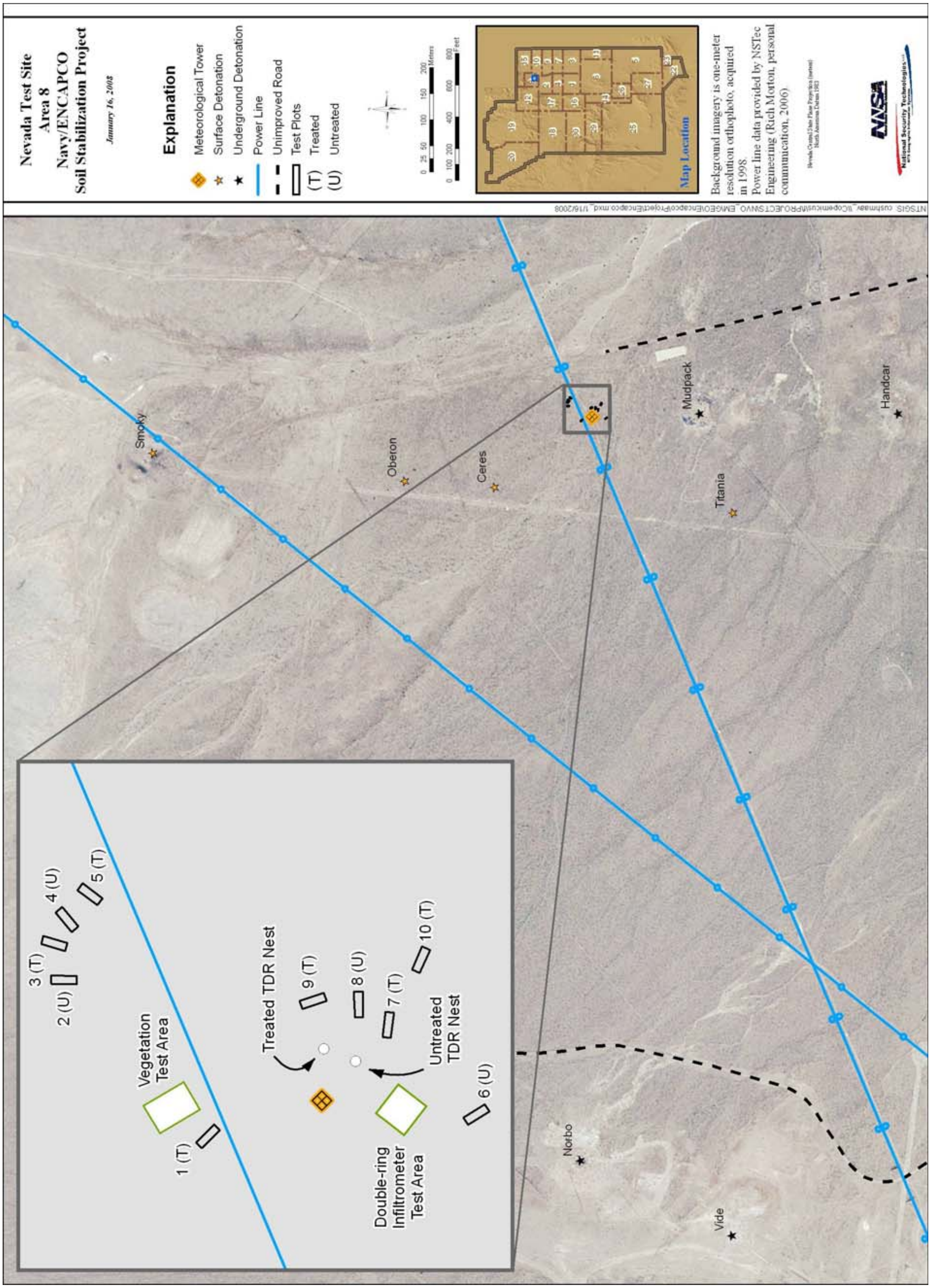

Figure 2-10. Location of Test Plots within the SMOKY Site

2.6 Emulsion Application

Six of the ten rainfall-runoff test plots were treated with the Encapco emulsion on September 28, 2005. Four plots were untreated to serve as experimental controls (see Table 2-1). Two additional areas were also treated to assess the impact of the emulsion on infiltration and vegetation. The emulsion was delivered to the site at a 4:1 dilution ratio and transferred to a trailer-mounted 500 gallon tank. The trailer was equipped with a 4 horsepower pump and manifold system (Figure 2-11) to apply the emulsion to the test plot surfaces.

Prior to the emulsion application, the test plots were pre-wetted with water to improve penetration of the emulsion into the soil. Plots to receive the emulsion treatment were sprayed with the 4:1 emulsion (see Figure 2-12) at an application rate of 1.08 gallons per square meter (gal/m^2) (0.9 gallons per square yard [gal/yd^2]). The flow rate of the spray system was previously determined to allow the loading rate to be measured by spray time. The emulsion was applied with a sweeping motion to ensure an even application over the soil surface.

Once the 4:1 dilution application was complete, a "fog seal" was applied to the treated surfaces. The "fog seal" consisted of an 8:1 diluted emulsion applied at a rate of 0.12 gal/m^2 (0.1 gal/yd^2). The treatment process gave the surfaces a dark brown appearance with a slight sheen (see Figure 2-13).

Figure 2-11. Trailer Mounted Tank with Pump and Manifold

Figure 2-12. Application of the Encapco Emulsion to Test Plot

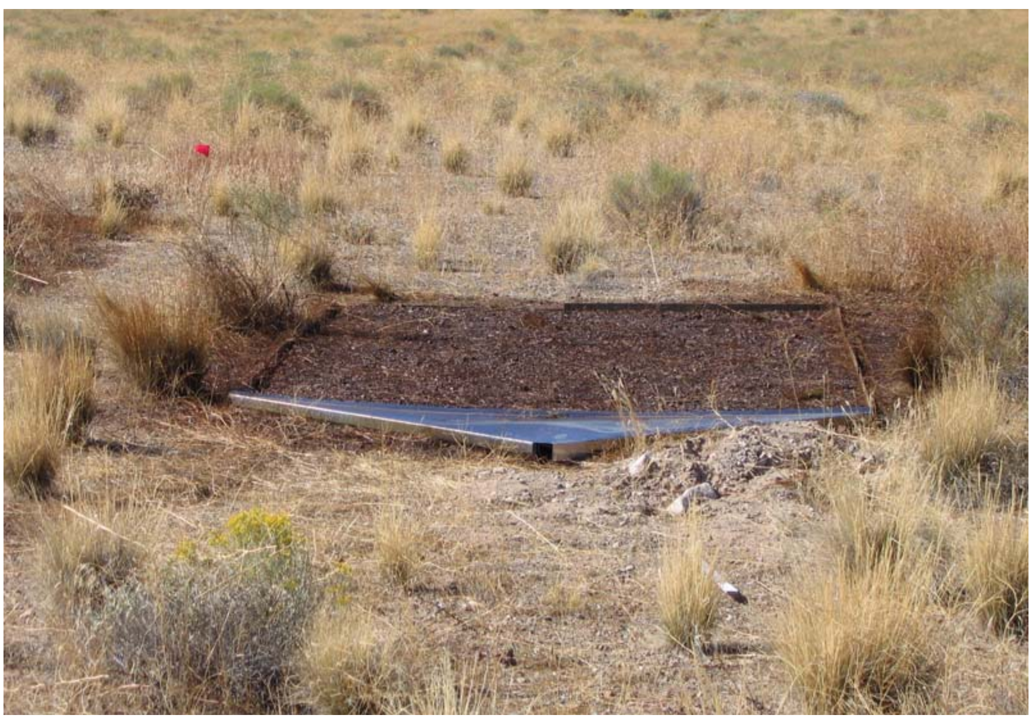

Figure 2-13. Appearance of Treated Test Plot

2.7 Meteorology and Soil Moisture Data

Basic meteorological data were collected at the field site using a 2-m tower located on the uncontaminated causeway. Measurements taken and sensors deployed are presented in Table 2-2. Data were stored on Campbell Scientific 23X datalogger equipped with a cellular modem to remotely download data for processing and analysis. The datalogger was powered by a 12-volt marine battery (battery is charged using a 20-watt solar panel). Meteorological data were collected every 10 seconds and compiled into hourly and daily output as listed below.

Two nests of time-domain reflectometers (TDRs) were installed to measure volumetric soil-water content. The TDR probes were installed at depths of 8, 15, 30, and 61 cm (3, 6, 12, and 24 in.). The soil surface of one of the TDR nests was treated with the Encapco emulsion while the other nest was untreated and was held as an experimental control. Soil volumetric water content data were collected once a day.

Table 2-2. Meteorological Sensors

Measurement	Sensor
Soil volumetric water content	Campbell Scientific CS610
Wind speed/direction	Met One 034B
Precipitation	Texas Electronics TE525MM
Solar radiation	Licor LI200X
Air temperature/relative humidity	Vaisala HMP45C
Barometric pressure	Vaisala CS105

Daily Meteorology Data

- Average air temperature
- Maximum air temperature
- Minimum air temperature
- Average relative humidity
- Maximum relative humidity
- Minimum relative humidity
- Average wind speed
- Maximum wind speed
- Average barometric pressure
- Maximum barometric pressure
- Minimum barometric pressure
- Total precipitation
- Volumetric water content with depth

Hourly Meteorology Data

- Average air temperature
- Average relative humidity
- Average wind speed
- Average wind direction
- Average barometric pressure
- Average solar radiation
- Total precipitation (5 minute data were also collected)

2.8 Vegetation Evaluation

To assess the impact of emulsion application on native vegetation at the SMOKY site, evaluations of plant vigor were made. Vigor was estimated using a 0–5 vigor classification with 0 being dead and 5 indicating excellent growth. Plants within the study area (~5 x 10 m [16.4 x 33 ft]) were essentially dormant or at a period of low productivity when the emulsion was applied; however, there did not appear to be any dead plants as would be indicated by brittle, dry stems. Plant vigor assessments were made during the first growing season after the emulsion was applied.

2.9 Infiltration Measurements

Double ring infiltration measurements were conducted at 6, 12.5, and 20.5 months after the emulsion was applied. Measurements were conducted on treated and untreated surfaces. The measurement procedure consists of driving two concentric rings of diameter 0.6 m (2 ft) and 0.3 m (1 ft) into the soil surface approximately 5–10 cm (2–4 in.). Water is then ponded inside the rings. The water level inside the rings is kept constant with float valves placed inside each ring. The amount of infiltrating water is measured with volumetric water supply tubes. Water supply tube measurements were taken approximately every 10 minutes. Measurements were taken for 2–3 hours with steady state typically achieved within 60 minutes. The infiltration rate is calculated using the change in volume of water in the supply tube per unit of time per unit infiltration area. Figure 2-14 shows the double-ring infiltrometer apparatus being installed at the SMOKY CA.

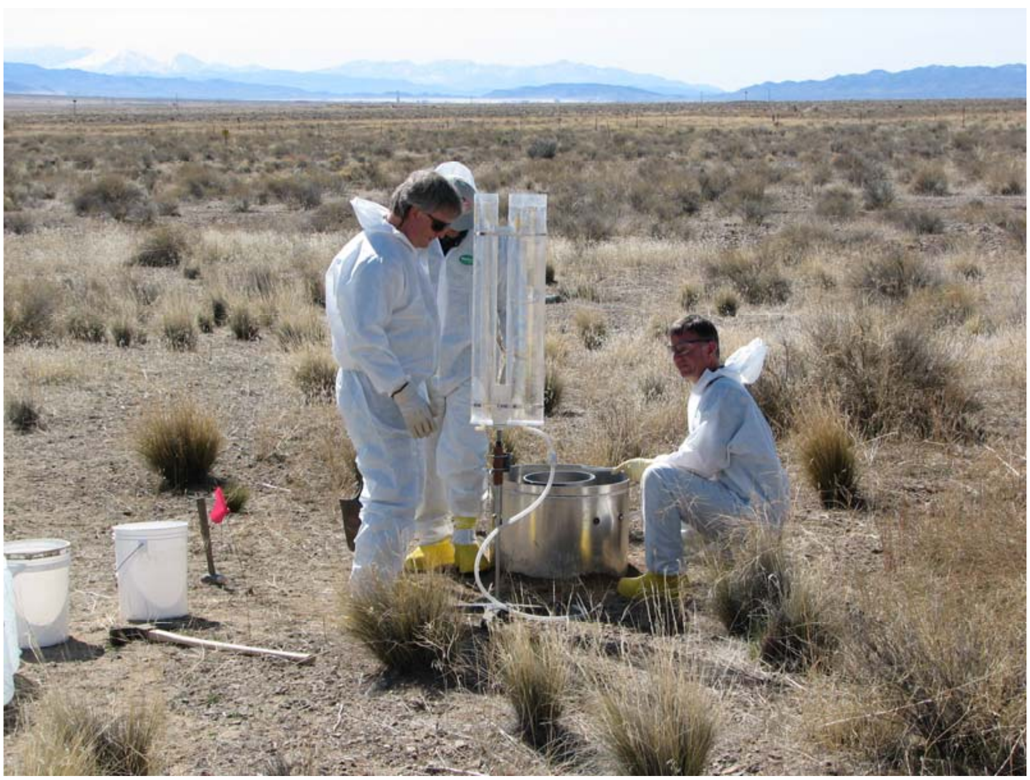

Figure 2-14. Installation of Double-Ring Infiltrometer inside CA

2.10 Rainfall Simulations

Rainfall-runoff experiments were conducted using a pressurized, portable rainfall simulation system. A trailer-mounted 500 gal tank equipped with a 4 horsepower pump and manifold system (see Figure 2-11) supplied water to the rainfall simulation towers. A low-angle #18 Senninger Wobbler® sprinkler nozzle is mounted onto each fiberglass rainfall simulation tower 0.9 m (2.9 ft) above the ground surface. The towers include 10 psi [pounds per square inch] pressure reducers to ensure uniform flow from each sprinkler nozzle. A 5,000 gal water truck supplied potable water to the 500 gal tank at the project site. Eight rainfall simulation towers were operated simultaneously for each rainfall-runoff test. Four towers were placed along each side of the plot at a spacing of 1.5 m (5 ft) (see Figure 2-15).

Several trial runs of the rainfall simulation system were conducted to evaluate the uniformity of the simulated rainfall and determine the required duration to generate runoff. The trial runs indicated that the simulated rainfall was highly uniform. The rate was approximately 13 centimeters per hour (cm/hr) (5.1 inches per hour [in./hr]), and a simulation duration of five minutes generated sufficient runoff. The first two actual field tests used a duration of five minutes and produced runoff at a rate that was too fast to be reliably measured. Four minute test durations were used for all subsequent tests.

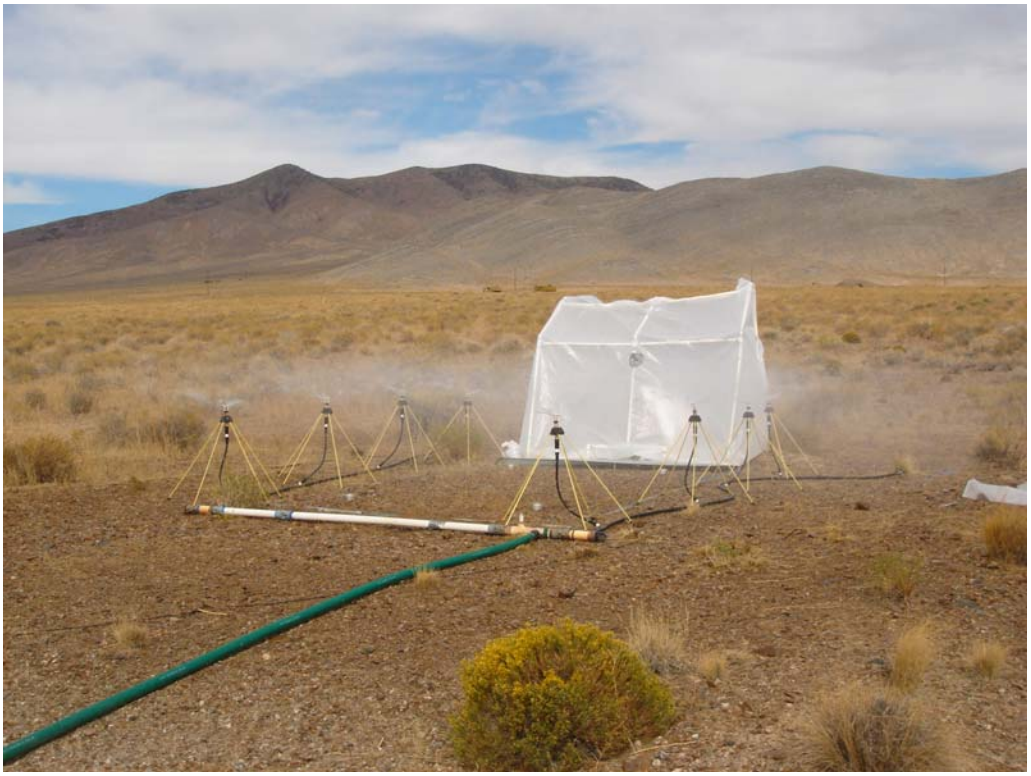

Figure 2-15. Rainfall Simulation System

The simulated rainfall distribution and rate was measured on the final set of irrigation tests using 15 collection tins (10 cm [4 in.] diameter) placed on each test plot on a 0.61 m (2 ft) grid. The four minutes of simulated rainfall produced an average rainfall intensity of 13 cm/hr (5.1 in./hr) on each plot with a standard deviation of 0.46 cm (0.18 in.). The calculated coefficient of uniformity for each test ranged from 0.91 to 0.96 with an average of 0.95, indicating the rainfall simulation system produced a highly uniform distribution. These measurements are consistent with the trial run simulations conducted. The simulated rate is approximately the 50-year, five-minute design storm intensity for the study site (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 2006).

Rainfall simulations were conducted on each of the ten rainfall-runoff test plots one plot at a time. Adjacent plots were covered with plastic to prevent impact from overspray (see Figure 2-16). Rainfall-runoff simulations were conducted at 6, 12.5 and 20.5 months after the emulsion was applied. Tests were conducted when wind speeds would not impact the distribution of the simulated rainfall.

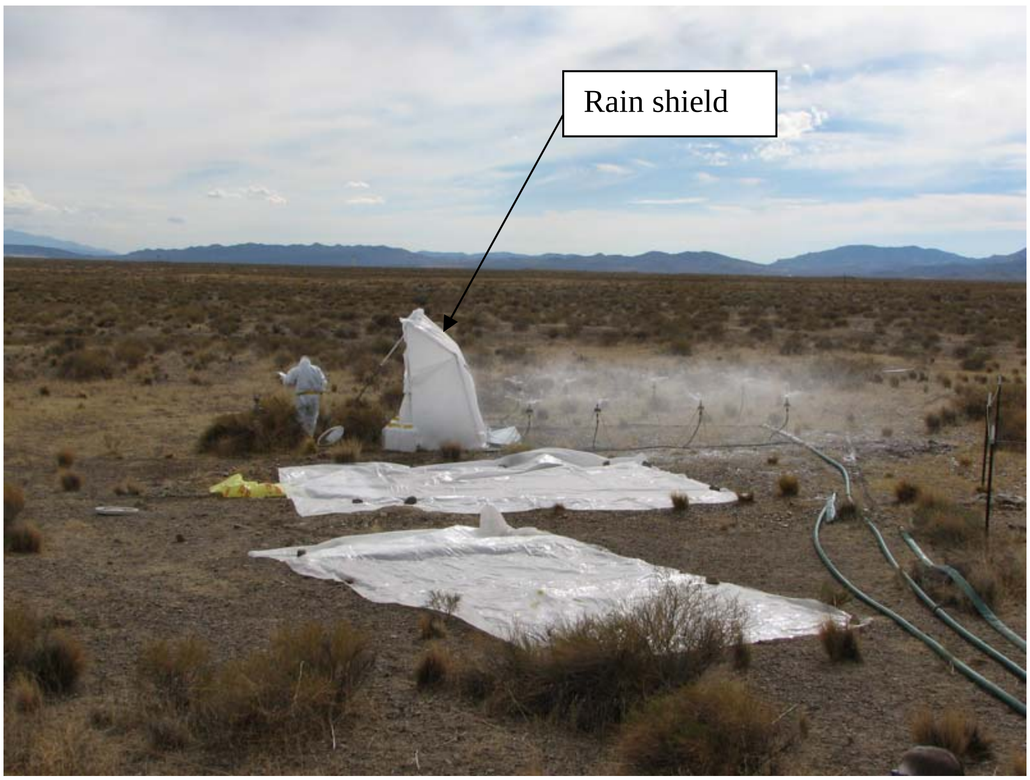

Figure 2-16. Rainfall Simulations in Progress with Adjacent Plots Covered with Plastic

2.11 Collection of Runoff

Runoff from the rainfall simulations was collected using graduated 3 liter (L) (0.8 gal) containers (see Figure 2-17) and transferred into 20 L (5 gal) carboys. The time required to collect each liter of runoff was recorded. A rain shield was used while collecting runoff samples to prevent simulated rainfall from entering the collection container and shield personnel (see Figure 2-16).

Figure 2-17. Collection of Runoff from Test Plot

2.12 Laboratory Analysis of Runoff

Each 20 L (5 gal) carboy was shipped to Clemson Environmental Technologies Laboratory and filtered to separate the liquid and solid fractions using Whatman GF/F 0.7 μm glass fiber filter paper. Filtered solids were dried to a constant weight in a desiccator. The total mass of liquid and solids content for each sample (one for each simulation) was calculated. Some simulations generated more than one carboy of runoff. These carboys were composited to generate a total for the simulation.

Once separated, the liquid and solid fractions were analyzed for Americium-241 (Am-241). Several samples contained less than 20 grams (g) of dried sediment, requiring the addition of clean sand to meet the minimum sample mass required for the analyses. Wet sieve analyses were performed on eight of the ten samples from the first round of testing (two of the samples required the addition of sand). Additional details of laboratory methods are presented in Appendix A.

3 Results

3.1 Soil Characterization

Five soil samples were collected from an uncontaminated location adjacent to the test area. The soil samples were analyzed for grain size using ASTM C-137/C-117. The soil analyses indicate the surface soils are approximately 30% gravel, 30% sand, and 40% silt and clay. Grain size distributions for the five samples are shown in Figure 3-1.

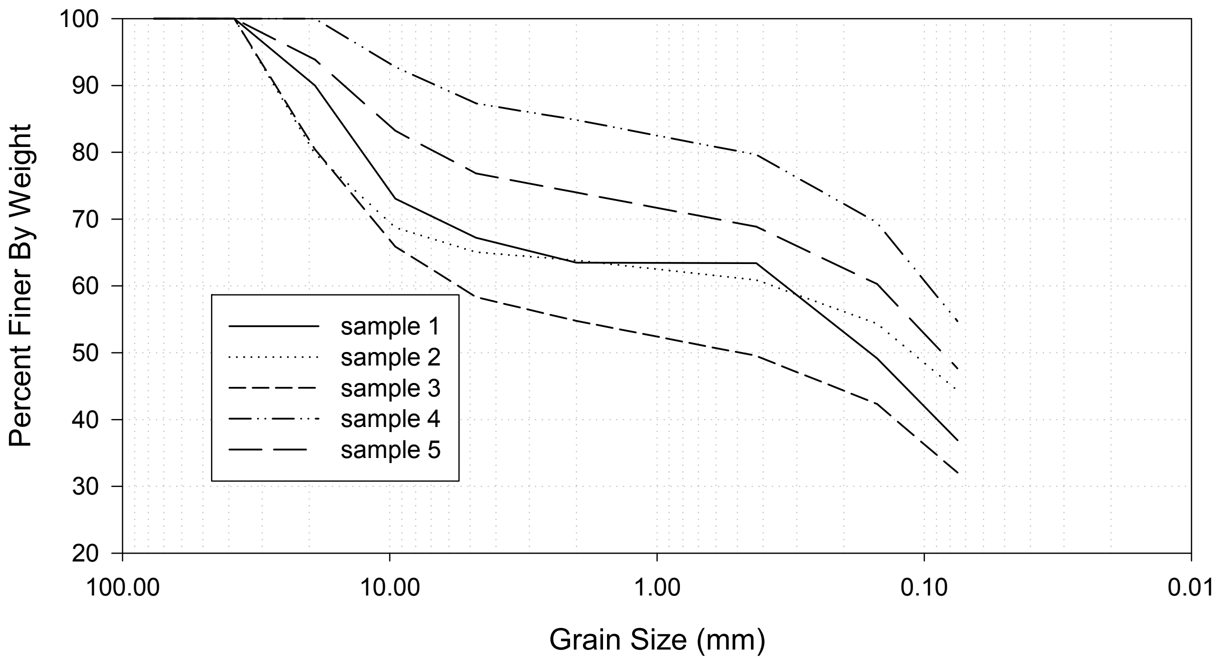

Figure 3-1. Soil Grain Size Distributions

3.2 Meteorology During Test Period

The average, maximum and minimum air temperatures over the test period were 13.2 degrees Celsius (°C) (55.7 degrees Fahrenheit [°F]), 40.5°C (105°F) and -13.2°C (8.3°F), respectively. Figure 3-2 shows the daily maximum, minimum, and average air temperatures for the test period. A power failure in August 2006 resulted in losing 18 days of metrological and soil moisture data. Eleven days during the test period had recorded temperatures above 37.8°C (100°F).

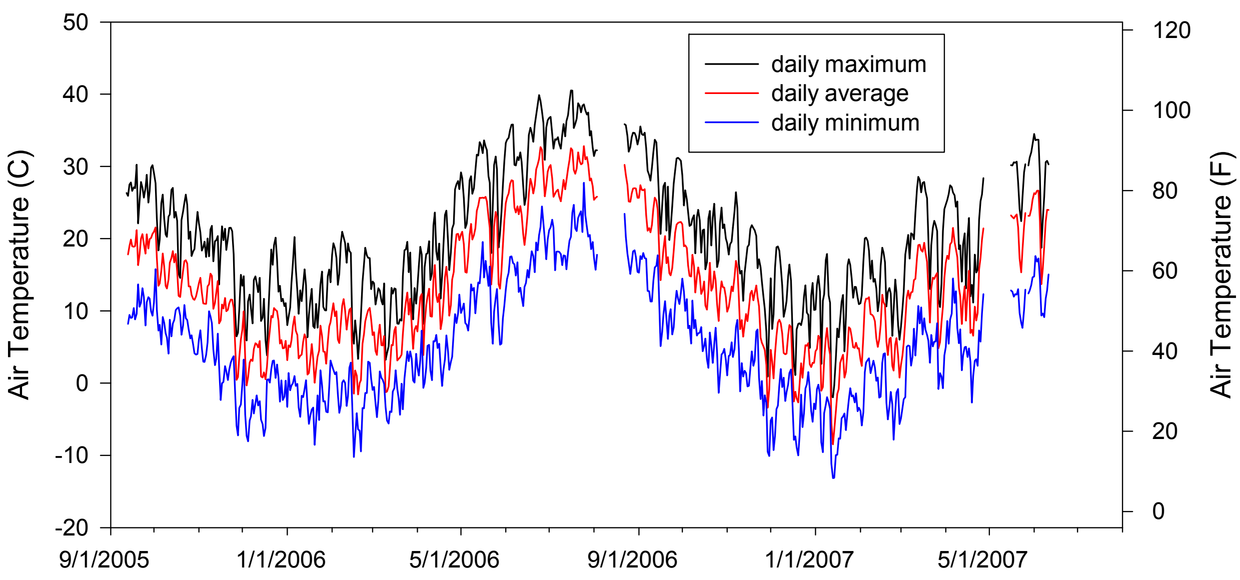

Figure 3-2. Daily Maximum, Minimum, and Average Air Temperatures

Hourly average air temperature data were used to estimate the number of freeze-thaw cycles for the soil surface. Assuming a temperature change from -2°C (28.4°F) to +2°C (35.6°F) constitutes a freeze-thaw cycle, 64 freeze-thaw cycles of the soil surface are estimated for the test period. Figure 3-3 shows the cumulative freeze-thaw cycles with time. Over 93% of the freeze durations were less than 20 hours.

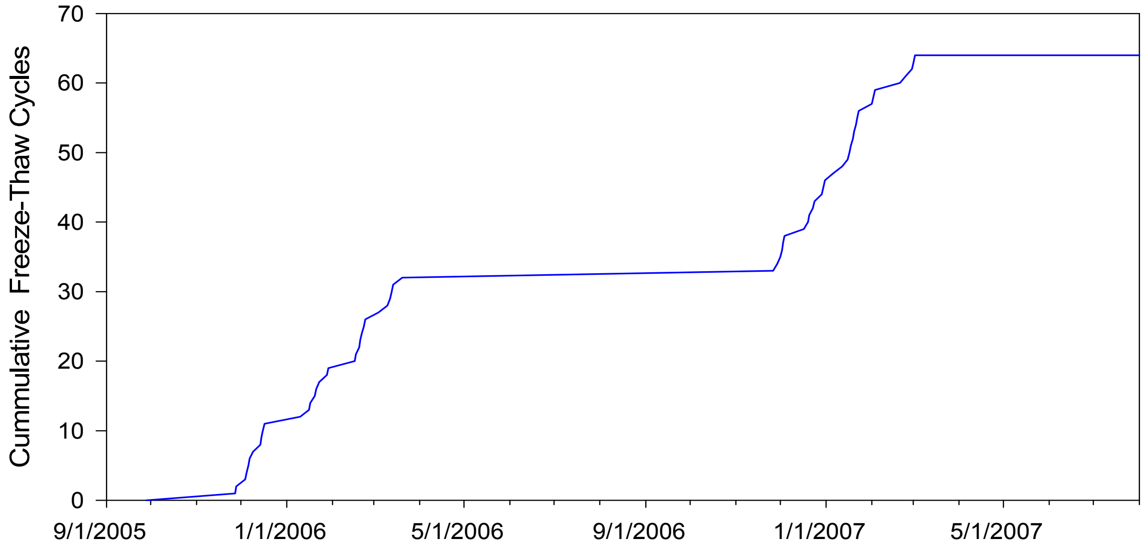

Figure 3-3. Cumulative Freeze-Thaw Cycles for the Test Period

The average relative humidity over the test period was 32.2%. The daily average relative humidity over the test period is shown in Figure 3-4.

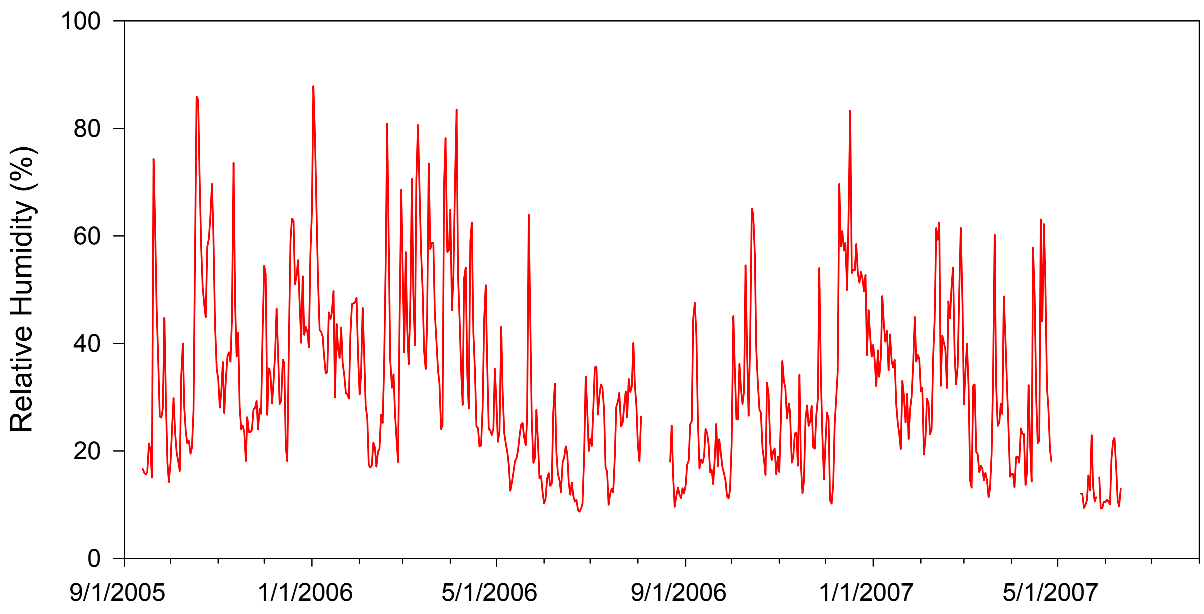

Figure 3-4. Daily Average Relative Humidity

The average and maximum wind speeds over the test period were 2.9 meters per second (m/s) (6.5 miles per hour [mph]) and 26.0 m/s (58.1 mph), respectively. Figure 3-5 shows the daily average and maximum wind speeds for the test period. A histogram of daily average wind speeds is shown in Figure 3-6. A wind rose diagram showing the wind direction and speed distribution is shown in Figure 3-7. Generally winds come from the northwest and the south. Daily average barometric pressure is shown in Figure 3-8.

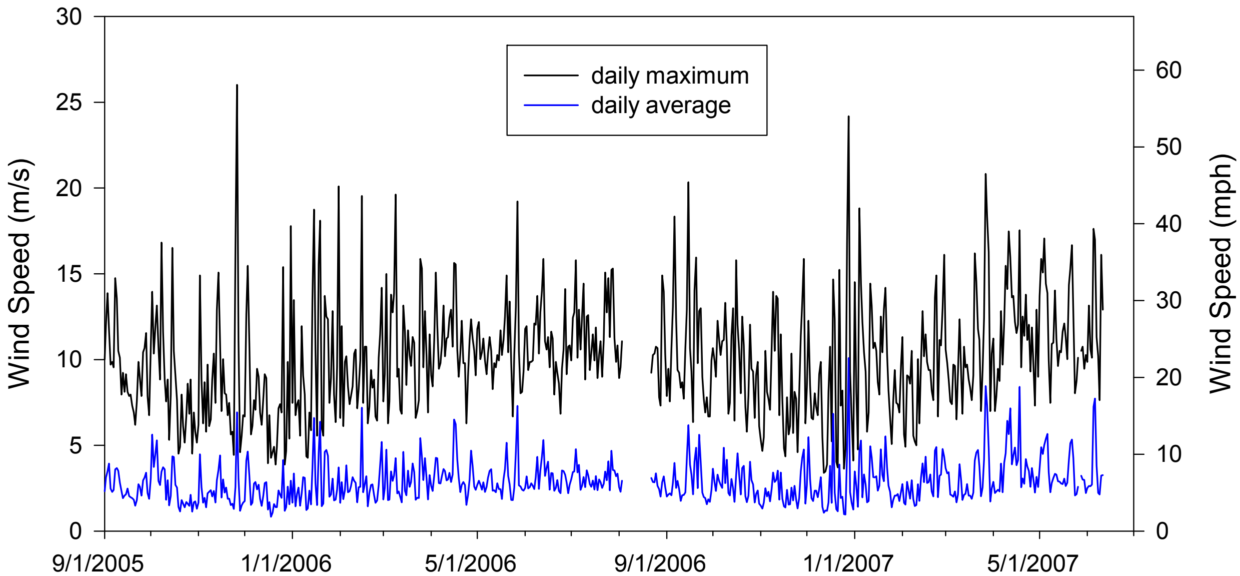

Figure 3-5. Daily Average and Maximum Wind Speeds

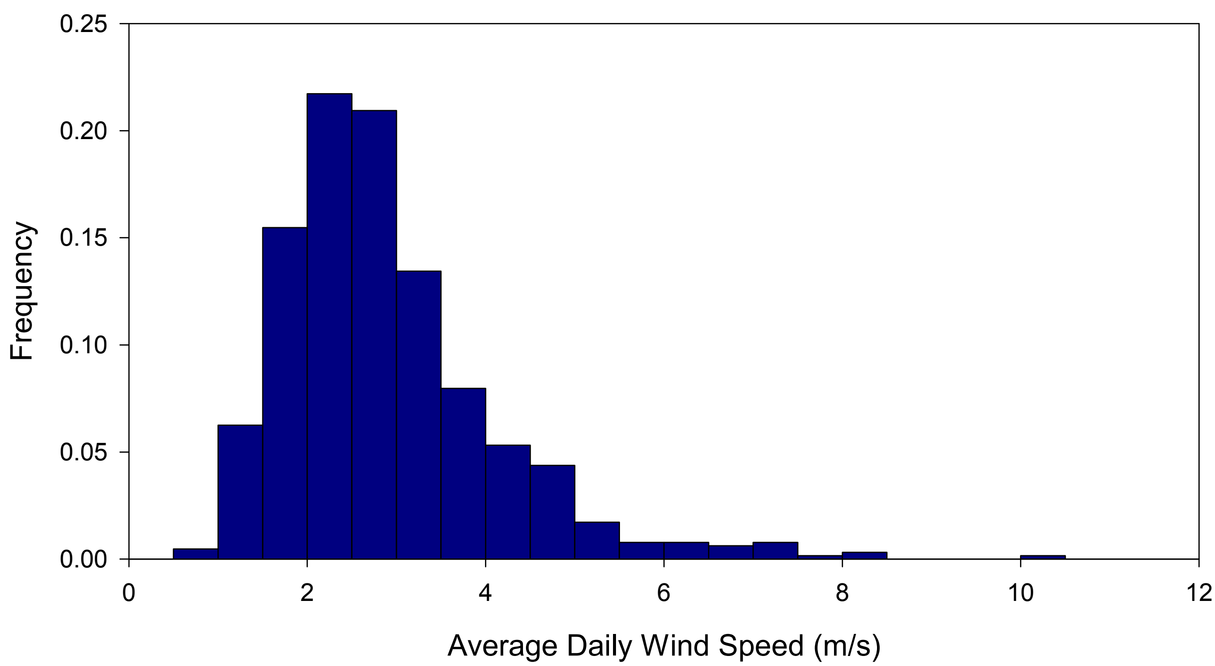

Figure 3-6. Histogram of Daily Average Wind Speed

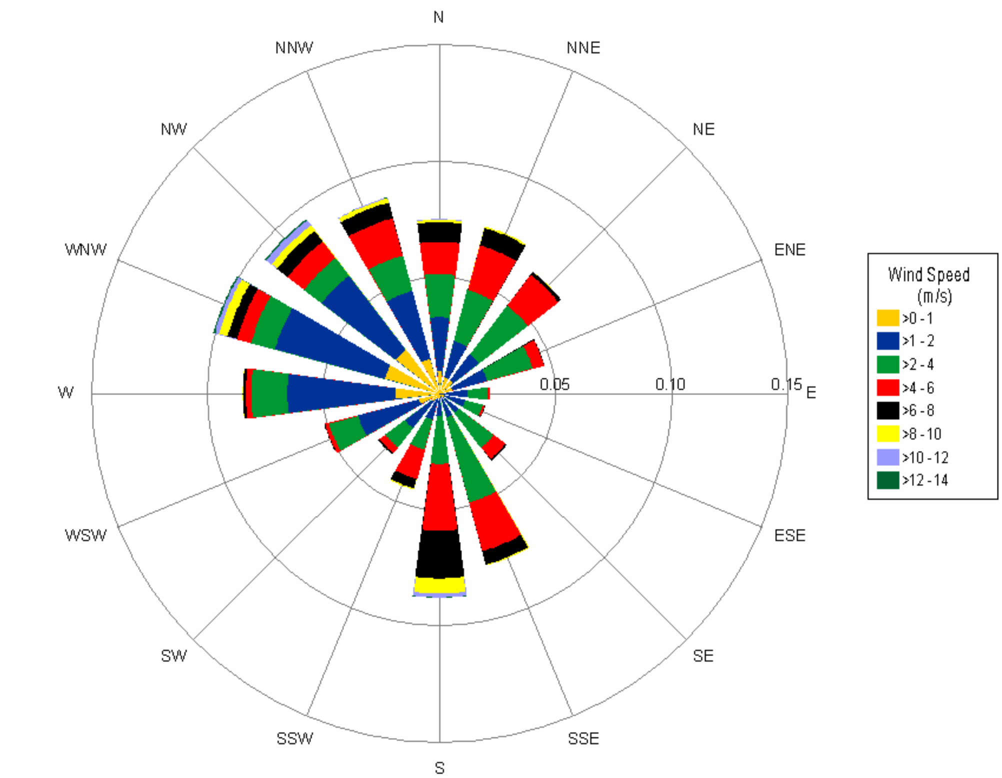

Figure 3-7. Wind Rose for Test Period

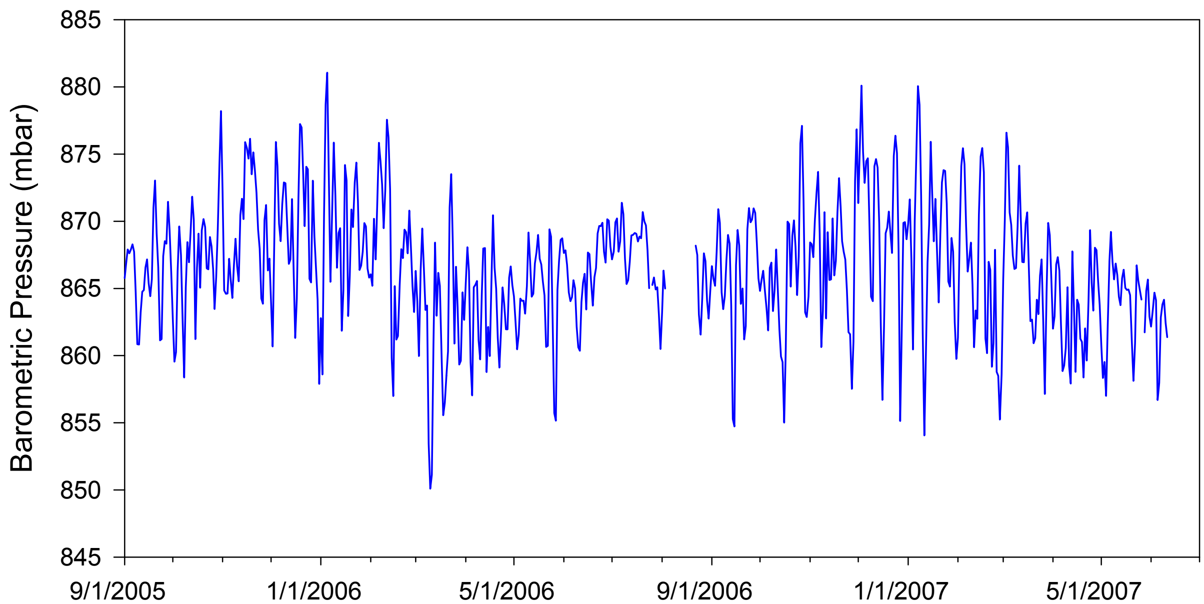

Figure 3-8. Daily Average Barometric Pressure

During the test period, 41 days had measurable precipitation, totaling 125 millimeters (mm) (4.9 in.). At least one precipitation event in February 2006 was not recorded due to sensor failure. The event(s) was evident from analyses of the soil moisture data. A nearby rainfall gauge recorded small events (~5 mm [0.2 in.] each) on February 28 and March 1, 2006. The test period was significantly drier than the long-term average. The recorded precipitation was only 37% of average based on a 42-year record from a nearby rain gauge.

Measured rainfall intensities were generally low throughout the test period, and no basin-wide runoff producing precipitation events were observed. Daily precipitation totals with time are shown in Figure 3-9. No snowfall was observed.

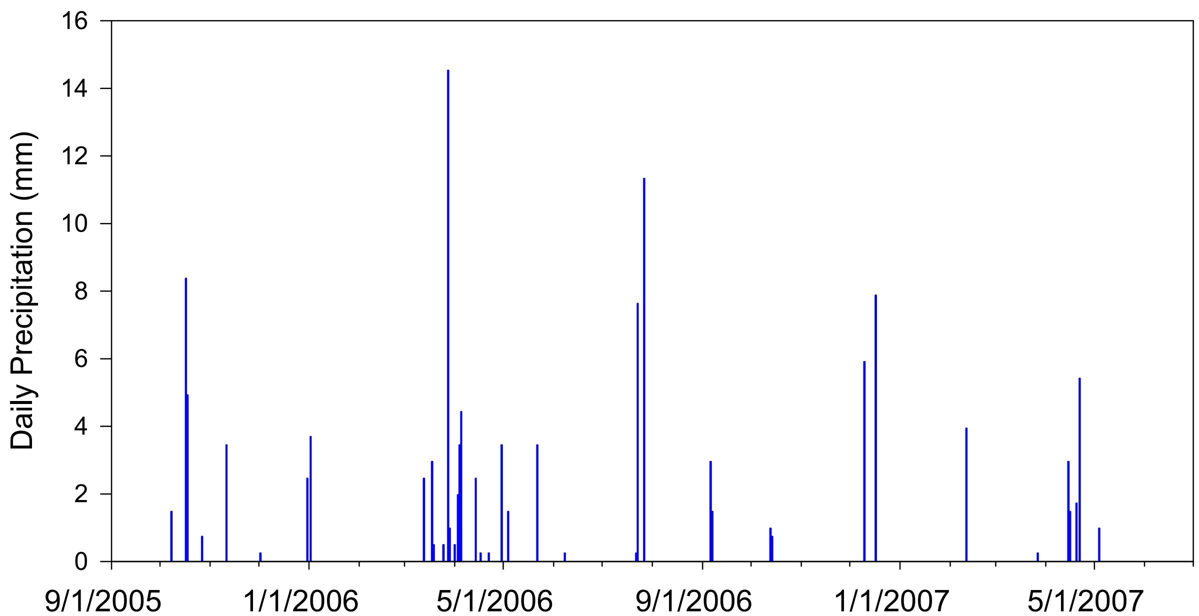

Figure 3-9. Daily Precipitation

Approximately 11,000 megajoules/m^2 of total incoming solar radiation was measured over the 20.5 month test period. Monthly total incoming solar radiation is presented in Figure 3-10. Daily maximum incoming solar radiation based on hourly averaged data is presented in Figure 3-11. Peak incoming solar radiation in the summer months is approximately 1,000 watts/m^2.

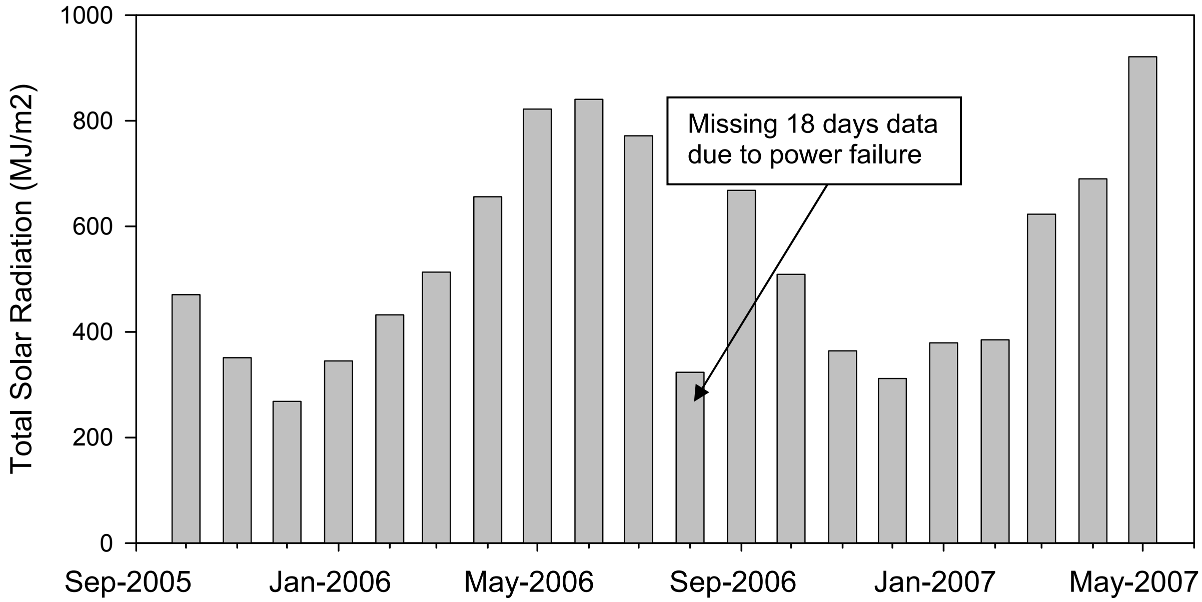

Figure 3-10. Monthly Total Incoming Solar Radiation

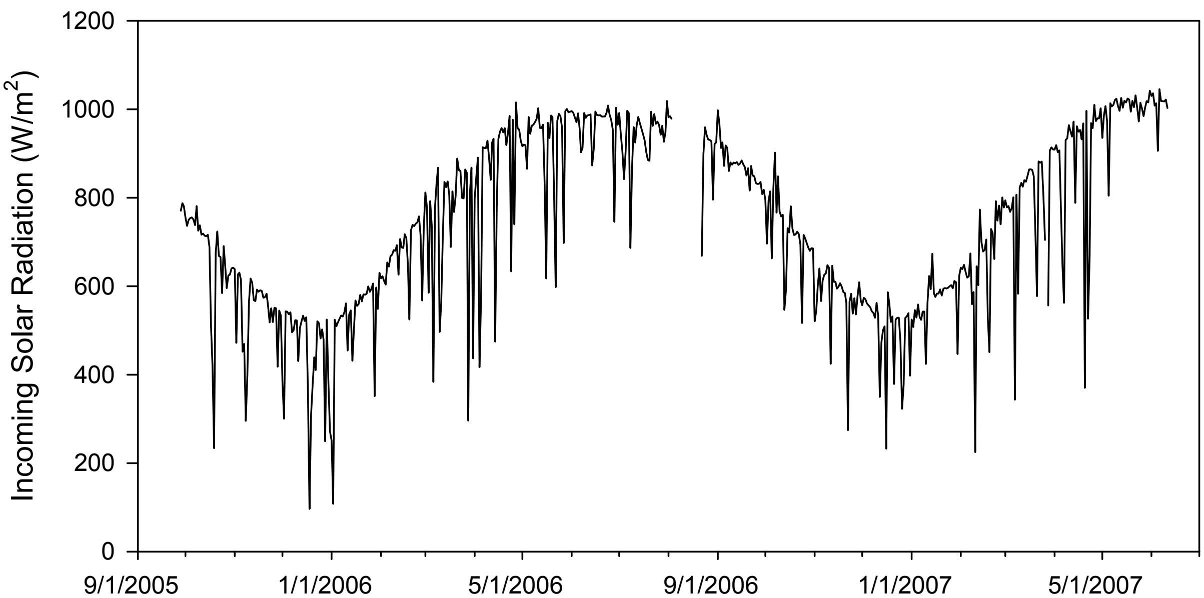

Figure 3-11. Daily Maximum Incoming Solar Radiation

The volumetric water content of the surface soils averaged approximately 10% over the study period. Due to scant precipitation, few wetting fronts were observed. Figures 3-12, 3-13, 3-14, and 3-15 show volumetric water content data at 8, 15, 30, and 61 cm (3, 6, 12, 24 in.) depths, respectively. The wetting front seen on the treated but not on the untreated surface in late September 2005 is a result of pre-wetting the surface prior to applying the emulsion. All but one of the observed wetting fronts were less than 30 cm (12 in.) deep. No wetting fronts reached the 61 cm (24 in.) depth (see Figure 3-15). Slight differences observed in TDR readings between locations is consistent with data collected prior to the emulsion application. TDR results between treated and untreated plots are judged to be generally equivalent.

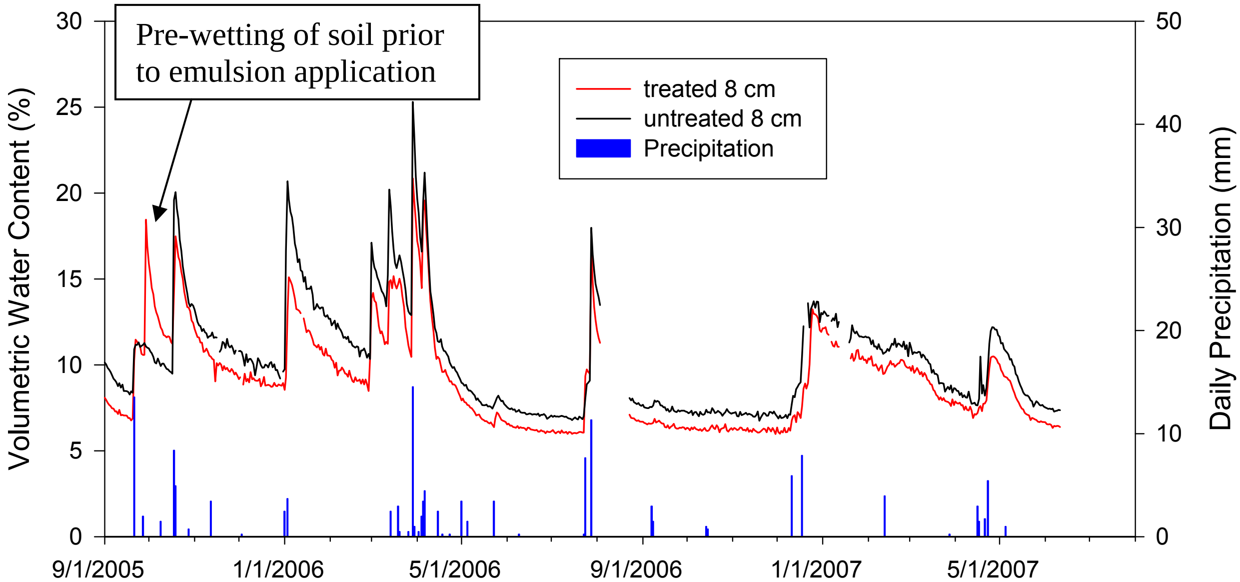

Figure 3-12. Soil Water Content at 8 cm Depth

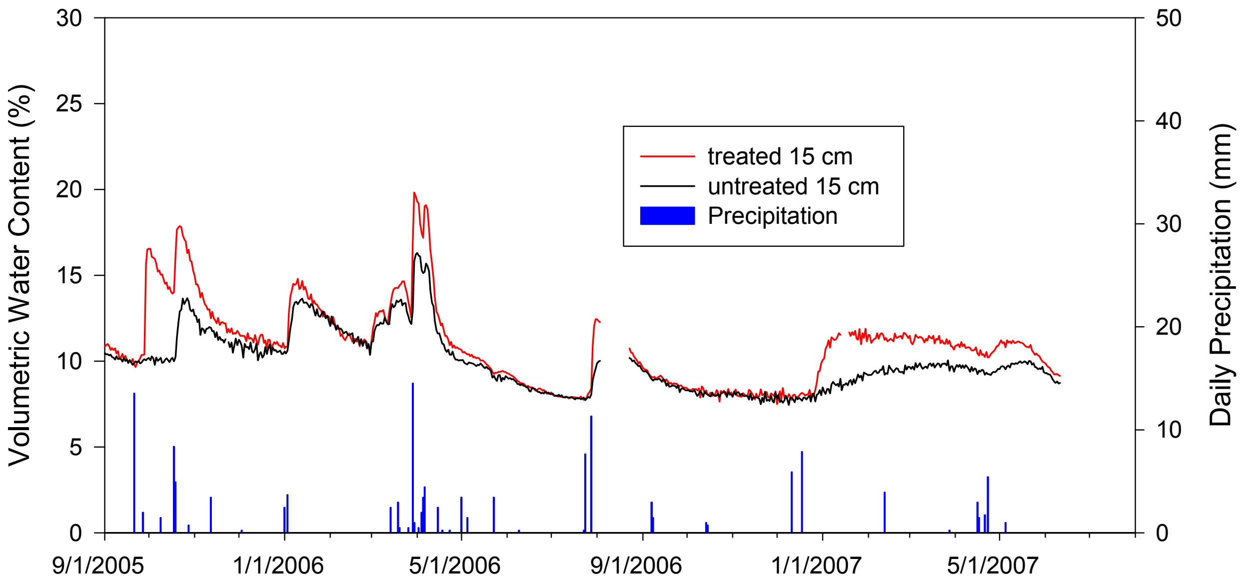

Figure 3-13. Soil Water Content at 15 cm Depth

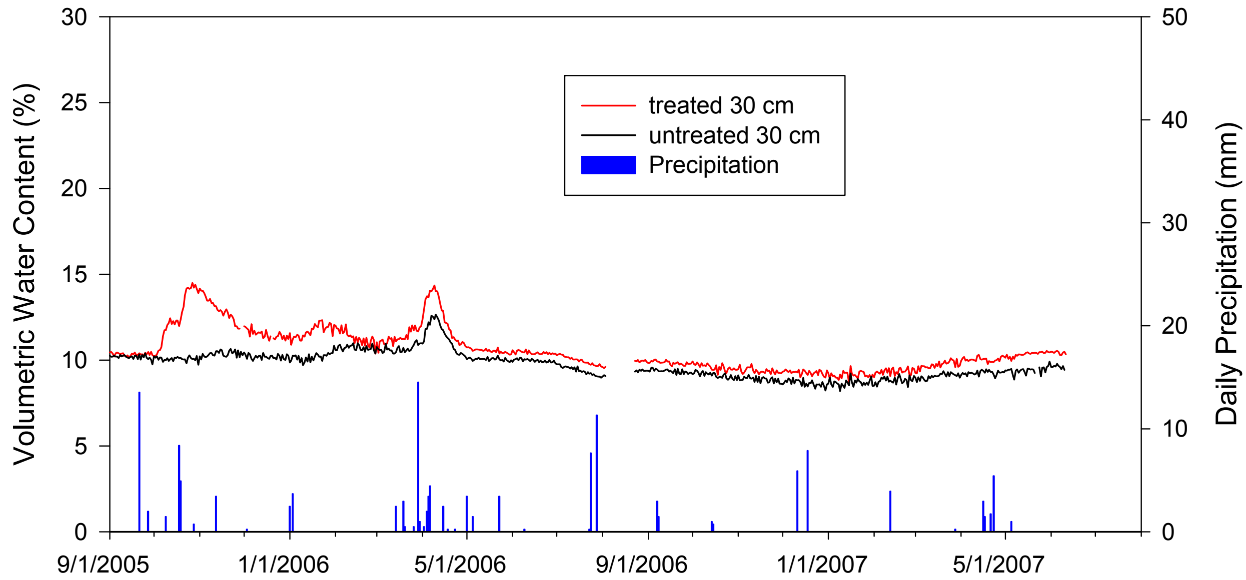

Figure 3-14. Soil Water Content at 30 cm Depth

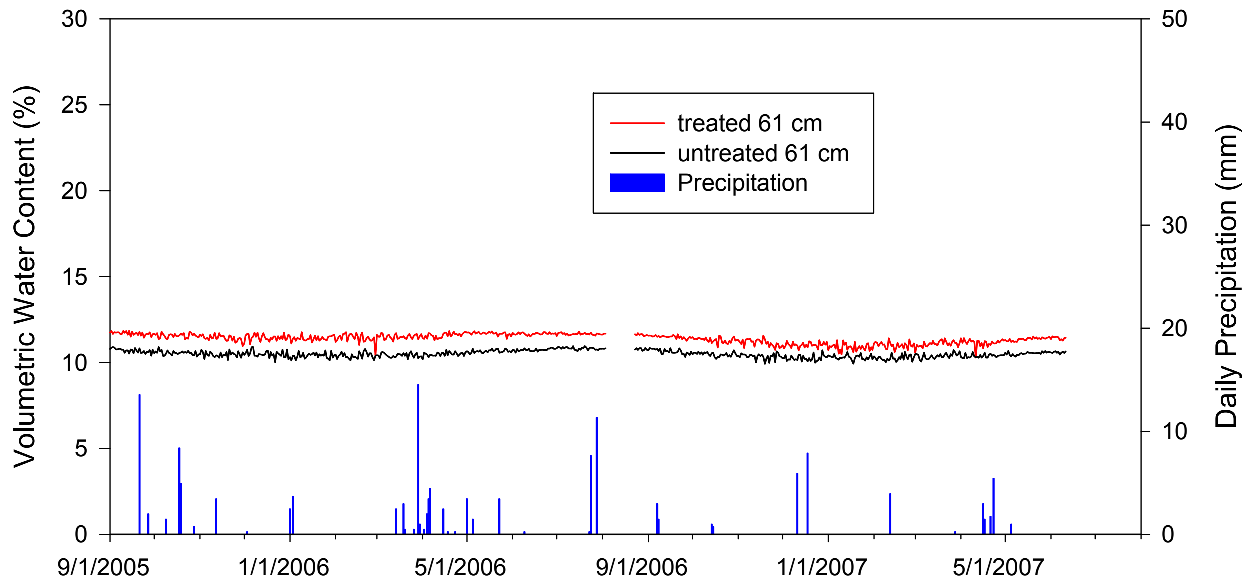

Figure 3-15. Soil Water Content at 61 cm Depth

3.3 Vegetation Assessment

Monitoring plants within the plant stress study area was completed on May 11, 2006. A scientist walked the entire area and recorded by species the vigor of all plants present within the 5 x 10 m (16 x 33 ft) area (see Figure 3-16). Vigor was estimated using a 0 to 5 vigor classification with 0 being dead and 5 indicating excellent growth. Vigor estimates were made when most plants were at peak production for the year. One exception was filaree, an early flowering species. Almost all filaree observed on the site had completed their life cycle and were represented by a tuft of dry leaves. Other species were either in flower or had set seed.

The results of the monitoring in 2006 are presented in Table 3-1 and do not indicate any signs of plant stress. Plants within the study site had been subjected to the emulsion treatment in September 2005, but in May 2006 they were healthy and showed no signs of premature leaf drop, leaf discoloration, or a decrease in overall plant vigor (see Figures 3-17, 3-18 and 3-19). Only on needleleaf rabbitbrush (see Figure 3-20) was there any indication of discoloration from the earlier emulsion application. The lower portion of some of the stems was darker, indicating some emulsion residue. This particular species normally has darker stem coloration, but without microscopic evaluation (or possibly chemical analysis) it was not possible to eliminate an emulsion residue. The soil surface was not discolored and probing of the soil surface did not indicate any crusting from the emulsion. Soils were loose and not compact.

Vegetation was again evaluated on June 11, 2007. No vigor assessments were made because there were no visual indication of plant stress (see Figure 3-21). Plants were less robust (less biomass); however this is not a result of the emulsion but a result of a prolonged drought that has occurred in the area.

Figure 3-16. Scientist conducting Plant Vigor Assessments

Table 3-1. Plant Vigor Assessment

Plant	Number Observed	Vigor Rating*	Number of Plants	Comments
Shrubs				
Cheesebush	12	5	11	5 plants in flower, 1 setting seed, 1 old plant, no evidence of emulsion on stems
		4	1	plant in flower
Desert globemallow	2	5	2	in flower, some setting seed, no evidence of emulsion
Needle rabbitbrush	2	3	2	leaves at base of stem dark brown, plant leafing out, none in flower
Rubber rabbitbrush	6	5	4	new growth evident
		4	2	leaves at base of stem darker
Virgin River encelia	4	5	4	
Grasses				
Desert needlegrass	15	5	16	in flower, some setting seed, no evidence of emulsion
Forbs				
Tansyaster species	75+	5	75+	
Cutleaf filaree	100+	5	100+	dried up, but very abundant, no evidence of emulsion
Desert trumpet	1	5	1	

*Vigor Rating

0 - Dead	100% of leaves prematurely dropped; stems dry, break when bent
1 - Poor	>50% of plant leaves prematurely dropped, discolored or disfigured; 50% of stems wilting
2 - Fair	25–50% of plant leaves prematurely dropped, discolored or disfigured; 25–50% stems wilting
3 - Good	<25% of plant leaves prematurely dropped, discolored or disfigured; <25% stems wilting
4 - Very Good	<10% of plant leaves prematurely dropped, discolored or disfigured; <10% stems wilting
5 - Excellent	no outward signs that plant is under stress; no signs of premature leaf drop, discoloration, disfiguring; stems rigid not wilting

	Common Name	Scientific Name
Shrubs		
	Virgin River encelia	*Encelia virginensis*
	Rubber rabbitbrush	*Ericameria nauseosa*
	Needleleaf rabbitbrush	*Ericameria teretifolia*
	Cheesebush	*Hymenoclea salsola*
Grasses		
	Desert needlegrass	*Achnatherum speciosum*
Forbs		
	Desert trumpet	*Eriogonum inflatum*
	Cutleaf filaree	*Erodium cicutarium*
	Tansyaster	*Macaeranthera* species
	Desert globemallow	*Sphaeralcea ambigua*

Figure 3-17. Plant Study Area 7.5 Months after Emulsion Application – May 2006


Figure 3-18. Cheesebush Showing No Signs of Stress – May 2006


Figure 3-19. Desert Needlegrass Showing No Signs of Stress – May 2006


Figure 3-20. Needleleaf Rabbitbrush with Signs of Emulsion Residue – May 2006


Figure 3-21. Plant Study Area 20.5 Months after Emulsion Application – June 2007

3.4 Infiltration Tests

Double-ring infiltration measurements were taken at approximately 6, 13.5, and 20.5 months post emulsion application. The steady-state infiltration rate was generally achieved within 60 minutes for all tests. Table 3-2 presents the results for the six tests conducted. The three measurements on treated surfaces show essentially no variation over time with an average infiltration rate of 10.7 cm/hr (4.2 in./hr). The first and third measurements taken on the untreated surface are slightly higher than the measurements from the treated surface with an average of 13.0 cm/hr (5.1 in./hr). The second measurement of 7.1 cm/hr (2.8 in./hr) taken on the untreated surface was the lowest of all measurements taken. This result shows some variability in the surface hydraulic properties exists within the test area. Overall, the infiltration measurements are consistent with sandy soils and were constant over time. Differences between treated and untreated surfaces were not significant.

Table 3-2. Summary of Infiltration Measurements

Approximate time post application (mo)	Treated surface steady-state infiltration rate (cm/hr)	Untreated surface steady-state infiltration rate (cm/hr)
6	11.3	13.9
13.5	9.8	7.1
20.5	11.0	12.0

3.5 Rainfall-Runoff Simulations

3.5.1 Runoff Volume and Rates

The first round of rainfall-runoff simulations was conducted March 15–16, 2006, approximately six months after application of the emulsion. Five minute simulations were conducted on plots 8(U) and 9(T) (see Figure 2-10). These simulations resulted in runoff at rates judged to be too high to be reliably collected. All remaining simulations had four minute durations. Figure 3-22 shows the cumulative runoff volume versus time for each plot for the March 15 and 16 simulations. Tables 3-3 and 3-4 present total runoff volumes collected and peak runoff rates for each simulation, respectively.

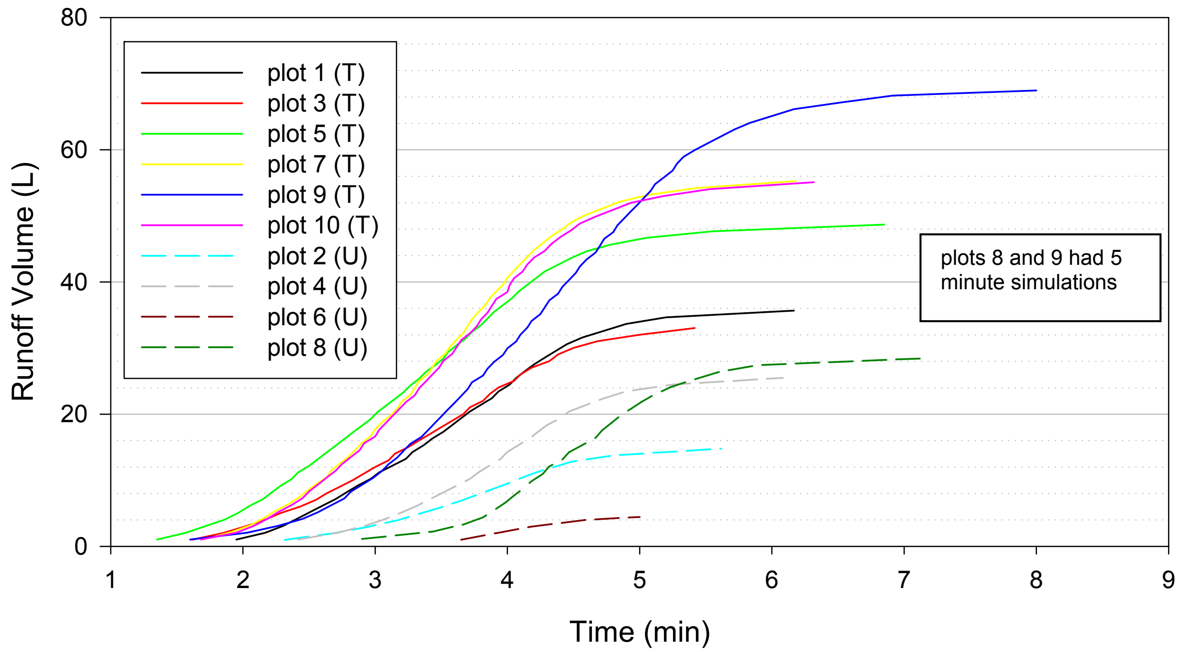

Figure 3-22. Cumulative Runoff with Time for the First Round of Simulations

Table 3-3. Total Runoff Collected

plot	Total runoff collected (L)		
	Mar-06 test	Oct-06 test	Jun-07 test
1 (T)	35.7	33.5	3.4
3 (T)	33.0	24.1	2.4
5 (T)	48.7	42.2	10.7
7 (T)	55.2	27.3	3.1
9 (T)	69.0[1]	22.0	1.6
10 (T)	55.1	26.6	1.7
2 (U)	14.8	5.6	1.6
4 (U)	25.5	13.4	1.8
6 (U)	4.4	1.4	1.4
8 (U)	28.5[1]	2.6	1.9

[1] 5 minute simulation

Table 3-4. Peak Runoff Rates

plot	Peak runoff rate (L/min)		
	Mar-06 test	Oct-06 test	Jun-07 test
1 (T)	13.9	16.6	2.0
3 (T)	13.2	10.1	0.8
5 (T)	17.4	16.4	5.3
7 (T)	23.3	15.0	1.1
9 (T)	21.2[1]	11.8	0.7
10 (T)	21.7	12.6	0.9
2 (U)	7.3	2.7	0.5
4 (U)	12.3	7.1	0.7
6 (U)	3.8	0.7	0.6
8 (U)	13.7[1]	0.8	0.5

[1] 5 minute simulation

All treated plots had smaller initial abstractions, higher peak runoff rates, and higher runoff volumes than the untreated plots. Initial abstraction is the amount of precipitation which infiltrates into the surface prior to the start of runoff. A smaller initial abstraction results in runoff beginning sooner. The relative magnitude of the initial abstraction can be assessed by the time required to collect 1 L (0.26 gal) of runoff. The average time to collect 1 L (0.26 gal) of runoff on treated plots was 1.7 minutes and 2.8 minutes on untreated plots.

Treated plot runoff volumes ranged from 33 to 69 L (8.7 to 18.2 gal) with a mean of 49.4 L (13 gal). Untreated plot runoff volumes ranged from 4.4 to 28.5 L (1.2 to 7.5 gal) with a mean of 18.3 L (4.8 gal). Treated plot peak runoff rates ranged from 13.2 to 23.3 liters per minute (L/min) (3.5 to 6.1 gal/min) with a mean of 17.9 L/min (4.7 gal/min). Untreated plot peak runoff rates ranged from 3.8 to 12.3 L/min (1 to 3.2 gal/min) with a mean of 7.8 L/min (2 gal/min). Figure 3-23 shows the relationship between total runoff volume and peak runoff rates for all three rounds of simulations. Using Pearson's r method (Helsel and Hirsch, 1992), total runoff and peak flow rate are highly correlated (r=0.97, p=0.00), as would be expected with simulations of constant duration and equal plot areas.

A 0.24 cm (0.1 in.) precipitation event was measured at the site two days prior to the test simulation. TDR readings indicate elevated near surface soil moisture contents at about 14% by volume (see Figure 3-12) which may have resulted in increased runoff over baseline conditions (~7% by volume).

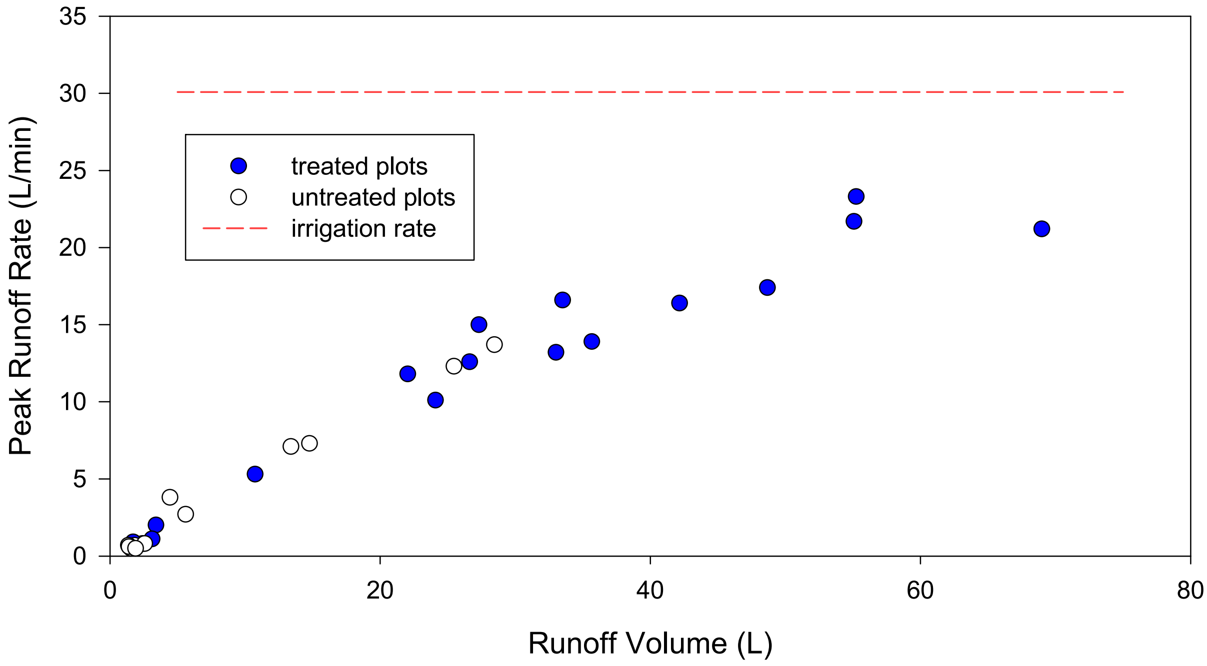

Figure 3-23. Variation of Peak Runoff Rate with Runoff Volume

The second round of rainfall simulations was conducted on October 24, 2006, approximately 13 months post emulsion application. All simulations had four minute durations. The simulation on plot 4(U) was repeated on November 20, 2006, due to questionable results obtained from the October test. Figure 3-24 shows the cumulative runoff volume versus time for each plot for the second round of simulations. All treated plots had higher peak runoff rates and higher runoff volumes than the untreated plots (see Tables 3-3 and 3-4).

Five of the six treated plots had initial abstractions less than or equal to the smallest untreated initial abstraction. The average time to collect 1 L (0.26 gal) of runoff increased from the first round of tests. The average time to collect 1 L (0.26 gal) of runoff during the second round of tests on treated plots was 2.3 minutes and 3.1 minutes on untreated plots.

Less runoff volumes were collected in the second round of testing as compared to the first round. Treated plot runoff volumes ranged from 22 to 42.2 L (5.8 to 11.1 gal) with a mean of 29.3 L (7.7 gal). Untreated plot runoff volumes ranged from 1.4 to 13.4 L (0.37 to 3.5 gal) with a mean of 5.7 L (1.5 gal) (Table 3-3). Treated plot peak runoff rates ranged from 10.1 to 16.6 L/min (2.7 to 4.4 gal) with a mean of 14.5 L/min (3.8 gal/min). Untreated plot peak runoff rates ranged from 0.7 to 7.1 L/min (0.2 to 1.9 gal/min) with a mean of 3.5 L/min (0.92 gal/min) (Table 3-4).

No precipitation was measured in the five days prior to the second round of simulations; 0.17 cm (0.07 in.) was measured in the prior 30 days. TDR readings indicate baseline soil moisture levels at approximately 6–7% by volume at the time of the simulations. Lower antecedent soil moisture conditions and possible degradation of the emulsion may have contributed to the reduced runoff volumes as compared with the first round of simulations.

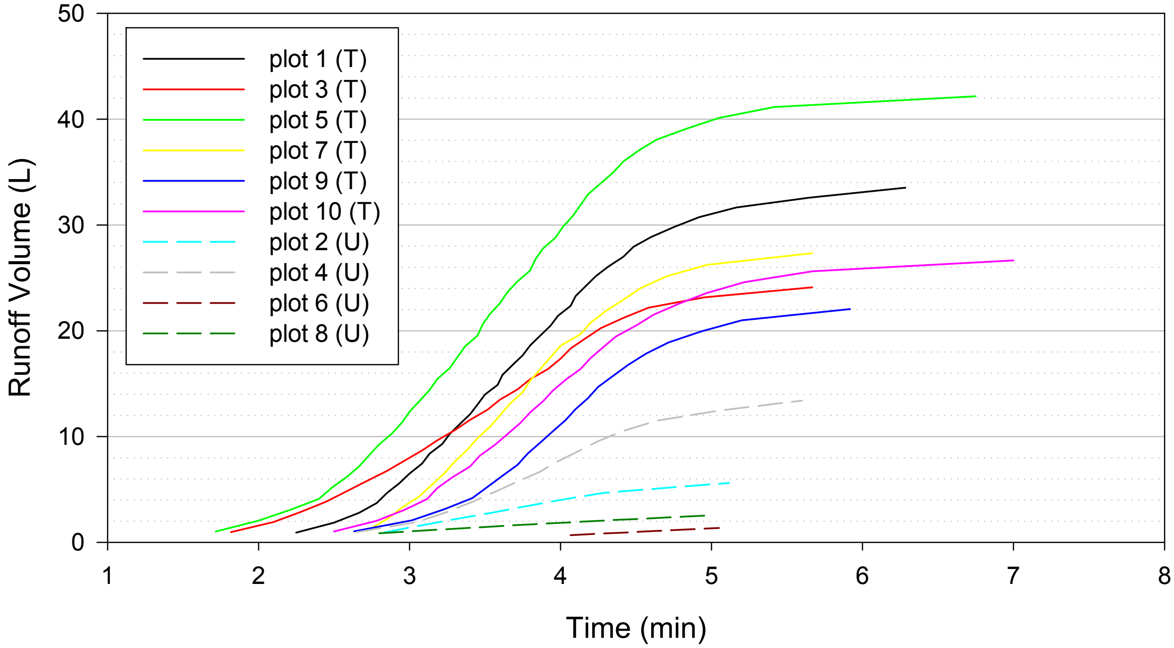

Figure 3-24. Cumulative Runoff with Time for the Second Round of Simulations

The third round of rainfall simulations was conducted on June 11, 2007, approximately 20.5 months after applying the emulsion. All simulations had four minute durations. Figure 3-25 shows the cumulative runoff volume with time for each plot for the third round of simulations.

Runoff volumes collected from treated and untreated surfaces are not significantly different using the exact version of the Mann-Whitney test (p=0.11) (Helsel and Hirsh, 1992). Treated plot runoff volumes ranged from 1.6 to 10.7 L (0.42 to 2.8 gal) with a mean of 3.8 L (1.0 gal). Untreated plot runoff volumes were uniform, ranging from 1.4 to 1.9 L (0.37 to 0.5 gal) with a mean of 1.7 L (0.45 gal). On average, 25.5 and 4.1 L (6.7 and 1.08 gal) less runoff was collected as compared to the second round for the treated and untreated plots, respectively (Table 3-3).

Peak runoff rates on the treated plots ranged from 0.7 to 5.3 L/min (0.2 to 1.4 gal/min) with a mean of 1.8 L/min (0.48 gal/min). Untreated plot peak runoff rates were uniform ranging from 0.5 to 0.7 L/min (0.13 to 0.18 gal/min) with a mean of 0.6 L/min (0.16 gal/min) (Table 3-4). Due to the limited runoff volumes, peak rates for the third round of testing have somewhat greater uncertainty than the prior two rounds. The average time to collect 1 L (0.26 gal) of runoff increased from the second round of testing to 3.1 minutes on treated plots and 3.4 minutes on untreated plots.

No precipitation was measured in the 30 days prior to the third round of simulations. TDR readings indicate baseline soil moisture levels at approximately 6–7% by volume at the time of the simulations.

Significantly lower volumes of runoff collected from the treated plots indicate further degradation of the emulsion has occurred since the second round of testing. With the exception of plot 5(T), the treated and untreated plots show very similar responses to the third round of rainfall simulations. Plot 5(T) was observed to have more rock clasts on the surface, which may result in higher runoff volumes. Figure 3-26 shows total runoff for all simulations.

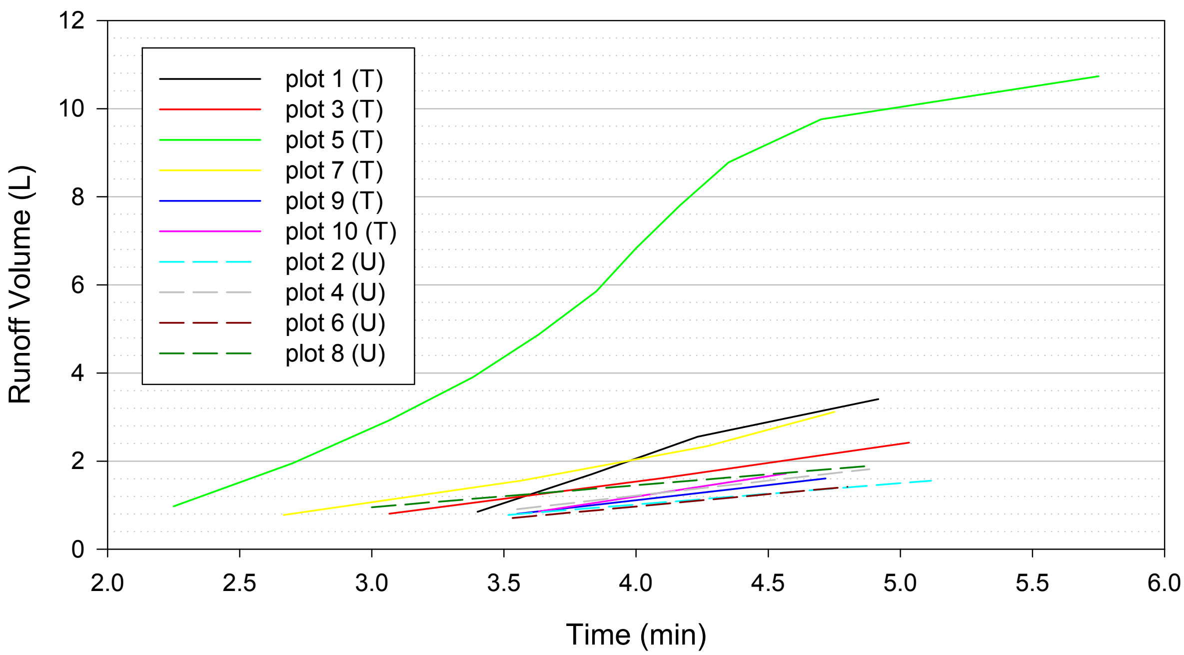

Figure 3-25. Cumulative Runoff with Time for the Third Round of Simulations

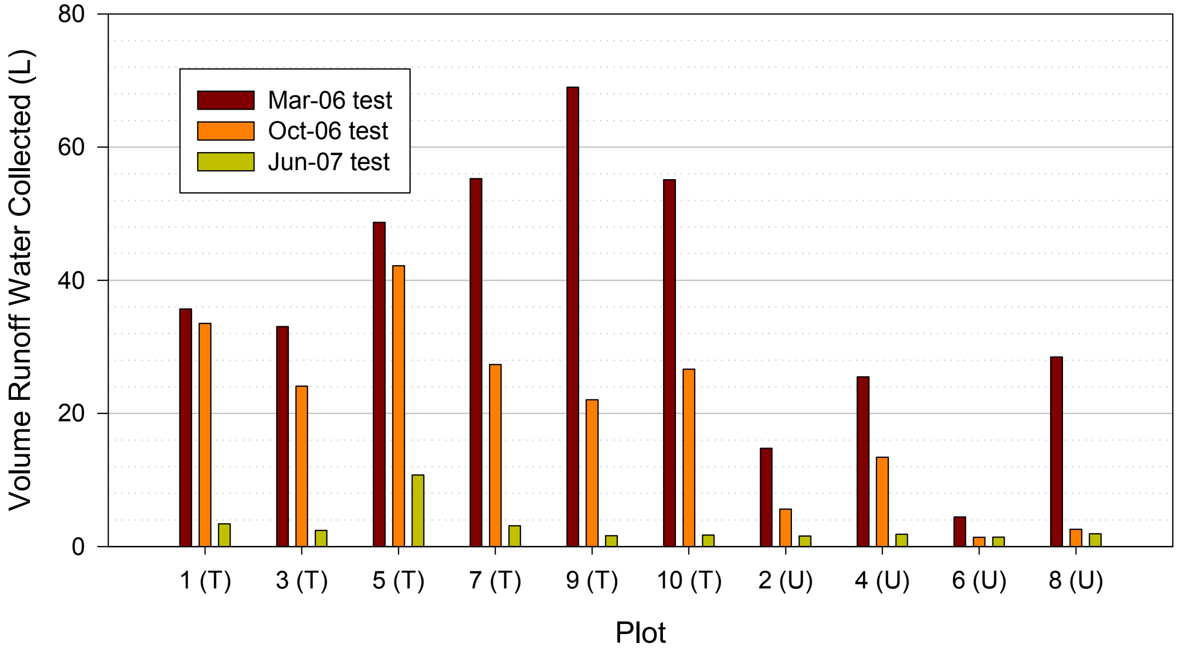

Figure 3-26. Cumulative Runoff for All Simulations

3.5.2 Sediment Mass

Table 3-5 and Figure 3-27 present total sediment mass collected from each rainfall-runoff simulation. Figure 3-28 presents peak runoff rate versus total sediment collected and shows increased sediment mass with increased runoff. Using Kendall's Tau rank correlation method (Helsel and Hirsh, 1992), sediment mass and peak runoff rate are strongly correlated (p=0.00, T=0.8). This result is expected as sediment transport capacity is increased with increased runoff. Figure 3-29 presents total runoff volume versus total sediment collected. Because peak runoff rate and total runoff volume are linearly correlated (see Figure 3-23), total runoff volume and sediment collected are also strongly correlated. Due to this strong correlation with runoff volume, the sediment mass collected generally follows the same pattern discussed in the runoff volume section: higher on treated plots with an overall decreasing pattern with time.

Figure 3-30 presents the grain size distribution for sediment collected from the first round of simulations. Funding was only available to perform the analyses on one set of samples. The analysis was only performed for plots with sediment totals greater than 20 g. This figure indicates at least 60% of the sediment collected from each plot can be classified as fine sand or smaller.

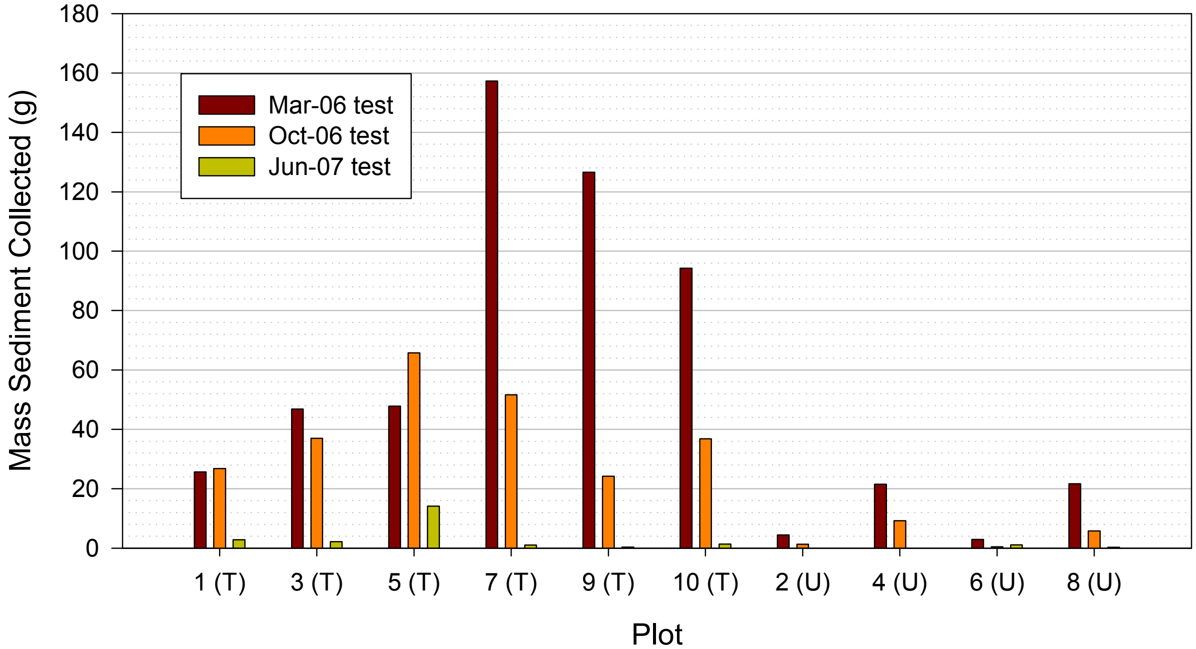

Figure 3-27. Total Sediment Collected for All Simulations

Table 3-5. Total Sediment Collected

plot	Total sediment collected (g)		
	Mar-06 test	**Oct-06 test**	**Jun-07 test**
1 (T)	25.66	26.76	2.79
3 (T)	46.83	36.99	2.18
5 (T)	47.80	65.71	14.11
7 (T)	157.29	51.65	1.06
9 (T)	126.5[1]	24.23	0.34
10 (T)	94.20	36.78	1.36
2 (U)	4.39	1.31	0.02
4 (U)	21.49	9.19	0.06
6 (U)	2.94	0.45	1.13
8 (U)	21.70[1]	5.80	0.28

[1] 5 minute simulation

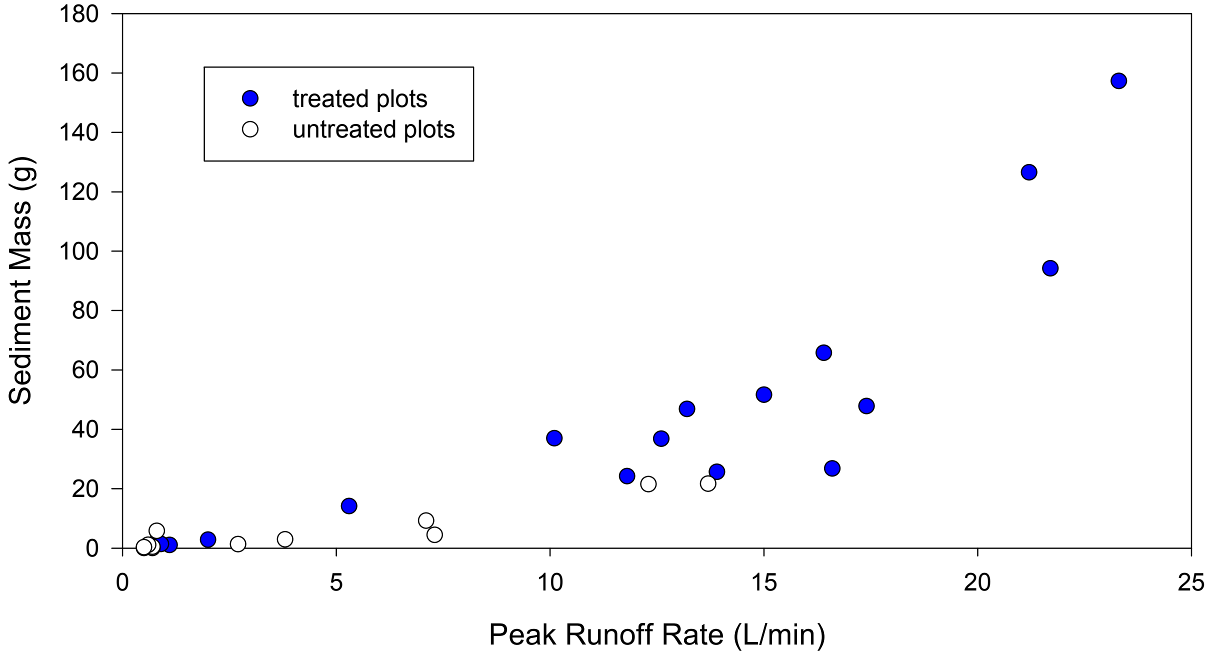

Figure 3-28. Variation of Sediment Mass with Peak Runoff Rate

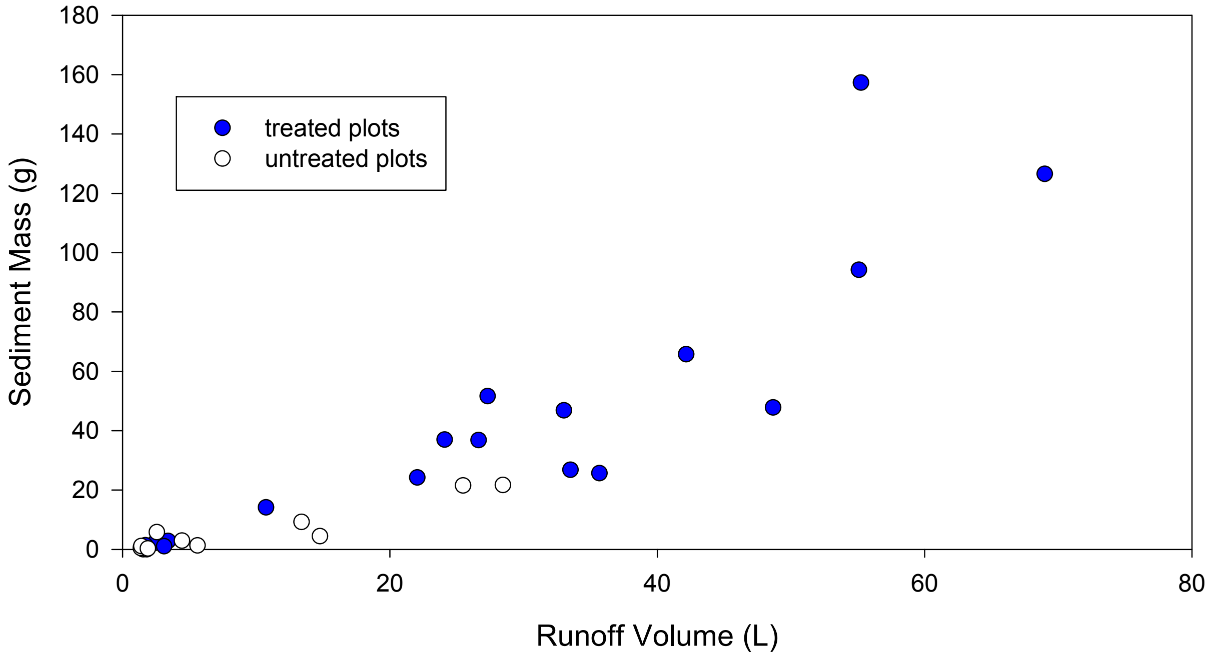

Figure 3-29. Variation of Sediment Mass with Runoff Volume

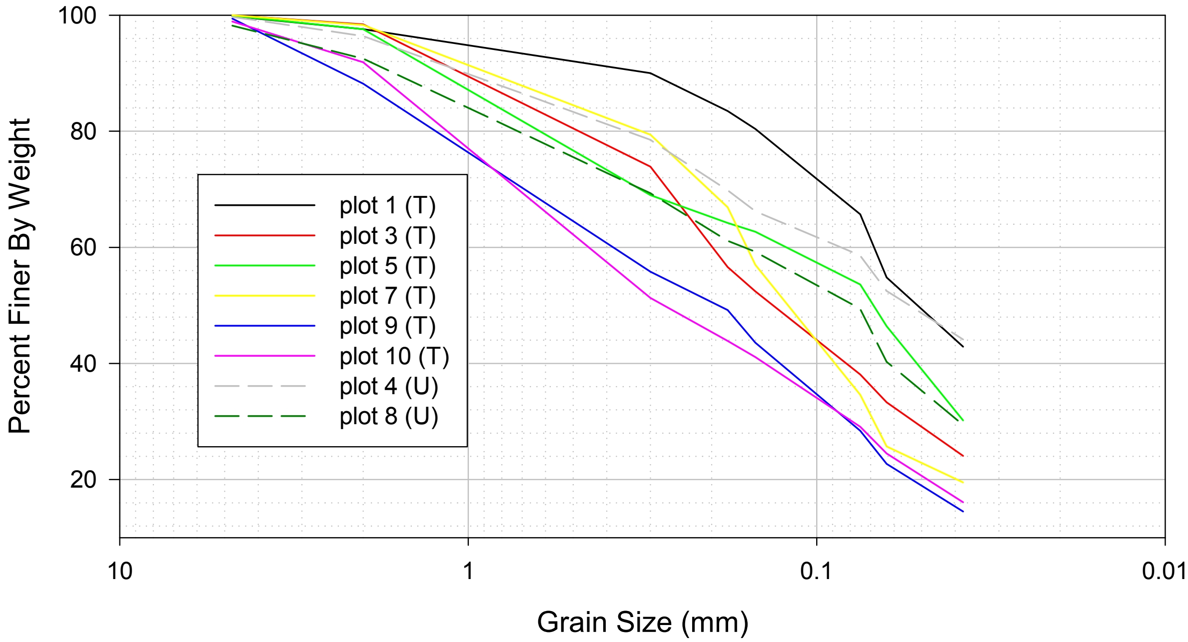

Figure 3-30. Grain Size Distribution of Sediment from the First Round of Simulations

3.5.3 Sediment Concentration

Table 3-6 and Figure 3-31 present Am-241 concentrations in sediment collected for each simulation. Prior radionuclide characterization of surface soils at the SMOKY site indicates a ratio of 7.2 for Pu-239+240 to Am-241 (McArthur, 1991). Pu-239+240 concentrations in collected sediments can therefore be estimated by multiplying the measured Am-241 concentration by 7.2. The Am-241 concentration in sediments from plots on the north side (plots 1–5) of the pole line road is higher than the concentrations from sediment collected on the south side (plots 6–10) of the pole line road. These spatially dependent results are consistent with previously collected Am-241 data as shown in Figure 2-2. The spatial structure of Am-241 in sediment is a function of the radioactivity dispersal pattern from the above ground nuclear tests conducted to the north of the field test location. Am-241 concentration in sediments collected from plots on the north side of the pole line road range from 0.23 to 2.04 picocuries per gram (pCi/g) with an average of 1.04 pCi/g. The south side sediments had slightly lower but highly uniform concentrations ranging from 0.29 to 0.33 pCi/g with an average of 0.31 pCi/g. The data do not indicate that Am-241 sediment concentration varies due to the surface treatment (Table 3-6).

Analysis of the aqueous fraction of collected samples showed all results were less than the method detection limit for the first two sets of samples. Analysis of the aqueous fraction for third round of samples was deemed not necessary.

Quality control measures including instrument calibration and replicate analyses are described in Attachment 1. These measures indicate analytical results are accurate and reproducible. Samples with less than 20 g of sediment required the addition of clean sand to meet the minimum range of the calibration curve.

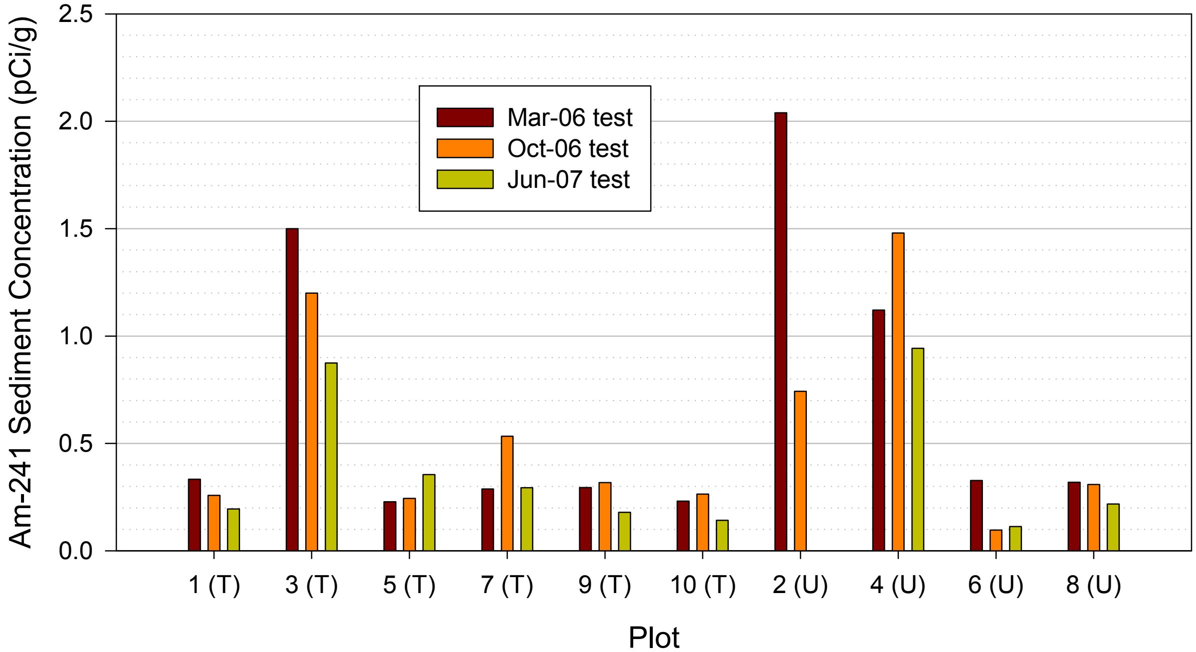

Figure 3-31. Am-241 Concentration in Sediment

Table 3-6. Am-241 Concentration in Sediment

plot	Sediment Am-241 concentration (pCi/g)		
	Mar-06 test	**Oct-06 test**	**Jun-07 test**
1 (T)	0.33	0.26	0.20
3 (T)	1.50	1.20	0.88
5 (T)	0.23	0.24	0.36
7 (T)	0.29	0.53	0.29
9 (T)	0.30[1]	0.32	0.18
10 (T)	0.23	0.26	0.14
2 (U)	2.04	0.74	<0.1
4 (U)	1.12	1.48	0.94
6 (U)	0.33	0.10	0.11
8 (U)	0.32[1]	0.31	0.22

[1] 5 minute simulation

4 Conclusions

The Encapco emulsion was applied to test plots and subjected to a harsh field environment at the NTS characterized by scant precipitation, low relative humidity, and high incident solar radiation for nearly two years. Field tests were conducted at approximately 6, 13, and 20.5 months following application of the emulsion. Significant differences were not observed in either the double ring infiltration measurements or the daily soil water content measurements taken on treated and untreated surfaces.

Significant differences were observed in the amount of runoff and sediment collected from treated and untreated plots for the first two but not the third round of rainfall-runoff simulations, indicating significant degradation of the emulsion. Treated plots had higher total runoff volumes and sediment loads as compared to untreated plots for the first two rounds of simulations. Two possible explanations for the increased runoff on the treated surfaces are (1) the emulsion clogged the soil pores, thus limiting infiltration and (2) the emulsion induced surface soil hydrophobicity, thereby repelling simulated rainfall. If the emulsion treatment significantly clogged the soil pores, differences in the infiltration rate as measured with the double ring infiltrometer would likely have been observed, but were not. Induced hydrophobicity is likely the reason the treated plots had higher runoff totals.

Regardless of the origin, as runoff increases, the sediment transport capacity increases. The higher sediment loads measured on the treated plots indicate the emulsion did not sufficiently increase the cohesion between soil particles to resist splash impact particle detachment and the increased transport capacity resulting from the increased runoff (volume and rate).

Plant vigor assessments indicate no negative effects on existing vegetation. This is an important observation as vegetation generally decreases wind and water induced erosion.

The results from field testing the Encapco emulsion indicate it is not a viable long-term option for the stabilization of radionuclide impacted surface soils at the NTS in its current formulation. Post application observations indicate the emulsion had limited penetration into the soil surface. This limited penetration may have resulted in increased exposure to solar radiation which could accelerate its degradation. Dust suppression studies conducted by Etyemezian et al. (2006) at an uncontaminated location near the SMOKY site showed that the emulsion significantly reduced dust emissions for at least four months post application, suggesting that the emulsion may be useful for short-term applications.

5 References

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Appendix A

Characterization of Runoff from Nevada Test Site Test Plots
For Samples Collected
March 15-16, October 24, 2006, and June 2007.

In Support of the

Encapco Treatment Process

Prepared for:
Encapco Technologies, LLC

Prepared by:
Steve Hoeffner
Clemson Environmental Technologies Laboratory
100 Technology Drive
Anderson, SC 29625
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CETL Project Number:
226-2003661

Preparation Date: September 20, 2007
Revision 1 Date: November 20, 2007

Introduction

Three sets of carboys of runoff water from Nevada Test Site (NTS) test plots were received, logged in, filtered (to separate liquids from solids) and analyzed for Americium-241 by gamma spectroscopy.

NTS Runoff Samples Received by the Clemson Environmental Technologies Laboratory

First Set – A total of 10 runoff samples and two water control samples were collected on March 15-16, 2006, and shipped from the Nevada Test Site to Clemson University. The samples were received at Clemson Environmental Technologies Laboratory on April 7, 2006. The runoff samples were in a total of twenty three 20-liter carboys, and the control samples were in four 1-liter bottles:

Carboy Samples
1306 a and b
2306
3306 a and b
4306 a and b
5306 a, b and c

6306
7306 a, b and c
8306 a and b
9306 a, b, c and d
10306 a, b and c

1-Liter Samples
S031506a and b
S031606a and b

Second Set – A total of 10 runoff samples and one water control sample were collected on October 24, 2006, and shipped from the Nevada Test Site to Clemson University. The samples were received at Clemson Environmental Technologies Laboratory on November 8, 2006. A follow-up sample was sent and received on November 27, 2006. This sample was sent to replace 41006, which we were told to ignore and discard. The runoff samples were in a total of twenty 20-liter carboys (includes the replacement sample), and the control sample was in a 1-liter bottle:

Carboy Samples
11006 a and b
21006
31006 a and b
41006 a, b and c
Replacement → 41106
51006 a, b and c

61006
71006 a and b
81006
91006 a and b
101006 a and b

<u>1-Liter Sample</u>
S102406

Third Set – A total of 10 runoff samples were collected in June 2007, and shipped from the Nevada Test Site to Clemson University. The samples were received at Clemson Environmental Technologies Laboratory June 18, 2007. The runoff samples were in a total of ten 20-liter carboys:

<u>Carboy Samples</u>
1607
2607
3607
4607
5607
6607
7607
8607
9607
10607

A copy of all the Chain of Custody records is included in Appendix 1.

Filtration of Runoff Samples

To separate the water from the solids, carboy samples from each of the test plots were filtered though a Whatman GF/F 0.7 um glass fiber filter. Filtration on the 23 carboys (first set from the 10 test plots) was begun on May 23, 2006 and completed on June 6, 2006. Filtration on the 17 carboys (second set from the 10 test plots) was begun on November 11, 2006 and completed on November 28, 2006. Filtration on the 10 carboys (third set from the 10 test plots) was begun on June 20, 2007 and completed on July 12, 2007.

Empty carboys were rinse 2-3 times and then filtered water was returned to these for storage. The filtered solids were scraped off of the filter paper, placed in a stainless steel tray, allowed to air dry, and then dried to constant weight in a desiccator. The weights of the initial unfiltered water, filtered water and dried solid were taken. The solids content (mg dry solids/kilogram unfiltered water) was calculated for each test plot.

Analytical Testing

The filtered water and dried solids were analyzed for Americium-241 in accordance with HASL-300, 28th Edition, Method Am-02-RC, Rev. 0, 1997, Americium-241 in Soil – Gamma Spectrometry. Background was determined and subtracted from all samples.

Filtered waters and the NTS control samples were placed in 1-liter Marinelli beakers. An NIST-traceable polymer standard in a 1-liter Marinelli beaker was used to calibrate the gamma spectrometer energy and efficiency for water.

Dried soils were placed in 125 mL Nalgene PMP wide mouth jars. A NIST-traceable sand standard in a 125 mL Nalgene PMP wide mouth jar was used to calibrate the gamma spectrometer energy and efficiency for solids.

The NIST standard contained 200 grams of sand. The amount of solid that was collected from the filtered runoff waters ranged from 0.5 up to 158 grams. The efficiency of the gamma spectrometer detector for americium-241 is very dependent on the mass of sample. To account for the varied amount of solid in each of the PMP jars, small amounts of NTS soil were spiked with known quantities of the Am-241 and the americium efficiency was determined as a function of dry solids weight (see Figure 1). The plot covers the range from 20 up to 500 grams.

A few of the dried solids samples (and all of the dried solid samples from the third sampling event) contained less than 20 grams. In those instances, the dried solid sample was mixed with clean sand, counted, and the results converted from pCi/[gram of (dried solids + sand)] to pCi and then to pCi/(gram of dried solids). As an additional check that the efficiency calibration curve was correct, for one of the dried solid samples, several aliquots of sand were added and counts were made after each addition. Results are shown in Appendix 2.

For many of the above analyses, samples were analyzed in duplicate. Duplicate analyses are also shown in Appendix 2.

Wet sieve analysis was performed on 8 of the 10 remaining soils from the first set of samples (two of the samples had sand added to them). To break up any clumps, the soil was soaked in 4% sodium hexametaphosphate solution. The slurry was then filtered through a stack of sieves (4750, 2000, 300, 180, 150, 75, 45, and 38 microns). A peristaltic pump was used to feed tap water through three spray heads on the top of sieve stack at a flow rate of 160 mL/minute for 5 minutes (total volume of about 800 mL). During this time the sieve stack was also being vibrated on a Fritsch laboratory sieve shaker. The solids from each sieve were rinsed into a weigh boat, dried under a heat lamp and weighed. The liquids and solids in the pan were transferred to a small tub, dried in an oven at 60 degrees and weighed.

Test Plot Analytical Results

Results from the filtration of the first set of test plot runoff waters are summarized in Table 1. Dry solids content ranged from 297 to 2839 mg/Kg. Americium-241 in all filtered water samples and both NTS control samples was below the 0.01 pCi/L reporting limit (see Table 2). Americium-241 was detected in all of the dried soil samples and ranged from 0.23 to 1.5 pCi/g (see Table 3).
Results from the filtration of the second set of test plot runoff waters are summarized in Table 4. Dry solids content ranged from 234 to 2257 mg/Kg. Americium-241 in all filtered water samples and both NTS control samples was below the 0.01 pCi/L reporting limit (see Table 5). Americium-241 was detected in all of the dried soil samples and ranged from 0.01 to 1.48 pCi/g (see Table 6).
Results from the filtration of the third set of test plot runoff waters are summarized in Table 7. Dry solids content ranged from 13 to 1313 mg/Kg. By request, no analyses were performed on the filtered waters. (Americium-241 in all filtered water samples from the first two sampling events was below the 0.01 pCi/L reporting limit). Americium-241 was detected in all but one of the dried soil samples and ranged from <0.1 to 0.94 pCi/g (see Table 8).

Results of the wet sieve particle size analysis are summarized in Figure 9.

Figure 1. Americium-241 Efficiency as a Function of Dried Solids Weight

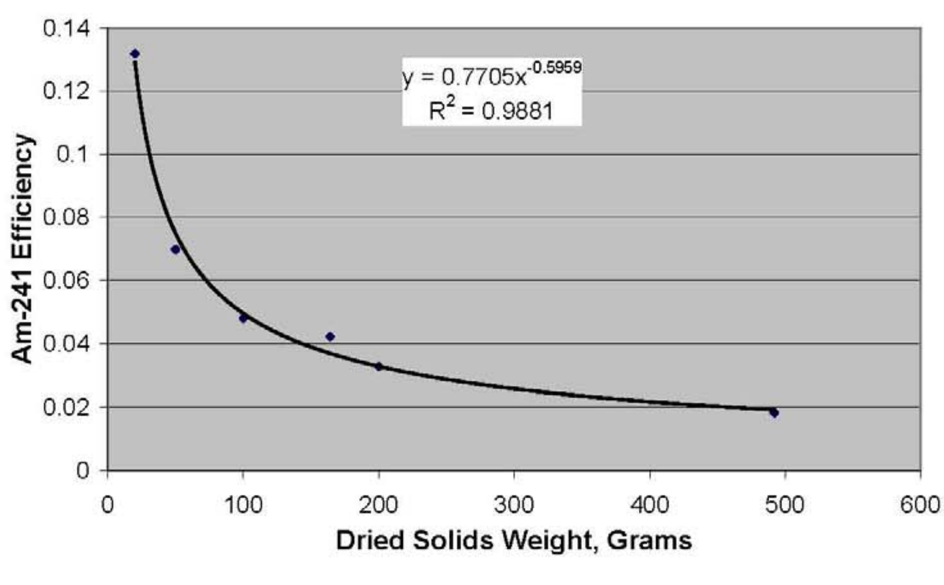

Table 1. Weight of Unfiltered Water, % Recovery, and Dry Solids Content for the First Set of Samples from the Ten Test Plots

NTS Sample ID	Unfiltered Water, grams	% Recovered	Dry Solids, mg/Kg
1306	35695	99.94	719
2306	14766	---*	297
3306	33069	100.01	1416
4306	25498	99.68	843
5306	48721	99.74	981
6306	4452	99.89	660
7306	55405	99.72	2839
8306	28478	100.42	762
9306	69112	99.43	1831
10306	55184	99.63	1708

* Not Measured.

Table 2. Americium-241 Analysis of Filtered Water from the First Set of Samples from the Ten Test Plots

NTS Sample ID	Result		Reporting Limit	MDA	Units
	Reported	Measured			
1306	<0.01	-2.23E-03	0.01	1.93E-03	pCi/L
2306	<0.01	2.04E-03	0.01	2.09E-03	pCi/L
3306	<0.01	3.89E-03	0.01	1.97E-03	pCi/L
4306	<0.01	2.35E-03	0.01	1.98E-03	pCi/L
5306	<0.01	-1.18E-03	0.01	1.60E-03	pCi/L
6306	<0.01	-1.33E-03	0.01	2.04E-03	pCi/L
7306	<0.01	2.45E-03	0.01	2.12E-03	pCi/L
8306	<0.01	2.32E-04	0.01	1.84E-03	pCi/L
9306	<0.01	-9.02E-04	0.01	2.10E-03	pCi/L
10306	<0.01	1.69E-04	0.01	2.16E-03	pCi/L

Table 3. Americium-241 Analysis of Dried Solids from the First Set of Samples from the Ten Test Plots

NTS Sample ID	Reported Result	Count Uncertainty	Reporting Limit	MDA	Units
1306	3.33E-01	6.7E-03	1.00E-04	4.43E-05	pCi/g
2306	2.04E+00	4.1E-02	1.00E-03	2.24E-04	pCi/g
3306	1.50E+00	3.0E-02	1.00E-04	5.54E-05	pCi/g
4306	1.12E+00	2.2E-02	1.00E-03	1.00E-04	pCi/g
5306	2.28E-01	4.6E-03	1.00E-04	3.66E-05	pCi/g
6306	3.27E-01	6.5E-03	1.00E-03	2.40E-04	pCi/g
7306	2.88E-01	5.8E-03	1.00E-04	3.44E-05	pCi/g
8306	3.19E-01	6.4E-03	1.00E-04	3.28E-05	pCi/g
9306	2.95E-01	5.9E-03	1.00E-04	3.85E-05	pCi/g
10306	2.31E-01	4.6E-03	1.00E-04	5.65E-05	pCi/g

Table 4. Weight of Unfiltered Water, % Recovery, and Dry Solids Content for the Second Set of Samples from the Ten Test Plots

NTS Sample ID	Gross Weight, grams	% Recovered	Dry Solids, mg/Kg
11006	33540	99.62	798
21006	5613	98.04	234
31006	24143	99.59	1532
41106	13400	99.49	686
51006	42229	99.40	1556
61006	1366	98.01	329
71006	27370	99.55	1887
81006	2568	98.01	2257
91006	22067	99.54	1098
101006	26672	99.31	1379

Table 5. Americium-241 Analysis of Filtered Water from the Second Set of Samples from the Ten Test Plots

NTS Sample ID	Result		Reporting Limit	MDA	Units
	Reported	Measured			
11006	<0.01	1.48E-04	0.01	1.97E-03	pCi/L
21006	<0.01	4.20E-03	0.01	1.91E-03	pCi/L
31006	<0.01	0.00E+00	0.01	1.49E-03	pCi/L
41106	<0.01	6.77E-03	0.01	2.00E-03	pCi/L
51006	<0.01	2.88E-03	0.01	1.42E-03	pCi/L
61006	<0.01	6.65E-03	0.01	1.57E-03	pCi/L
71006	<0.01	0.00E+00	0.01	2.09E-03	pCi/L
81006	<0.01	2.94E-03	0.01	1.91E-03	pCi/L
91006	<0.01	1.21E-03	0.01	1.93E-03	pCi/L
101006	<0.01	0.00E+00	0.01	1.98E-03	pCi/L

Table 6. Americium-241 Analysis of Dried Solids from the Second Set of Samples from the Ten Test Plots

NTS Sample ID	Reported Result	Count Uncertainty	Reporting Limit	MDA	Units
11006	2.58E-01	5.2E-03	1.00E-04	3.52E-05	pCi/g
21006	7.43E-01	1.5E-02	1.00E-03	3.80E-04	pCi/g
31006	1.20E+00	7.5E-01	1.00E-04	2.87E-05	pCi/g
41106	1.48E+00	3.0E-02	1.00E-04	5.26E-05	pCi/g
51006	2.44E-01	4.9E-03	1.00E-04	2.15E-05	pCi/g
61006	9.6E-02	1.9E-03	1.00E-02	1.10E-03	pCi/g
71006	5.34E-01	1.1E-02	1.00E-04	3.40E-05	pCi/g
81006	3.09E-01	6.2E-03	1.00E-03	1.34E-04	pCi/g
91006	3.18E-01	6.4E-03	1.00E-04	4.01E-05	pCi/g
101006	2.64E-01	5.3E-03	1.00E-04	4.28E-05	pCi/g

Table 7. Weight of Unfiltered Water, % Recovery, and Dry Solids Content for the Third Set of Samples from the Ten Test Plots

NTS Sample ID	Gross Weight, grams	% Recovered	Dry Solids, mg/Kg
1607	3409	98.81	818
2607	1555	98.34	13
3607	2420	99.41	901
4607	1814	99.63	33
5607	10750	99.75	1313
6607	1414	99.96	799
7607	3114	99.73	340
8607	1900	99.56	148
9607	1606	99.29	212
10607	1718	98.81	792

Table 8. Americium-241 Analysis of Dried Solids from the Third Set of Samples from the Ten Test Plots

NTS Sample ID	Reported Result	Count Uncertainty	Reporting Limit	MDA	Units
1607	1.95E-01	3.90E-03	1.00E-02	1.08E-03	pCi/g
2607	<1.00E-01	3.28E-04	1.00E-01	1.75E-02	pCi/g
3607	8.75E-01	1.75E-02	1.00E-03	2.96E-04	pCi/g
4607	9.43E-01	1.89E-02	1.00E-01	2.31E-02	pCi/g
5607	3.55E-01	7.10E-03	1.00E-04	5.20E-05	pCi/g
6607	1.13E-01	2.25E-03	1.00E-03	5.31E-04	pCi/g
7607	2.94E-01	5.88E-03	1.00E-03	9.78E-04	pCi/g
8607	2.18E-01	4.36E-03	1.00E-02	2.13E-03	pCi/g
9607	1.79E-01	3.57E-03	1.00E-02	1.93E-03	pCi/g
10607	1.42E-01	2.83E-03	1.00E-03	4.27E-04	pCi/g

Table 9. Particle Size Distribution of Solids from the First Set of Samples

Percent Cummulative Weights Retained								
NTS Sample ID --> / Screen Opening (microns)	1306	3306	4306	5306	7306	8306	9306	10306
4750	0.2%	0.0%	0.3%	0.1%	0.0%	1.8%	0.6%	1.1%
2000	2.4%	1.6%	3.6%	2.4%	1.7%	7.5%	11.8%	8.1%
300	10.0%	26.1%	21.5%	31.0%	20.6%	30.7%	44.2%	48.7%
180	16.5%	43.4%	30.2%	35.8%	33.1%	38.9%	50.8%	56.1%
150	19.6%	47.6%	33.8%	37.3%	43.0%	40.8%	56.4%	58.9%
75	34.3%	61.9%	41.4%	46.4%	65.4%	50.6%	71.6%	70.9%
63	45.2%	66.7%	47.5%	53.6%	74.3%	59.7%	77.3%	75.5%
38	57.1%	75.9%	55.9%	69.8%	80.5%	70.6%	85.5%	83.9%
0 (pan)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Initial Wt, g	25.07	47.57	22.16	48.76	159.21	22.07	128.23	95.50
Final Wt., g	24.47	44.94	21.42	47.62	154.95	21.28	124.10	93.02
% Recovered	97.6%	94.5%	96.6%	97.7%	97.3%	96.4%	96.8%	97.4%

Appendix 1. Chain of Custody Records

Bechtel Nevada

ANALYTICAL LABORATORY

SERVICES REQUEST AND CHAIN OF CUSTODY RECORD

Page 2 (1) of 3

PROJECT / CLIENT INFORMATION

Project: Navy / Encapco   BN Org#:

Charge Number:

Project Manager: Lloyd Desotell

Phone: 295-1754   Fax: M/S:

REPORT & TURNAROUND INFORMATION

Send Report to:

Phone: Fax: M/S:

Turnaround: ( ) Standard – 14 days IH, 28 days Non-rad Env, 45 days Rad Env
( ) RUSH Preliminary by: ______ (IH)
__1 __2 __7 __14 (non-Rad Env)
__1 __7 __14 __28 (Radiological Env)

SAMPLE INFORMATION

Sampling Site: Area 8

The samples submitted contain (check):

( ) **Hazardous** - *(list)*

( ) **Radioactive** - *(list)*

( ) **Unknown** contamination. If known, identify contaminants. This information will ensure compliance with applicable regulations and allow for the safe handling of the sample materials.

SAMPLE MANAGEMENT INFORMATION

SDG: ______ (IH) ______ (Non-Rad Env) ______ (Rad Env)

Samples submitted are associated with a signed Project SOW. ( ) YES ( ) NO

Analyses entered here agree with the SOW. ( ) YES ( ) NO ( ) N/A

If not, identify the variation:

Subcontract Lab(s) used for this work:

ID/DESCRIPTION	SAMPLING DATE	SAMPLING TIME	MATRIX	CONTAINER #	CONTAINER Est. Vol	QC MD	QC MS	QC MSD	Pres – Analysis eg. HCl - VOCs	Pay Item, Analysis, Method							
1306 a	3-16-06	1000	soil/water	1	18 L				γ-spec/Pu								
1306 b		1000			20												
2306		1040			15												
3306 a		1110			15												
3306 b		1110			19												
4306 a		1130			20												
4306 b		1130			7												
5306 a		1200			19												
5306 b					16												
5306 c					16												

CUSTODY TRANSFER

Sampled/Relinquished (print)	Signature	DATE / TIME	Received by (print)	Signature	DATE / TIME
Lloyd T. Desotell	[signature]	3-21-06 1110	Cheryl Schmit	Cheryl Schmit	3/21/06 1110
			Carl L. Rathz	Carl L. Rathz	4/7/06 12 NOON
Carl L. Rathz	[signature]	4/10/06 10:00	Steve Hoeffner	Steve Hoeffner	4/10/06 10:00 am

BN-0732 (04/02)

Bechtel Nevada

ANALYTICAL LABORATORY

SERVICES REQUEST AND CHAIN OF CUSTODY RECORD

PROJECT / CLIENT INFORMATION

Project: Navy / Encapco   BN Org#:

Charge Number:

Project Manager: Lloyd Desotell

Phone: 295-1454   Fax: M/S:

REPORT & TURNAROUND INFORMATION

Send Report to:

Phone: Fax: M/S:

Turnaround: ( ) Standard – 14 days IH, 28 days Non-rad Env, 45 days Rad Env
( ) RUSH Preliminary by: ______ (IH)
__1 __2 __7 __14 (non-Rad Env)
__1 __7 __14 __28 (Radiological Env)

SAMPLE INFORMATION

Sampling Site: Area 8

The samples submitted contain (check);

( ) **Hazardous** - *(list)*

( ) **Radioactive** - *(list)*

( ) **Unknown** contamination. If known, identify contaminants. This information will ensure compliance with applicable regulations and allow for the safe handling of the sample materials.

SAMPLE MANAGEMENT INFORMATION

SDG: ______ (IH) ______ (Non-Rad Env) ______ (Rad Env)

Samples submitted are associated with a signed Project SOW. ( ) YES ( ) NO

Analyses entered here agree with the SOW. ( ) YES ( ) NO ( ) N/A

If not, identify the variation:

Subcontract Lab(s) used for this work:

Pay Item, Analysis, Method

ID/DESCRIPTION	SAMPLING DATE	SAMPLING TIME	MATRIX	CONTAINER #	CONTAINER Est. Vol	QC MD	QC MS	QC MSD	Pres – Analysis eg. HCl - VOCs
6306	3-15-06	1240	soil/water	1	5 L				8 spec / Pu
7306 a		1215			19				
7306 b		1215			19				
7306 c		1215			20				
8306 a		1030			8				
8306 b		1030			20				
9306 a		1115			9				
9306 b					20				
9306 c					20				
9306 d	↓	↓	↓	↓	20 ↓				↓

CUSTODY TRANSFER

Sampled/Relinquished (print)	Signature	DATE / TIME	Received by (print)	Signature	DATE / TIME
Lloyd T Desotell	[signature]	3-21-06 1100	Cheryl Schmit	Cheryl Schmit	3/21/06 1110
			Carl L. Rathz	Carl L. Rathz	4/7/06 12 NOON
Carl L. Rathz	Carl L. Rathz	4/10/06 10:00	Steve Hoffner	Steve Hoffner	4/10/06 10:20 am

BN-0732 (04/02)

Bechtel Nevada

ANALYTICAL LABORATORY

SERVICES REQUEST AND CHAIN OF CUSTODY RECORD

PROJECT / CLIENT INFORMATION

Project: Navy / Encapco   BN Org#:

Charge Number:

Project Manager: Lloyd Desotell

Phone: 295-1454   Fax: M/S:

REPORT & TURNAROUND INFORMATION

Send Report to:

Phone: Fax: M/S:

Turnaround: ( ) Standard – 14 days IH, 28 days Non-rad Env, 45 days Rad Env
( ) RUSH Preliminary by: ____ (IH)
__ 1 __ 2 __ 7 __ 14 (non-Rad Env)
__ 1 __ 7 __ 14 __ 28 (Radiological Env)

SAMPLE INFORMATION

Sampling Site: Area 8

The samples submitted contain (check);

( ) **Hazardous** - *(list)*

( ) **Radioactive** - *(list)*

( ) **Unknown** contamination. If known, identify contaminants. This information will ensure compliance with applicable regulations and allow for the safe handling of the sample materials.

SAMPLE MANAGEMENT INFORMATION

SDG: ____ (IH) ____ (Non-Rad Env) ____ (Rad Env)

Samples submitted are associated with a signed Project SOW. ( ) YES ( ) NO

Analyses entered here agree with the SOW. ( ) YES ( ) NO ( ) N/A

If not, identify the variation:

Subcontract Lab(s) used for this work:

ID/DESCRIPTION	SAMPLING DATE	SAMPLING TIME	MATRIX	CONTAINER #	CONTAINER Est. Vol	QC MD	QC MS	QC MSD	Pres – Analysis eg. HCl - VOCs	Pay Item, Analysis, Method							
103060 a	3-15-06	1140	soil/water	1	20 L				γ-spec/Pu								
103060 b	↓	↓	↓	↓	19 ↓				↓								
103060 c	↓	↓	↓	↓	18 ↓				↓								
S031506a	3-15-06		water	1	1L				γ-spec/Pu								
S031506b	↓		↓	↓	↓				↓								
S031606a	3-16-06		↓	↓	↓				↓								
S031606 b	↓		↓	↓	↓				↓								

CUSTODY TRANSFER

Sampled/Relinquished (print)	Signature	DATE / TIME	Received by (print)	Signature	DATE / TIME
Lloyd T Desotell	[signature]	3-21-06 1110	Cheryl Schmit	[signature]	3/21/06 1110
			Carl L. Rathz	[signature]	4/7/06 12 NOON
Carl L. Rathz	[signature]	4/10/06 10:00	Steve Hoeffner	[signature]	4/10/06 10:00am

BN-0732 (04/02)

Sample Notes

Sample ID	Test Plot ID
1306a	1
1306b	1
2306	2
3306a	3
3306b	3
4306a	4
4306b	4
5306a	5
5306b	5
5306c	5
6306	6
7306a	7
7306b	7
7306c	7
8306a	8
8306b	8
9306a	9
9306b	9
9306c	9
9306d	9
10306a	10
10306b	10
10306c	10

composite containers into 10 total for analyses based or the IDs to the left.

National Security Technologies LLC

GENERAL SHIPPING ORDER

NO. 2067056

OFF-SITE

10/26/2006 1:16PM

SHIP FROM	SHIPMENT INFORMATION	SHIP TO
NSTec FOR USDOE NEVADA TEST SITE RECEIVING WAREHOUSE 160 MERCURY, NV 89023, USA LLOYD DESOTELL at 702/295-1494 NTS AREA 23 WHSE 160	REASON: GENERAL MOVEMENT (NO HAZ/RAM) REQUIRED AT DESTINATION: 11/02/2006 CHARGES: PREPAID CARRIER: ROADWAY EXPRESS INC PIECE(S): 1 WEIGHT: 676 LBS SHIP DATE: 10/30/2006 ARRIVAL DATE: 11/13/2006 CHARGE/ORG NO: 5ELCSTAB/H120	CLEMSON ENVIRONMENTAL TECHNOLOGIES LAB (CETL) 100 TECHNOLOGY DRIVE BOX 345740 ANDERSON, SC 29625, USA STEVE HOEFFNER at 864/646-2413 REFERENCE NO.: N/A

LI	PROPERTY NO.	SERIAL NO.	MATERIAL DESCRIPTION	QUANTITY	U/M
1			WATER/SOIL SAMPLES	20.00	EA
			PLEASE PACK INDIVIDUALLY AND FILL BOX WITH VERMICULITE. COMPLETE PHONE NUMBER OF CONTACT IS 864/646-2413, EXTENSION 264.		

BN-0947

Bechtel Nevada NSTec

ANALYTICAL LABORATORY

SERVICES REQUEST AND CHAIN OF CUSTODY RECORD

PROJECT / CLIENT INFORMATION

Project: Navy / Encapco   BN Org#:

Charge Number:

Project Manager: Lloyd Desotell

Phone: 295-1494   Fax: M/S:

REPORT & TURNAROUND INFORMATION

Send Report to:

Phone: Fax: M/S:

Turnaround ( ) Standard – 14 days IH, 28 days Non-rad Env, 45 days Rad Env
( ) RUSH Preliminary by: ______ (IH)
__1 __2 __7 __14 (non-Rad Env)
__1 __7 __14 __28 (Radiological Env)

SAMPLE INFORMATION

Sampling Site: Area 8

The samples submitted contain (check):

( ) **Hazardous** - *(list)*

( ) **Radioactive** - *(list)*

( ) **Unknown** contamination. If known, identify contaminants. This information will ensure compliance with applicable regulations and allow for the safe handling of the sample materials.

SAMPLE MANAGEMENT INFORMATION

SDG: ______ (IH) ______ (Non-Rad Env) ______ (Rad Env)

Samples submitted are associated with a signed Project SOW. ( ) YES ( ) NO

Analyses entered here agree with the SOW. ( ) YES ( ) NO ( ) N/A

If not, identify the variation:

Subcontract Lab(s) used for this work:

ID/DESCRIPTION	SAMPLING DATE	SAMPLING TIME	MATRIX	CONTAINER #	CONTAINER Est. Vol (L)	QC MD	QC MS	QC MSD	Pres – Analysis eg. HCl - VOCs	Pay Item, Analysis, Method							
1006 a	10-24-06	1045	soil/water	1	15				γ-spec								
11006 b	↓	1045	↓	↓	20				↓								
21006	↓	1105	↓	↓	6				↓								
31006 a	↓	1145	↓	↓	7				↓								
31006 b	↓	1145	↓	↓	20				↓								
41006 a	↓	1125	↓	↓	20				↓								
41006 b	↓	↓	↓	↓	10				↓								
41006 c	↓	↓	↓	↓	20				↓								
51006 a	↓	1210	↓	↓	20				↓								
51006 b	↓	1210	↓	↓	5				↓								

CUSTODY TRANSFER

Sampled/Relinquished (print)	Signature	DATE / TIME	Received by (print)	Signature	DATE / TIME
Lloyd T. Desotell	[signature]	10-25-06 15:30	Fred G Garcia Jr	[signature]	10-25-06 15:30
			Steve Hoffner	[signature]	11/8/06 11:30 am

BN-0732 (04/02)

Bechtel Nevada NSTec

ANALYTICAL LABORATORY

SERVICES REQUEST AND CHAIN OF CUSTODY RECORD

PROJECT / CLIENT INFORMATION

Project: Navy / Encapes   BN Org#:

Charge Number:

Project Manager: Lloyd Desotell

Phone: 295-1494   Fax: M/S:

REPORT & TURNAROUND INFORMATION

Send Report to:

Phone: Fax: M/S:

Turnaround ( ) Standard – 14 days IH, 28 days Non-rad Env, 45 days Rad Env
( ) RUSH Preliminary by: ______ (IH)
__1 __2 __7 __14 (non-Rad Env)
__1 __7 __14 __28 (Radiological Env)

SAMPLE INFORMATION

Sampling Site: Area 8

The samples submitted contain (check):

( ) **Hazardous** - *(list)*

( ) **Radioactive** - *(list)*

( ) **Unknown** contamination. If known, identify contaminants. This information will ensure compliance with applicable regulations and allow for the safe handling of the sample materials.

SAMPLE MANAGEMENT INFORMATION

SDG: ______ (IH) ______ (Non-Rad Env) ______ (Rad Env)

Samples submitted are associated with a signed Project SOW. ( ) YES ( ) NO

Analyses entered here agree with the SOW. ( ) YES ( ) NO ( ) N/A

If not, identify the variation:

Subcontract Lab(s) used for this work:

Pay Item, Analysis, Method

ID/DESCRIPTION	SAMPLING DATE	SAMPLING TIME	MATRIX	CONTAINER (L) #	CONTAINER (L) Est. Vol	QC MD	QC MS	QC MSD	Pres – Analysis eg. HCl - VOCs
51006c	10-24-06		soil/water	1	20				γ-spec
61006		1345			1				
71006a		1400			8				
71006b		1400			20				
81006		1430			3				
91006a		1440			4				
91006b		1440			20				
101006a		1230			20				
101006b		1230			10				
S102406	↓	1200	↓	↓	1				↓

CUSTODY TRANSFER

Sampled/Relinquished (print)	Signature	DATE / TIME	Received by (print)	Signature	DATE / TIME
Lloyd Desotell	[signature]	10-25-06 1530	Fred Garcia	[signature]	10-25-06 15:30
			Steve Hoeffner	[signature]	11/8/06 11:30am

BN-0732 (04/02)

Sample ID	Test Plot ID
11006a	1
11006b	1
21006	2
31006a	3
31006b	3
41006a	4
41006b	4
41006c	4
51006a	5
51006b	5
51006c	5
61006	6
71006a	7
71006b	7
81006	8
91006a	9
91006b	9
101006a	10
101006b	10

composite 5 gallon containers into 10 total samples for analyses based on the IDs to the left

Call Lloyd Desotell
@ (702) 295-1494
if there are questions

National Security Technologies LLC

GENERAL SHIPPING ORDER

NO. 2067608

OFF-SITE

11/21/2006 8:01AM

SHIP FROM	SHIPMENT INFORMATION	SHIP TO
NSTec FOR USDOE NEVADA TEST SITE RECEIVING WAREHOUSE 160 MERCURY, NV 89023, USA LLOYD DESOTELL at 702/295-1494 NTS AREA 23 WHSE 160	REASON: GENERAL MOVEMENT (NO HAZ/RAM) REQUIRED AT DESTINATION: 11/22/2006 CHARGES: PREPAID CARRIER: FEDEX PRIORITY OVERNIGHT PIECE(S): 1 WEIGHT: 44 LBS SHIP DATE: 11/21/2006 ARRIVAL DATE: 11/22/2006 CHARGE/ORG NO: 5ELCSTAB/H120	CLEMSON ENVIRONMENTAL TECHNOLOGIES LAB 100 TECHNOLOGY DRIVE, P.O. BOX 345740 ANDERSON, SC 29625, USA STEVE HOEFFNER at 864/646-2413 REFERENCE NO.: N/A

LI	PROPERTY NO.	SERIAL NO.	MATERIAL DESCRIPTION	QUANTITY	U/M
1			SAMPLE CONTAINERS STEVE HOEFFNER, 864-646-2413, EXETENSION 264. FEDEX. PACK WITH VERMICULITE.	1.00	BX

THIS SHIPMENT CONTAINS PRECISION MATERIALS/EQUIPMENT.

ENSURE DISPOSITION OF CONTENTS PRIOR TO RECEIPT OR REMOVAL FROM RECEIVING DOCK. IF DAMAGE IS OBSERVED, NOTE ON CARRIER'S DELIVERY RECEIPT AND CONTACT NSTec AT (702)295-3266. REFERENCE THE SHIPPING ORDER NUMBER LISTED ABOVE.

BN-0947

NSTec

ANALYTICAL LABORATORY

SERVICES REQUEST AND CHAIN OF CUSTODY RECORD

Page 1 of 1

PROJECT / CLIENT INFORMATION

Project: Navy Encapes BN Org#:

Charge Number:

Project Manager: Lloyd Desotell

Phone: (702) 295-1494 Fax: M/S:

REPORT & TURNAROUND INFORMATION

Send Report to:

Phone: Fax: M/S:

Turnaround: ( ) Standard 14 days IH, 28 days Non-rad Env, 45 days Rad Env
( ) RUSH Preliminary by: ______ (IH)
__ 1 __ 2 __ 7 __ 14 (non-Rad Env)
__ 1 __ 7 __ 14 __ 28 (Radiological Env)

SAMPLE INFORMATION

Sampling Site: Area 8

The samples submitted contain (check);

( ) **Hazardous** - *(list)* ______

( ) **Radioactive** - *(list)* ______

( ) **Unknown** contamination. If known, identify contaminants. This information will ensure compliance with applicable regulations and allow for the safe handling of the sample materials.

SAMPLE MANAGEMENT INFORMATION

SDG: ______ (IH) ______ (Non-Rad Env) ______ (Rad Env)

Samples submitted are associated with a signed Project SOW. ( ) YES ( ) NO

Analyses entered here agree with the SOW. ( ) YES ( ) NO ( ) N/A

If not, identify the variation: ______

Subcontract Lab(s) used for this work: ______

ID/DESCRIPTION	SAMPLING DATE	SAMPLING TIME	MATRIX	CONTAINER #	CONTAINER Est. Vol	QC MD	QC MS	QC MSD	Pres – Analysis eg. HCl - VOCs	Pay Item, Analysis, Method							
4/1106	11-20-06	11:15	soil/water	1	~~13L~~ 20L				γ-spec								

CUSTODY TRANSFER

Sampled/Relinquished (print)	Signature	DATE / TIME	Received by (print)	Signature	DATE / TIME
Lloyd T. Desotell	Lloyd T. Desotell	11-20-06	Wayne Brozelle	Wayne Brozelle	11-20-06
			Steve Hoeffner	Steve Hoeffner	11-27-06

FRM-0732 (11/06)

Appendix 2.

Table A2.1. Duplicate Analyses, Confirmation of Efficiency Curve, and Counting of Tamped and Un-Tamped Samples – First Set.

Sample ID	Total Wt.	pCi/g	pCi/g Reported
2306			
2306	4.5	0.923	
2306 untamped	4.5	0.779	
2306 + sand	147.6	2.106	
2306 + sand	147.6	2.102	
2306 + sand	147.6	3.274	
2306 + sand	147.6	1.929	
2306 + sand	147.6	2.038	2.04
3306			
3306	47.73	1.504	
3306 untamped	47.73	1.753	1.5
5306			
5306	48.18	0.228	
5306 untamped	48.18	0.220	0.228
6306			
6306	2.97	0.093	
6306 DUP	2.97	0.097	
6306 + 17.46g sand	20.43	0.250	
6306 + 17.46g sand	20.43	0.242	
6306 + 17.46g sand	20.43	0.258	
6306 + 17.46g sand	20.43	0.252	
6306 + 47.16g sand	50.13	0.335	
6306 + 47.16g sand	50.13	0.310	
6306 + 47.16g sand	50.13	0.326	
6306 + 96.99g sand	99.96	0.327	
6306 + 96.99g sand	99.96	0.354	0.327
10306			
10306	94.44	0.231	
10306 DUP	94.44	0.231	0.231

Comments:

1) Duplicate analyses indicate good reproducibility (6303, 2.97 grams and 10306).
2) No consistent or significant difference between tamped and un-tamped samples (2306, 3306 and 5306).
3) Weights below 20 grams are outside the efficiency calibration curve and do not provide quantitative results (2306, 4.5 grams and 6303 2.97 grams).
4) Weights above 20 grams, and especially above 50 grams, provide good quantitative and self-consistent results (see 2306 and 6306 series).

Table A2.2. Duplicate Analyses from Second Set of Samples.

Sample ID	Total Wt.	pCi/g	pCi/g Reported
21006			
21006 + 50.88g sand	52.17	0.720	
21007 + 50.88g sand	52.17	0.777	
21008 + 50.88g sand	52.17	0.732	0.743
31006			
31006	37.38	1.159	
31006	37.38	1.162	
31006	37.38	1.265	1.20
41006			
41106 + 45.09g sand	54.39	1.453	
41106 + 45.09g sand	54.39	1.492	
41106 + 45.09g sand	54.39	1.485	1.48
61006			
61006 + 53.82g sand	54.27	0.092	
61006 + 53.82g sand	54.27	0.096	
61006 + 53.82g sand	54.27	0.101	0.096
81006			
81006 + 50.29g sand	55.99	0.309	
81006 + 50.29g sand	55.99	0.302	
81006 + 50.29g sand	55.99	0.317	0.309