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## **Technical Work Plan for: Meteorological Monitoring and Data Analysis**

Prepared for:  
U.S. Department of Energy  
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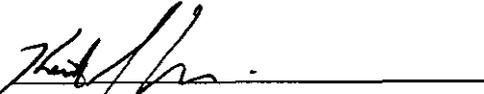
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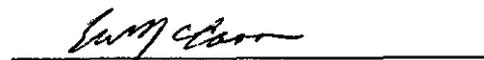
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## REVISION HISTORY

<b>Revision Number</b>	<b>Date of Revision</b>	<b>Purpose of the Revision</b>
00	10/01/2000	Initial issue
0A		Detail on the Meteorological Monitoring Program
0B		FY2001 Activity Evaluation for WP#72012152N4(A) – Meteorology, and WP#72012152N4(B) – M&TE
0C	03/08/2001	Revised FY2001 Activity Evaluation to include ISMQAP applicability evaluation with grading report
0D	01/04/02	Add new FY2002 Activity Evaluation and ISMQAP grading report
01	05/30/2002	Revision 1 issued to satisfy DR-BSC-02-D-095. Minor editorial changes were made
02	03/27/2003	Revised to comply with AP-2.27Q and to satisfy BSC(B)-03-D-076
03	01/20/2006	Revised to update references to procedures, organizational changes, and add precipitation sample collection workscope.

## ACRONYMS AND ABBREVIATIONS

BSC	Bechtel SAIC Company, LLC
DOE	U.S. Department of Energy
ES&H	Environmental Safety and Health
M&TE	measuring and test equipment
ORD	Office of Repository Development
TDMS	Technical Data Management System
USGS	United States Geological Survey

## 1. Work Scope

The meteorological monitoring and analysis program has five objectives.

- 1) Acquire qualified meteorological data from YMP meteorological monitoring network using appropriate controls on measuring and test equipment. Because this activity is monitoring (i.e., recording naturally occurring events) pre-test predictions are not applicable. All work will be completed in accordance with U.S. Department of Energy (DOE) Office of Repository Development (ORD) administrative procedures and Bechtel SAIC Co., LLC (BSC) line procedures. The meteorological monitoring program includes measuring and test equipment calibrations, operational checks, preventive and corrective maintenance, and data collection.
- 2) Process the raw monitoring data collected in the field and submit technically reviewed, traceable data to the Technical Data Management System (TDMS) and the Records Processing Center.
- 3) Develop analyses or calculations to provide information to data requesters and provide data sets as requested.
- 4) Provide precipitation amounts to Site Operations to support requirements to perform inspections in the Stormwater Pollution Prevention Plan (implemented in LP-OM-050Q-BSC) following storm events of greater than 0.5 inches. The program also provides meteorological data during extreme weather conditions (e.g., high winds, rainstorms, etc.) to support decisions regarding worker safety.
- 5) Collect samples of precipitation for chemical and isotopic analysis by the United States Geological Survey (USGS).

The BSC ES&H Environmental Compliance organization is responsible for performing this work. Data from calendar-year periods are submitted to the TDMS to provide YMP users with qualified meteorological data for scientific modeling and analyses, engineering designs of surface facilities, performance assessment analyses, and operational safety issues.

## 2. Scientific Approach and Technical Methods

The scientific approach for the design and operation of the program is to acquire meteorological data intended to satisfy information needs for atmospheric modeling, environmental monitoring, and weather-related design purposes. Modeling activities are not included in the scope of this plan. Data are being used for pre-closure safety analyses, engineering design, and the biosphere analyses.

The technical methods used to acquire the meteorological data are based on regulatory agency monitoring guidance and applicable standards. The numerical uncertainty associated with the information collected is expressed as the measurement tolerances that are taken

from the guidance documents discussed in Sections 2.2 and 3. Details on the approach and methods follow in this section.

## 2.1 Scientific Approach

Meteorological monitoring guidance applicable in the complex terrain in the Yucca Mountain area states that site-specific data should be obtained from a network of stations rather than a single location (NRC 1987, p.2.3.2-2; ANSI/ANS-3.11-2000, p.7). The stations acquire data for a full range of meteorological parameters for the atmospheric dispersion and other purposes mentioned above. The remaining stations provide detailed information on the spatial distribution and temporal occurrence of precipitation events in the area. Details on the monitoring network are presented in Addendum A. Work is performed under Field Work Package FWP-SB-99-001, *Field Activities in Support of Meteorological Programs*.

The monitoring work was designed to satisfy environmental monitoring requirements contained in DOE Order 450.1. The line procedures are linked to the relevant portions of this order through the BSC requirements management system.

The field measurements of meteorological conditions are processed using on-site data loggers into various mean, extreme, standard deviation, and total summaries using ten-minute, hourly, and daily time periods. Wind gusts occurring in a 3-second period are recorded, as are the extreme daily 1-minute average wind speed and temperature values. The main summaries of all measurements are made for 10-minute and 1-hour time periods, with some daily summary values recorded. In addition, quality control steps include identifying instantaneous extreme values to assist in identifying possible periods of malfunctioning equipment.

Meteorological data collected in this program have been used to characterize Features, Events, and Processes (FEP) 2.3.11.01.0A, *Precipitation* and 2.3.13.01.0A, *Biosphere Characteristics* (BSC 2005a, 2005b).

## 2.2 Technical Methods

The monitoring work is designed to satisfy nuclear and environmental regulatory requirements and guidance, and internal ORD requirements. Applicable line procedures are identified in Section 6. The field operations work is described in *Field Activities in Support of Meteorological Programs* (BSC 2006). The primary monitoring guidance documents are:

- **ANSI/ANS-3.11-2000** - *National Standard for Determining Meteorological Information at Nuclear Facilities*. This standard covers topics such as instrumentation, locating monitoring stations, data handling, and quality assurance.
- **NRC Regulatory Guide 1.23** - *Onsite Meteorological Programs (Safety Guide 23)* (NRC 1972). This is the approved U.S. Nuclear Regulatory Commission guide for meteorological monitoring. The principles of this regulatory guide are incorporated into the meteorological monitoring program, but specific items are excluded because they are no longer practiced in the industry due to technology improvements.

- **Environmental Protection Agency Guidance Documents-*Meteorological Monitoring Guidance for Regulatory Modeling Applications*** (EPA 2000). Detailed technical guidance from the U.S. Environmental Protection Agency on quality assurance applied to meteorological measurements, equipment installation, operations, and calibrations are included in these comprehensive documents.

### 3. Standards and Criteria

Applicable standards and criteria for accuracy, precision, and representativeness are discussed in this section.

#### 3.1 Standards

The monitoring guidance and standards documents listed in Section 2 are the primary references used in performing the monitoring and data processing work. Some of the calibration methods, instrument exposure requirements, and data recording methods are based on ASTM meteorological standard practices and test methods. These standards include:

- D5741: *Standard Practice for Characterizing Surface Wind Using a Wind Vane and Rotating Anemometer*
- D5096: *Standard Test Method for Determining the Performance of a Cup Anemometer or Propeller Anemometer*
- D5366: *Standard Test Method for Determining the Performance of a Wind Vane*
- D3631: *Standard Test Methods for Measuring Surface Atmospheric Pressure*
- D6176M: *Standard Practice for Measuring Surface Atmospheric Temperature with Electrical Resistance Temperature Sensors.*

The monitoring program uses operating equipment to measure conditions and collect data, and test equipment to calibrate and check the operating equipment. The calibrations and checks are performed using standards that comply with LP-12.1Q-BSC, *Control of Measuring and Test Equipment*. The procedure requires that the calibration standards are either traceable to nationally recognized standards, such as the National Institute of Standards and Technology, or demonstrate justification for use of another standard.

#### 3.2 Criteria

The meteorological monitoring program collects, analyzes, and reports information that is used in subsequent presentations and analyses. There are no specific criteria for precision of the meteorological measurements as there is no precision assessment being performed.

The accuracy criteria for the measurements are based on the regulatory guidance documents

identified in Section 2. The criteria are expressed as acceptable tolerances on the difference values calculated during calibration and performance check quality control activities. These criteria are summarized in Table A-2.

The semi-annual independent performance audits required by the U.S. Environmental Protection Agency regulatory monitoring guidance (EPA 2000) provides one additional accuracy assessment. The audit produces results using equipment and staff independent from those used during normal operations and maintenance activities.

Regulatory monitoring guidance specifies that the data be representative and complete. To be representative, the data should correctly describe the locations and conditions suitable for the intended purposes. The site locations are described in Addendum A. The distribution of sites in the monitoring network was based on the guidance documents listed in Section 2.2.

The completeness criterion is satisfied for most guidance when valid data are available from at least 90 percent of the monitoring period. The missing portions should not occur during long single periods or during likely critical conditions.

### **3.3 Requirements**

The Stormwater Pollution Prevention Plan has an inspection requirement that all storm water control measures will be inspected at least once every 7 calendar days and within 24 hours following any storm event of 0.5 inches or greater. This requirement is implemented by Site Operations through LP-OM-050Q-BSC, *Visual Observations of Drainage Ditches and Graded Roads and Pads*. Precipitation events that exceed the 0.5-inch threshold for any of the meteorological monitoring stations are reported to Site Operations.

No Key Technical Issues from the Nuclear Regulatory Commission are addressed in the meteorological monitoring program.

## **4. Implementing Documents**

The Project procedures required to perform the work include, but are not limited to:

*AP-5.2Q, Testing Work Implementation and Control*

*AP-16.1Q, Condition Reporting and Resolution*

*AP-ESH-004, Occupational Safety and Health Program*

*AP-SIII.3Q, Submittal and Incorporation of Data to the Technical Data Management System*

*CM-PRO-1001, Request for Offsite Affiliates and Loaned Personnel Services*

*EG-PRO-3DP-G06B-00002, Subcontracts*

*EG-PRO-3DP-G04B-00057, Technical Service Contracts*

*EV-PRO-5011, Collection of Precipitation Samples for Analysis of Isotope Composition*

*FWP-SB-99-001, Field Activities in Support of Meteorological Programs*

*GM-PRO-1001, Procedure Development*

GM-PRO-4000, *Management Self-Assessments and Organizational Self-Assessments*  
LP-2.14Q-BSC, *Document Review*  
LP-2.29QBSC, *Planning for Science Activities*  
LP-3.15Q-BSC, *Managing Technical Product Inputs*  
LP-4.5Q-BSC, *Requisitions and Procurement Documents*  
LP-12.1Q-BSC, *Control of Measuring and Test Equipment*  
LP-CAL-004Q-BSC, *Analytical Balance Calibration*  
LP-MM-001Q-BSC, *Tests and Checks of Meteorological Measuring and Test Equipment*  
LP-MM-002Q-BSC, *Test, Checks, and Performance Audits of Meteorological Equipment*  
LP-MM-003Q-BSC, *Routine Operations and Maintenance of Meteorological Equipment*  
LP-MM-004Q-BSC, *Meteorological Data Processing*  
LP-OM-014-BSC, *Fall Protection Procedure*  
LP-OM-025-BSC, *Ladders/Scaffolding*  
LP-SI.11Q-BSC, *Software Management*  
LP-SII.3Q-BSC, *Collection, Submission, Return, and Documentation of Non-Core and Non  
Cuttings Samples/Specimens to the Sample Management Facility*  
LP-SV.1Q-BSC, *Control of the Electronic Management of Information*  
OP-PRO-9110, *Site Access Control*  
QA-PRO-1071, *Acceptance of Items & Services*

## **5. Equipment**

Suitable meteorological monitoring equipment is procured, installed, and operated for the conditions occurring on and around Yucca Mountain. The site locations and equipment used in the measurements are described in Addendum A.

The line procedures implement the equipment controls contained in LP-12.1Q-BSC. Environmental Compliance staff, following LP-MM-001Q-BSC and LP-MM-002Q-BSC, calibrates some of the calibration standards and operational monitoring equipment. Standards that are used to calibrate other standards are calibrated by outside vendors and have accuracy greater than that of the item being calibrated. Other equipment, such as the wind sensors and some electronic measuring and test equipment (M&TE) is calibrated by outside vendors. Most M&TE and operating equipment have a one-year calibration period, although equipment may be stored for three years prior to activating the calibration period.

## **6. Records**

Records generated by work associated with this plan include the documentation of field monitoring activities produced by the specific line procedures governing that portion of the work. The work includes routine operations and maintenance, calibrations and checks, and data processing tasks. The technical product resulting from the monitoring work includes data submittals to the TDMS and the Records Processing Center.

## 7. Quality Verifications

An independent auditor using M&TE independent of that used by the meteorological staff for routine performance checks and calibrations conducts semi-annual performance audits to verify the performance and calibrations of the data collection systems and sensors (LP-MM-002Q-BSC). The ES&H organization performs self-assessments in accordance with GM-PRO-4000, *Management Self-Assessments and Organizational Self-Assessments*.

## 8. Prerequisites, Special Controls, Environmental Conditions, Processes or Skills

The meteorological monitoring and data analysis program is subject to the requirements of *Quality Assurance Requirements and Description* (DOE 2004a). The data produced in this program may be used to assess potential dispersion of radioactive materials from the licensed facility.

The work associated with the program is subject to the *Augmented Quality Assurance Program* (DOE 2004b). Special quality assurance controls are not required for this activity. Two levels of personnel safety hazards and controls exist in the meteorological monitoring and analysis program. Standard office practices apply to work in the offices (in the field and in the Summerlin complex). The field monitoring work contains certain low risks associated with personnel working with tools and being exposed to environmental conditions. The risks associated with the field monitoring work are incorporated into line procedures according to integrated safety management principles and project guidance.

There are no prerequisites or special controls applicable to this program. The quality control and quality assurance activities associated with this program are adequate to assure the quality of the results and the technical product.

Operational equipment and M&TE in long-term storage prior to activating the calibration period must be stored in a secure, indoor location. Precipitation samples collected for chemical and isotopic analysis should be protected from freezing temperatures during handling, storage, and shipping to prevent container rupture by ice formation. Precipitation samples also shall be stored in airtight containers to prevent evaporation.

There are no special controls, processes, or skills required for meteorological monitoring and data analysis activities.

The meteorological monitoring and data analysis program includes the electronic storage and transfer of data. A process control evaluation was performed in accordance with LP-SV.1Q-BSC, *Control of the Electronic Management of Information*, which showed satisfactory controls in place through the data handling line procedures.

## 9. Software

The EFPData software (PC. 10420-4.2.1-00) routine (BSC 2004) imports the raw data files into a database by date and time according to data type and monitoring site. The routine also identifies missing data periods and "flags" (highlights the data to an operator) data that exceed expected threshold values. It also performs atmospheric humidity calculations to convert relative humidity to dew-point temperature. The routine is also used to edit the database during data validation, and the edits are documented in a separate file. This routine was developed in accordance with LP-SI.11Q-BSC, *Software Management* and is qualified software that is maintained on the software baseline. Microsoft Access 2000 and Excel software are used for data storage and manipulation. Neither software package requires a software tracking number.

Software is used to verify the correct transfer of electronic data. The checking is described in the line procedures controlling the data transfer operations.

The on-site data logger produces input files that are controlled within the routine operations line procedure. Continuous use software is not used.

## 10. Organizational Interfaces

The USGS provides the materials (collection devices, glass transfer vials, etc.) for the collection of the precipitation samples. BSC collects the precipitation samples according to EV-PRO-5011, *Collection of Precipitation Samples for Analysis of Isotope Composition* and transfers the samples to the USGS for analysis through the Sample Management Facility in accordance with LP-SII.3Q-BSC, *Collection, Submission, Return, and Documentation of Non-Core and Non Cuttings Samples/Specimens to the Sample Management Facility*.

Output of this work includes meteorological data in the TDMS plus any specific climatological and wind summaries requested by users. The meteorological monitoring data from the TDMS can be used to describe atmospheric dispersion and local meteorological conditions. These descriptions support the preclosure radiological safety analyses, engineering design of surface facilities, and performance assessment.

Precipitation events that exceed the 0.5-inch threshold for any of the meteorological monitoring stations are reported to Site Operations.

The monitoring work includes procurements of equipment and services from outside vendors, and contracted independent "performance audits" accomplished to satisfy regulatory guidance. Environmental Compliance personnel responsible for the M&TE procure the material and service using standard project procedures.

Meteorological site technicians, working in Area 25 of the Nevada Test Site, work in compliance with the Test Coordination Office and work to an approved Test Work Authorization. The work complies with procedures controlling work in that area.

## 11. Procurement

Procurements for the meteorological monitoring consist of purchases of equipment to replace old instrumentation and subcontract services for calibration of weather sensors. Procurements are executed under LP-4.5Q-BSC, *Requisitions and Procurement Documents*. Subcontracts and/or Technical Service Agreements for the calibration of instrumentation are processed through EG-PRO-3DP-G06B-00002, *Subcontracts* and EG-PRO-3DP-G04B-00057, *Technical Service Contracts* as applicable. The acceptability and documentation of acceptance for procured items or services are processed through QA-PRO-1071, *Acceptance of Items & Services*.

## 12. References

### 12.1 Documents Cited

BSC 2004. *EFPData*. V.4.2.1. PC. 10420-4.2.1-00.

BSC 2005a. *Features, Events, and Processes in UZ Flow and Transport*. ANL-NBS-MD-000001, Rev 04. Las Vegas, Nevada: Bechtel SAIC Company, LLC. ACC: DOC.20050809.0002

BSC 2005b. *Evaluation of Features, Events, and Processes (FEP) for the Biosphere Model*. ANL-MGR-MD-000011, Rev 05. Las Vegas, Nevada: Bechtel SAIC Company, LLC. ACC: DOC.20050718.0006

BSC 2006. *Field Activities in Support of Meteorological Programs*. FWP-SB-99-001, Rev 02. Las Vegas, Nevada: Bechtel SAIC Company, LLC.

DOE (U.S. Department of Energy) 2004a. *Quality Assurance Requirements and Description*. DOE/RW-0333P, Rev. 16. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20040907.0002.

DOE (U.S. Department of Energy) 2004b. *Augmented Quality Assurance Program*. DOE/RW-0565, Rev. 0. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20040813.0001.

EPA (U.S. Environmental Protection Agency) 2000. *Meteorological Monitoring Guidance for Regulatory Modeling Applications*. EPA-454/R-00-005. Research Triangle Park, NC: U.S. Environmental Protection Agency. TIC: 253879.

NRC (U.S. Nuclear Regulatory Commission) 1987. *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants*. NUREG-0800. LWR Edition. Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 203894.

## 12.2 Codes, Standards, Regulations, and Procedures

ANSI/ANS-3.11-2000. *American National Standard for Determining Meteorological Information at Nuclear Facilities*. La Grange Park, Illinois: American Nuclear Society. TIC: 248540.

ASTM D 3631-99. 1999. *Standard Test Methods for Measuring Surface Atmospheric Pressure*. West Conshohocken, Pennsylvania: American Society for Testing and Materials. TIC: 253821.

ASTM D 5096-02. 2002. *Standard Test Method for Determining the Performance of a Cup Anemometer or Propeller Anemometer*. West Conshohocken, Pennsylvania: American Society for Testing and Materials. TIC: 253819.

ASTM D 5366-96. 1996. *Standard Test Method for Determining the Dynamic Performance of a Wind Vane*. West Conshohocken, Pennsylvania: American Society for Testing and Materials. TIC: 253820.

ASTM D 5741-96. 1998. *Standard Practice for Characterizing Surface Wind Using a Wind Vane and Rotating Anemometer*. West Conshohocken, Pennsylvania: American Society for Testing and Materials. TIC: 236772.

ASTM D 6176M-97. 1998. *Standard Practice for Measuring Surface Atmospheric Temperature with Electrical Resistance Temperature Sensors*. West Conshohocken, Pennsylvania: American Society for Testing and Materials. TIC: 253822.

DOE Order 450.1, Change 2. 2005. *Environmental Protection Policy*. Washington, D.C.: U.S. Department of Energy. Readily available.

EG-PRO-3DP-G06B-00002, Rev 1, *Subcontracts*. Las Vegas, NV: Bechtel SAIC Company, LLC. ACC: ENG.20060105.0001

EV-PRO-5011, Rev 0, *Collection of Precipitation Samples for Analysis of Isotope Composition*. Las Vegas, NV: Bechtel SAIC Company, LLC. ACC: DOC.20060130.0005

EG-PRO-3DP-G04B-00057, Rev 0, *Technical Service Contracts*. Las Vegas, NV: Bechtel SAIC Company, LLC. ACC: ENG.20051220.0021

LP-4.5Q-BSC, Rev 4, ICN 2. *Requisitions and Procurement Documents*. Las Vegas, NV: Bechtel SAIC Company, LLC. ACC: DOC.20050817.0006

LP-12.1Q-BSC, Rev 0, ICN 1. *Control of Measuring and Test Equipment*. Las Vegas, NV: Bechtel SAIC Company, LLC. ACC: DOC.20051025.0002.

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LP-MM-002Q-BSC, Rev 1, ICN 0. *Tests, Checks, and Performance Audits of Meteorological Equipment*. Las Vegas, NV: Bechtel SAIC Company, LLC. ACC: DOC.20050427.0008.

LP-OM-050Q-BSC, *Visual Observations of Drainage Ditches and Graded Roads and Pads*. Las Vegas, NV: Bechtel SAIC Company, LLC. ACC: DOC.20050719.0006

LP-SI.11Q-BSC, Rev. 0, ICN 1. *Software Management*. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20041005.0008.

LP-SV.1Q, Rev. 0, ICN 0, *Control of the Electronic Management of Information*. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20050531.0002.

QA-PRO-1071, Rev 1, *Acceptance of Items & Services*. Las Vegas, NV: Bechtel SAIC Company, LLC. ACC: DOC.20051107.0003.

Regulatory Guide 1.23, Rev. 0. 1972. *Onsite Meteorological Programs (Safety Guide 23)*. Washington, D.C.: U.S. Atomic Energy Commission. Readily available.

## ADDENDUM A

### DETAIL ON THE METEOROLOGICAL MONITORING NETWORK

#### A1. INTRODUCTION

The meteorological monitoring portion of the program began with five stations in December 1985 as part of an environmental monitoring network. Four stations were added to the network during 1992, primarily in response to information needs for localized airflow characteristics related to the Exploratory Studies Facility. Five of the nine stations were downgraded to precipitation sites in 1999, with accompanying temperature and humidity measurements. Three more precipitation sites were added to the network in 1997 on top of the Yucca Mountain ridge. Information on the measurements and monitoring equipment follow the description of station locations.

#### A2. STATION LOCATIONS

Figure A-1 is a map showing the monitoring locations. Geographic information on the station locations is shown in Table A-1. Descriptions of the site exposures follow.

Site 1 (NTS-60) is located in the west-central portion of Midway Valley at an elevation of 1,143 m (3,750 ft) above mean sea level (msl). Site 1 is representative of the area of the proposed repository surface facilities.

Site 2 (Yucca Mountain) is on the Yucca Mountain ridge crest, toward the north end of the ridge. Site 2 is 4 km west-northwest of Site 1, at an elevation of 1,478 m (4,850 ft) msl.

Site 3 (Coyote Wash) is in a narrow wash typical of the east side of the Yucca Mountain, at an elevation of 1,279 m (4,195 ft) msl. Site 3 is 1.6 km east of the Yucca Mountain site.

Site 4 (Alice Hill) is located on top of a sloping hill 3.4 km northeast of Site 1 (Alice Hill), at an elevation of 1,234 m (4,050 ft) msl. The elevated location of Alice Hill is advantageous for observing meteorological conditions aloft in Midway Valley.

Site 5 (Fortymile Wash) is in southern Jackass Flats on the east side of Fortymile Wash, southeast of Busted Butte. Site 5 is 9.4 km southeast of Site 1, at an elevation of 953 m (3,125 ft) msl. This location is on an airborne transport pathway between the proposed repository surface facility and the Amargosa Valley populated area.

Site 6 (WT-6) is at the WT-6 exploratory well pad, in the upper end of Yucca Wash, near the boundary line between the Nevada Test Site and the Nellis Air Force Range land. Site 6 is 6.1 km north-northwest of Site 1, at an elevation of 1,315 m (4,315 ft) msl.

Site 7 (Sever Wash) is in the topographic gap between Alice Hill and Fran Ridge, 2.1 km east-northeast of Site 1, at an elevation of 1,081 m (3,545 ft) msl. This location is along the surface-level nocturnal drainage airflow path out of Midway Valley.

Site 8 (Knothead Gap) is in a topographic saddle east of Bow Ridge, in the southern end of Midway Valley, and is 1.7 km south-southwest of Site 1, at an elevation of 1,131 m (3,710 ft) msl. This location is one kilometer east of the South Portal of the Exploratory Studies Facility.

Site 9 (Gate 510) is on the southern border of the Nevada Test Site, 3 km north of the commercial area on highway U.S. 95 in Amargosa Valley. Site 9 is 19 km south-southeast of Site 1, and 10.4 km south of Site 5, at an elevation of 838 m (2,750 ft) msl.

Site 401 (Bleach Bone Ridge) is on the northern end of the ridge on top of Yucca Mountain at an elevation of 1,562 m (5,125 ft) msl. It is about 5.7 kilometers northwest of Site 1, overlooking upper Yucca Wash.

Site 405 (Yucca Mt – WX4b) is about the center the ridge on top of Yucca Mountain at an elevation of 1,488 m (4,882 ft) msl. It is about 2.2 kilometers west-southwest of Site 1.

Site 415 (Yucca Mt SE or E of G-3) is further south along the ridge on top of Yucca Mountain, east of a small saddle separating the ridge top from the hill overlooking Abandoned Wash. It is at an elevation of 1,440 m (4,725 ft) msl, and is about 2.7 kilometers southwest of Site 1.

Site 418 (Solitario Canyon) is located on the west side of Solitario Canyon in a wash bottom on the east slope of Jet Ridge. It is at an elevation of 1301 m (4268 ft) msl, and is about 1.7 kilometers southwest of Site 2.

South Portal site is upslope and due west from the South Portal ramp approximately 170 meters. It is at an elevation of 1198 m (3930 ft) msl, and is about 1.2 kilometers west of Site 8.

### **A3. MONITORING EQUIPMENT**

Site 1 includes a 60-m tall tower, instrumented at two levels with wind and temperature sensors 10 and 60 m above ground level (m-agl). Horizontal wind speed and direction are measured at both levels, and vertical wind speed is measured at 10 m-agl. Temperature, relative humidity, and solar radiation sensors are located at 2 m-agl, and barometric pressure is nominally located at the surface.

All sites have two precipitation gauges. One gauge records by increments of 0.01-inch; the other gauge is a standard storage gauge. The recording gauge at Site 1 is heated to capture snowfall as it occurs.

Sites 2, 4 and 9 include towers instrumented at 10 m-agl with wind and temperature sensors virtually the same as those at Site 1 (except those at 60 m-agl), and the remaining other measurements. Sites 3, 5, 6, 7, and 8 have temperature and relative humidity sensors at 2 m-agl. Site 5 also includes a barometer. Sites 401, 405 and 415 have precipitation gauges.

Sites 1, 2, 6, 8, 401, 418, and a new location above the South Portal have a precipitation gauge supplied by the USGS for the purpose of collecting samples of precipitation. Each of these gauges is mounted on a post and precipitation samples are transferred to collection vials following precipitation events.

Table A-1. Coordinates of the Meteorological Monitoring Sites

Site	UTM Coordinates Zone 11 (meters)	Nevada System (feet)	Latitude-Longitude <sup>1</sup> (deg° min' sec")	Elevation (msl) <sup>2</sup>
Site 1 (NTS-60)	550,784E 4,077,374N	569,126E 761,795N	36° 50' 34"N 116° 25' 50"W	3750 ft 1143 m
Site 2 (Yucca Mountain)	547,646E 4,078,753N	558,844E 766,356N	36° 51' 19"N 116° 27' 56"W	4850 ft 1478 m
Site 3 (Coyote Wash)	548,874E 4,078,701N	562,874E 766,171N	36° 51' 17"N 116° 27' 06"W	4195 ft 1279 m
Site 4 (Alice Hill)	553,117E 4,079,779N	576,810E 769,661N	36° 51' 51"N 116° 24' 15"W	4050 ft 1234 m
Site 5 (Fortymile Wash)	554,385E 4,068,727N	580,843E 733,378N	36° 45' 52"N 116° 23' 26"W	3125 ft 953 m
Site 6 (WT-6)	549,388E 4,083,097N	564,612E 780,592N	36° 53' 40"N 116° 26' 45"W	4315 ft 1315 m
Site 7 (Sever Wash)	552,800E 4,077,847N	575,747E 763,324N	36° 50' 49"N 116° 24' 28"W	3545 ft 1081 m
Site 8 (Knothead Gap)	551,161E 4,075,773N	570,344E 756,538N	36° 49' 42"N 116° 25' 35"W	3710 ft 1131 m
Site 9 (G-510)	553,418E 4,058,398N	577,554E 699,491N	36° 40' 17"N 116° 24' 08"W	2750 ft 838 m
Site 401 (Bleach Bone Ridge)	547,995E 4,082,387N		36° 53' 16"N 116° 27' 42"W	5125 ft 1562 m
Site 405 (Yucca Mt – WX4b)	546,718E 4,076,063N		36° 49' 50"N 116° 28' 03"W	4882 ft 1488 m
Site 415 (Yucca Mt SE, E of G-3)	548,091E 4,074,129N		36° 48' 47"N 116° 27' 39"W	4725 ft 1440 m
Site 418 (Solitario Canyon)			36° 50' 48"N 116° 28' 54"W	4268 ft 1301 m
South Portal			36° 49' 42"N 116° 26' 23"W	3930 ft 1198 m

Notes: <sup>1</sup>NAD27 (North American Datum of 1927)  
<sup>2</sup>msl: above mean sea level

Table A-2. Accuracy

Measurement	Calibration Tolerance	Performance Check and Performance Audit Tolerance
Wind Direction Starting threshold	±3 degrees <0.447 m/s (0.5 mph) at 10°	±5 degrees Torque limits (gm-cm): Climatronics 100076: 6.0 MetOne 1564B: 2.5
Wind Speed (horizontal and vertical) Starting threshold	≤ 5 m/s: ±0.25 m/s > 5 m/s: ±5% of observed <0.447 m/s (0.5 mph)	Same Same Torque limits (gm-cm): Climatronics 100075: 0.3 MetOne 1565C: 0.25 Climatronics 102236: 0.75
Temperature	±0.5 degrees	Same
Delta-temperature	±0.1 degrees	Same
Precipitation Recording gauge Manual storage gauge	Orifice: ±0.75-inch diameter Volume: ±10%, Count: exact Measure: ±10%	Same Same N/A
Barometric pressure	±3 millibars	Same
Relative humidity	< ±1.5 C dew point	RH ≤ 40%: ±4 % RH > 40%: see calibration
Solar radiation Zero check Measurement	±10 W/m <sup>2</sup> ±5%	Same N/A

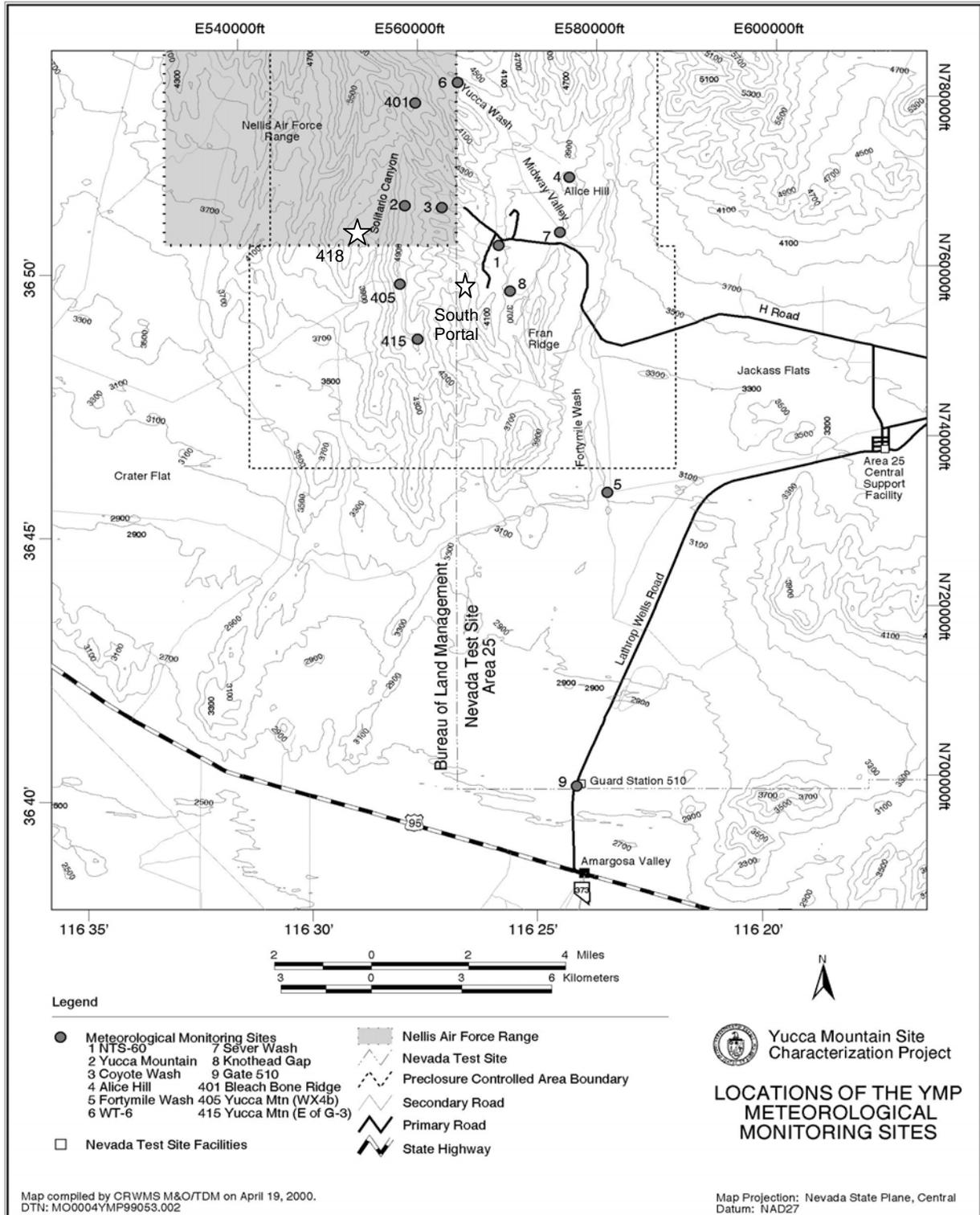


Figure A-1. Locations of the Yucca Mountain Project Meteorological Monitoring Sites and the two additional sites (418 and South Portal) for collection of precipitation samples (stars).