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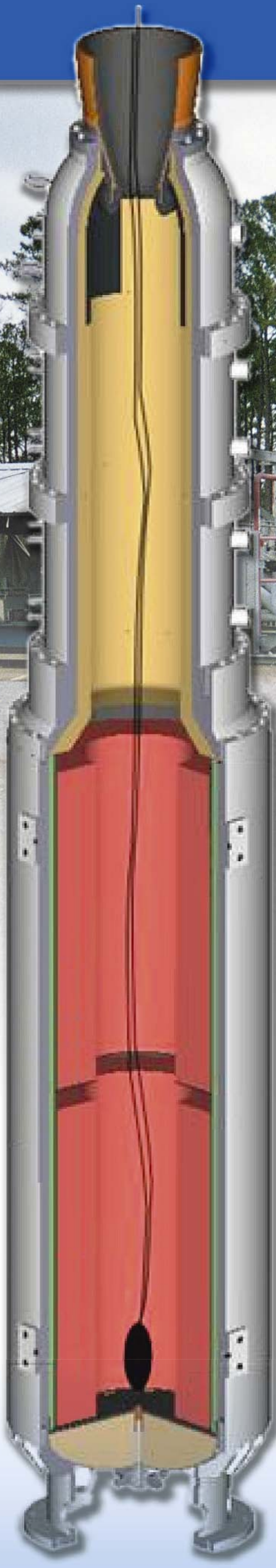

Environmental Assessment

Testing of Scale-Model Solid Rocket Motors at George C. Marshall Space Flight Center

Prepared for:
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National Aeronautics and Space Administration
Marshall Space Flight Center
Huntsville, Alabama

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ENVIRONMENTAL ASSESSMENT

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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Environmental Assessment Organization

This Environmental Assessment addresses the National Aeronautics and Space Administration's Proposed Action to conduct scale-model solid rocket motor testing at George C. Marshall Space Flight Center in Huntsville, Alabama. As required by 32 Code of Federal Regulations 651 and the National Environmental Policy Act, the potential effects of implementing this action are analyzed.

A ***LIST OF ACRONYMS*** is provided immediately following the Table of Contents.

SECTION 1:	***PURPOSE OF AND NEED FOR THE PROPOSED ACTION*** provides an introduction and background, summarizes the purpose of and need for the Proposed Action, discusses the scope of the document, and identifies the resources considered but eliminated from further analysis.
SECTION 2:	***DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES*** describes the Proposed Action and the alternatives to the Proposed Action.
SECTION 3:	***AFFECTED ENVIRONMENT*** describes the existing conditions of each resource for which the Proposed Action and alternatives to the Proposed Action are evaluated.
SECTION 4:	***ENVIRONMENTAL CONSEQUENCES*** presents the potential effects of implementing the Proposed Action and alternatives to the Proposed Action on the resources described in Section 3.
SECTION 5:	***SUMMARY OF ENVIRONMENTAL CONSEQUENCES AND CONCLUSIONS*** presents a tabulated summary of the potential consequences of the Proposed Action and No-Action Alternative and also presents the conclusions of the Environmental Assessment.
SECTION 6:	***REFERENCES*** presents bibliographical information about the sources used to prepare the Environmental Assessment.
SECTION 7:	***LIST OF PREPARERS*** provides information about the persons who prepared the Environmental Assessment
APPENDIXES	***A*** Regulatory Agency Correspondence
	B Public Involvement
	C Air Dispersion Modeling Memorandum
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Acronyms

ACM	asbestos containing material
ADEM	Alabama Department of Environmental Management
APCP	Ammonium Perchlorate Composite Propellant
ASMAT	Ares Scale Model Acoustic Test
AST	aboveground storage tank
BSM	Booster Separation Motor
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO	carbon monoxide
CO_2	carbon dioxide
CVOC	chlorinated volatile organic compound
dB	decibel
dBA	A-weighted decibel scale
EA	Environmental Assessment
EHS	Extremely Hazardous Substance
EO	Executive Order
ESA	ecologically sensitive area
ESC	Environmental Support Contractor
ft	feet
HCl	hydrogen chloride
HQ AFSPC/SG	Headquarters Air Force Space Command/Surgeon General
HWSF	Hazardous Waste Storage Facility
ICRMP	Integrated Cultural Resources Management Plan
lb	pound
LBP	lead-based paint
lbf	pounds force
Ldn	day-night averaged sound level
MEC	Munitions and Explosives of Concern
MMRP	Military Munitions Response Program
MNASA	Modified National Aeronautics and Space Administration
MSFC	George C. Marshall Space Flight Center
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NO_X	nitrogen oxides
NRHP	Natural Register of Historic Places
NRMP	Natural Resources Management Plan
OEHHA REL	Office of Environmental Health Hazard Assessment Reference Exposure Levels
OSHA	Occupational Safety and Health Administration

OASPL	overall sound pressure level
OU	Operable Unit
PCB	polychlorinated biphenyl
PM_{10}	particulate matter less than 10 micrometers in aerodynamic diameter
QD	Quantity Distance
RATO	Rocket Assisted Take Off
R&D	research and development
RCRA	Resource Conservation and Recovery Act
REC	Record of Environmental Consideration
RI	Remedial Investigation
RSA	Redstone Arsenal
SHPO	State Historic Preservation Office
SOP	Standard Operating Procedure
SPTA	Solid Propulsion Test Article
SRB	Solid Rocket Booster
SRM	solid rocket motor
TC	Test Complex
TCE	trichloroethene
TS	Test Stand
U.S.C.	United States Code
USEPA	U.S. Environmental Protection Agency
USM	Ullage Separation Motor
UST	underground storage tank
WNWR	Wheeler National Wildlife Refuge

SECTION 1

Purpose of and Need for the Proposed Action

1.1 Introduction

The National Aeronautics and Space Administration (NASA) plans to conduct static testing of various types and sizes of scale-model solid rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC) in Huntsville, Alabama. Static testing of scale-model SRMs is integral to SRM research and development (R&D), and is critical to NASA's overall mission. This Environmental Assessment (EA) broadly analyzes the conceivable scope of future static scale-model SRM testing that could occur at MSFC.

This EA has been prepared in compliance with the National Environmental Policy Act of 1969 (NEPA), as amended (42 United States Code [U.S.C.] 4321 et seq.), the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 *Code of Federal Regulations* [CFR] Parts 1500 through 1508), and NASA regulations (14 CFR Part 1216 Subpart 1216.3). The outline and content of the EA are consistent with NASA Procedural Requirements 8580.1 for implementing NEPA and Executive Order (EO) 12114 (NASA, 2001).

1.2 Background

A SRM is a rocket motor that uses solid propellants (fuel/oxidizer). Composite solid propellants that are ammonium-percholorate based are commonly used in space rockets. NASA uses solid propulsion primarily for booster rockets, such as the Space Shuttle Solid Rocket Boosters (SRBs), which are a pair of large solid rockets that provide most of the power for the Space Shuttle during the first two minutes of flight.

Static scale-model SRM testing is conducted on subscale models of SRMs to simulate the environments of full-scale static tests. Scale-model testing is integral to NASA's SRM R&D program and has been implemented by NASA since early development of SRMs for space exploration. MSFC is NASA's principal propulsion research center and has the lead role of conducting SRM R&D. Static scale-model SRM testing has been conducted at MSFC since the 1970's to support the Space Shuttle Program and more recently for the Constellation Program. Past scale-model SRM testing at MSFC has included tests on 48-inch (diameter) SRMs, 24-inch SRMS, and on smaller SRMs such as the Shuttle Booster Separation Motor (BSM) and Ullage Settling Motor (USM). Records of Environmental Consideration (RECs) have been prepared for past static testing of specific scale-model SRMs at MSFC. No significant impacts were determined to potentially result from static testing of the SRMs analyzed by these RECs. Based on these past assessments, the static scale-model SRM testing program at MSFC has not resulted in adverse environmental impacts. To eliminate the need for separate NEPA documentation to address each specific type of scale-model SRM proposed to be tested in the future, this EA has been prepared to broadly analyze the conceivable scope of future static scale-model SRM testing that could occur at MSFC.

1.3 Purpose and Need

Static scale-model SRM testing is critical to the success of NASA's aeronautics and space exploration programs. MSFC is the only NASA Center currently capable of conducting scale-model SRM testing. Static scale-model SRM testing allows NASA to reduce the risk and expense associated with the design of new SRMs and the selection/qualification of new SRM materials prior to implementation of full-scale static tests. Scale-model tests simulate the environments of full-scale tests for development/qualification of new materials (e.g., nozzle, insulation, and joint materials), ballistic assessments, thermal analyses, and qualification of instrumentation. In addition, scale-model SRM testing allows validation of predicted ignition overpressure, lift-off acoustic, and ground acoustic environments, and evaluation of water suppression systems designed for sound attenuation. Such overpressure and acoustics tests are the focus of the current Ares Scale Model Acoustic Test (ASMAT) program at MSFC. Static scale-model SRM testing will continue to be vital to the advancement of SRM research and technology development through future changes to NASA's mission.

1.4 Scope of EA

This EA assesses the potential environmental impacts associated with static testing of scale-model SRMs at MSFC. Potential impacts associated with the Proposed Action are evaluated against those associated with the No-Action Alternative, under which scale-model SRM testing would not be conducted at MSFC. This EA broadly analyzes the conceivable scope of future static scale-model SRM testing that could occur at MSFC via analysis of three size classes of SRMs, based on maximum thrust potential, as described in Section 2.1.

1.5 Public and Agency Consultation

A 30-day public review was held from June 27, 2010 through July 26, 2010 to solicit public comments on the draft EA. The public review period was announced in a public notice that was published in the Huntsville Times newspaper out of Huntsville, Alabama. Copies of the draft EA were made available to the public during the review period at the NASA External Relations Office at MSFC and at three public libraries in the local area. A copy of the public notice that was published in the Huntsville Times newspaper is presented as Appendix B. No comments were received during the public review period.

The draft EA was also coordinated with federal, state, and local entities through letter correspondence. All associated correspondence is included in Appendix A and discussed in pertinent sections of the EA.

1.6 Resources Considered but Eliminated From Further Analysis

NASA uses a systematic and interdisciplinary approach to ensure that all pertinent resources are analyzed and potential effects identified. Using this approach, the Proposed Action was determined to have no potential effect on several resources. As a result, these resources were eliminated from further analysis and discussion in this EA. Table 1-1 identifies the resources that would not be affected by the Proposed Action and, therefore, have been eliminated from further analysis.

TABLE 1-1
Resources Considered But Eliminated From Further Analysis
EA for Testing of Scale-Model SRMs at MSFC

Resource	Rationale
Land Use	Future scale-model SRM testing at MSFC would not change the land use classifications of the test sites. All of the test sites are located within the East Test Area of MSFC, which is classified entirely as testing land use. Other land uses within MSFC and land uses in the surrounding region would not be affected in any manner by the Proposed Action. Therefore, the Proposed Action would have no impact on land use.
Topography	Future scale-model SRM testing at MSFC would not involve land contouring or any other activity that would affect site topography. Therefore, the Proposed Action would have no impact on topography.
Geology	Future scale-model SRM testing at MSFC would not involve any intrusive activity that would affect subsurface geological formations. Therefore, the Proposed Action would have no impact on geology.
Soils	Future scale-model SRM testing at MSFC would not involve construction or any other activity that would directly or indirectly impact soils. All of the test sites are paved and devoid of exposed soils. Therefore, the Proposed Action would have no impact on soils.
Groundwater	Future scale-model SRM testing at MSFC would not involve withdrawals from, or discharges to, groundwater. The Proposed Action would not involve construction or any other activity that would directly or indirectly impact groundwater. Therefore, the Proposed Action would have no impact on groundwater.
Floodplains	None of the scale-model SRM test sites at MSFC are located within the 100-year floodplain. Future scale-model SRM testing at MSFC would not involve construction or any other activity that would directly or indirectly impact floodplains. Therefore, the Proposed Action would have no impact on floodplains.
Socioeconomics	Future scale-model SRM testing at MSFC is not expected to require personnel relocations or significant employee hires. The current work force level at MSFC is expected to be sufficient for conducting future testing. Therefore, the Proposed Action would not significantly change the number of persons working at MSFC or living in the local area. The Proposed Action would have no significant effect on the total labor force, employment, or economy of the region. For these reasons, the Proposed Action would have no impact on socioeconomics.
Housing, Schools, and Recreation	Future scale-model SRM testing at MSFC is not expected to require personnel relocations or significant employee hires. Therefore, the Proposed Action would have no impact on housing, schools, or recreation.
Utilities and Solid Waste	Future scale-model SRM testing at MSFC is not expected to require personnel relocations or significant employee hires; therefore, the Proposed Action would not significantly change the number of persons working at MSFC or living in the local area. All of the test facilities are currently operational and they do not require new utility systems or modifications to existing utility systems. Future testing would not involve construction/demolition or any other activity that would generate solid waste. For these reasons, the Proposed Action would have no impact on utility consumption/distribution, utility infrastructure, or solid waste.

TABLE 1-1
Resources Considered But Eliminated From Further Analysis
EA for Testing of Scale-Model SRMs at MSFC

Resource	Rationale
Traffic Flow	Future scale-model SRM testing at MSFC would not significantly change the number of persons working at MSFC or living in the local area. Future testing would not involve construction of new roads, modifications to existing road infrastructure, or other construction activity that would temporarily increase traffic levels at or outside MSFC. For these reasons, the Proposed Action would have no impact on traffic flow.
Rail, and Water Transportation	Future scale-model SRM testing at MSFC would not involve the use of rail or water transportation. There are no railroads or waterways within the vicinity of the test sites. Therefore, the Proposed Action would have no impact on rail or water transportation.
Aviation	Future scale-model SRM testing at MSFC would not involve any mode of air transportation and would not affect airspace or require coordination with airfield operations. Therefore, the Proposed Action would have no impact on aviation.

SECTION 2

Description of the Proposed Action and Alternatives

2.1 Description of the Proposed Action

Under the Proposed Action, future static scale-model SRM testing would be conducted in the East Test Area of MSFC on various types and sizes of scale-model SRMs. The intent of this EA is to broadly analyze the conceivable scope of future static scale-model SRM testing that could occur at MSFC. MSFC is located in north-central Alabama on approximately 1,841 acres of property within the Army's Redstone Arsenal (RSA) (Figure 2-1). The location of the East Test Area of MSFC is shown on Figure 2-2.

To provide a comprehensive analysis of the scope of future static scale-model SRM testing that could occur at MSFC, scale-model SRMs are grouped into three size classes, based on maximum thrust potential, to define the Proposed Action: small, medium, and large scale-model SRMs. Under the Proposed Action, small, medium, and large scale-model SRMs are defined as having maximum thrust potentials, measured in pounds force (lbf), of 10,000 lbf, 60,000 lbf, and 100,000 lbf, respectively. These size classes were selected based on the maximum thrust potentials of the following specific types of scale-model SRMs:

- Small size class - Rocket Assisted Take Off (RATO) SRM (10,000 lbf)
- Medium size class - 24-inch-diameter SRM (60,000 lbf)
- Large size class - 48-inch-diameter SRM (100,000 lbf)

Diagrams, including dimensions and weights, of representative models of the RATO, 24-inch, and 48-inch SRMs are shown on Figures 2-3, 2-4, and 2-5, respectively.

The solid propellant mixture used in scale-model SRMs that would be tested at MSFC is referred to as Ammonium Perchlorate Composite Propellant (APCP). This mixture consists of ammonium perchlorate (oxidizer), aluminum (fuel), iron oxide (catalyst), a polymer that serves as binder for holding the mixture together and acting as a secondary fuel, and an epoxy curing agent. Propellants will not be manufactured, processed, or added to SRMs, and containerized propellants will not be removed from the motor casings at MSFC. Building 4563 (SRM Processing Facility) in the East Test Area is used for processing of scale-model SRMs which are delivered to MSFC for testing. SRM processing primarily involves inspection, assembly, and application of instrumentation prior to testing.

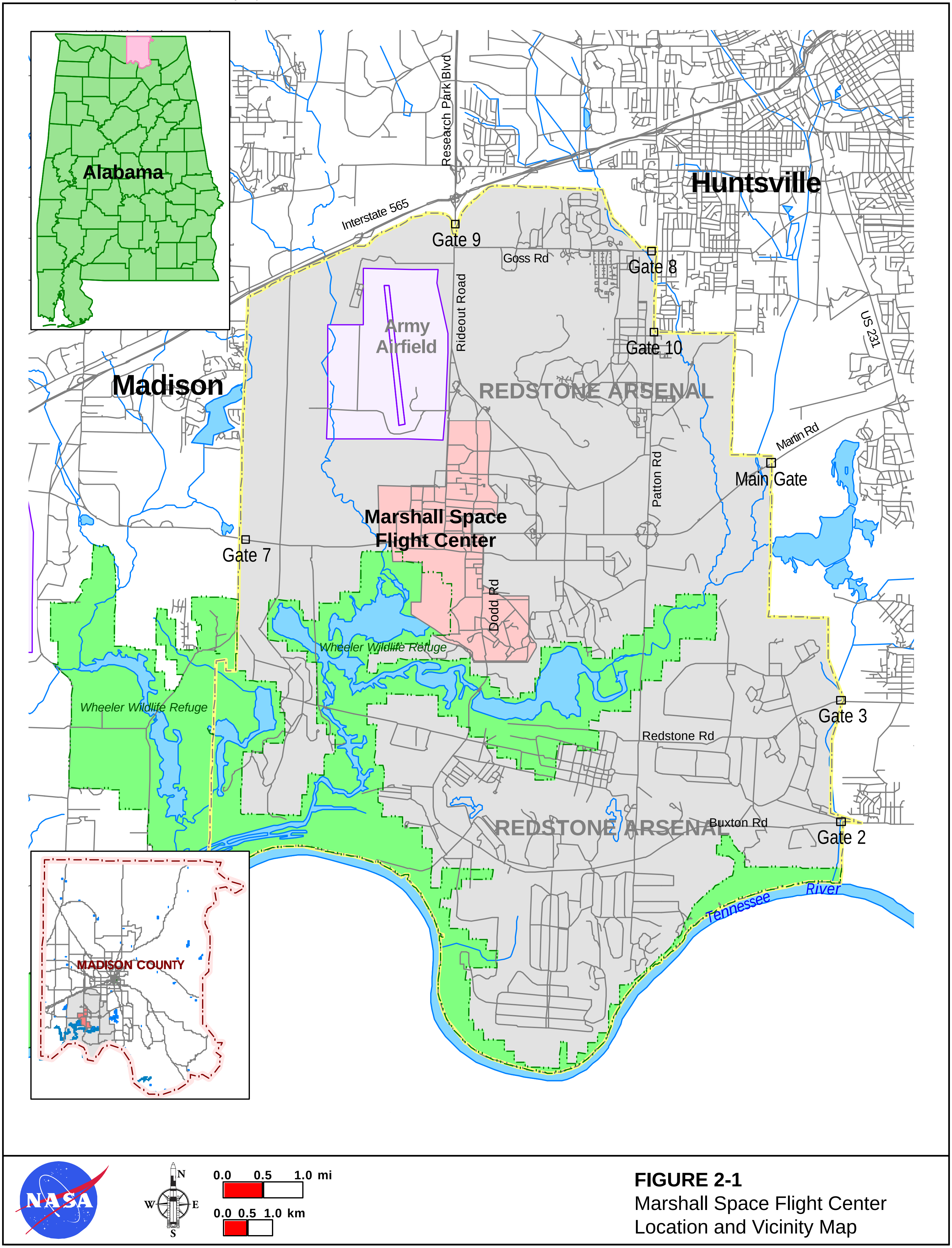
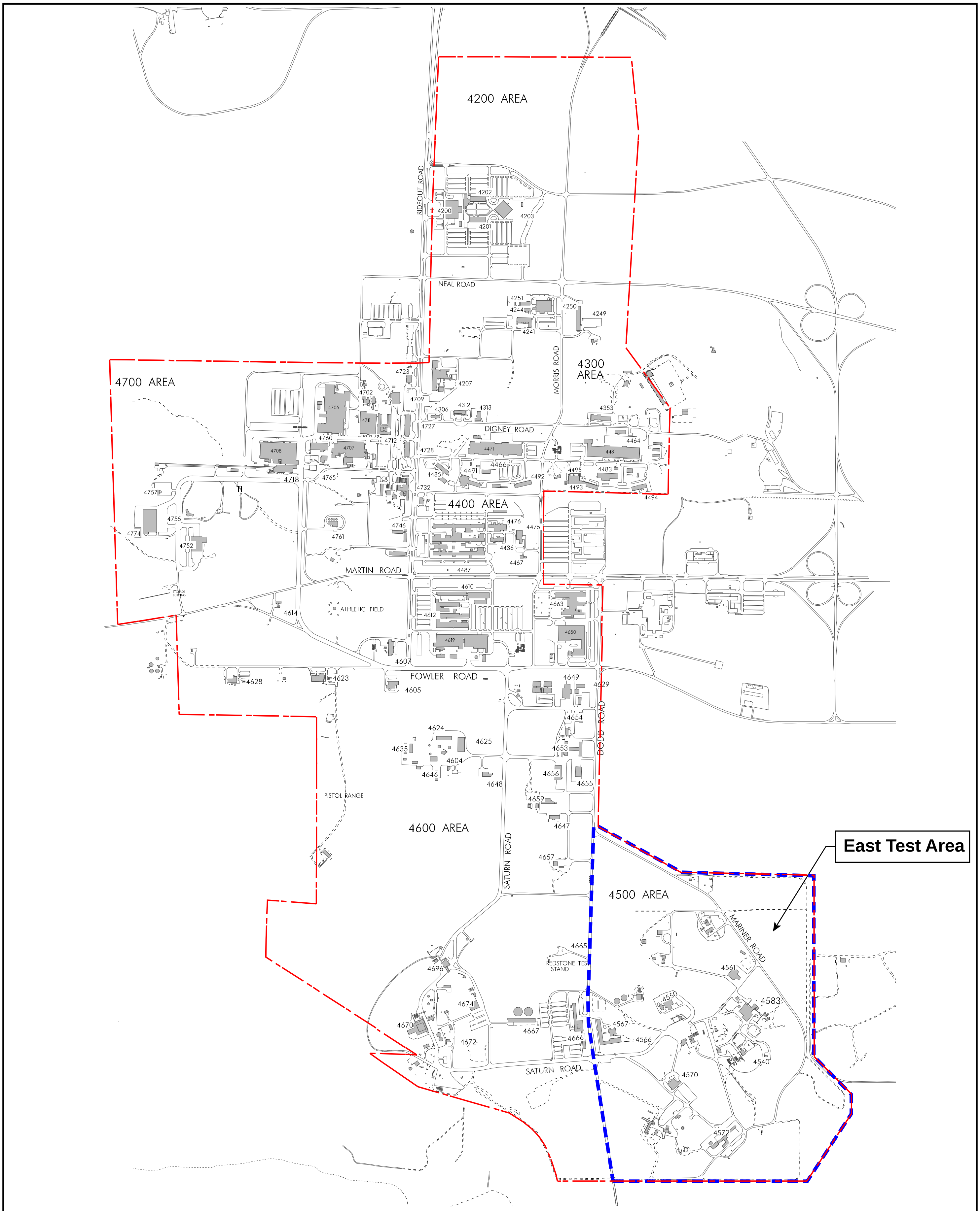


FIGURE 2-1
Marshall Space Flight Center
Location and Vicinity Map



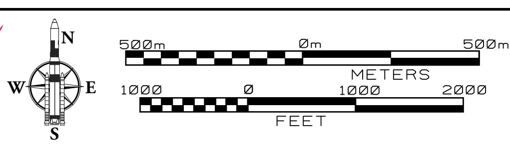
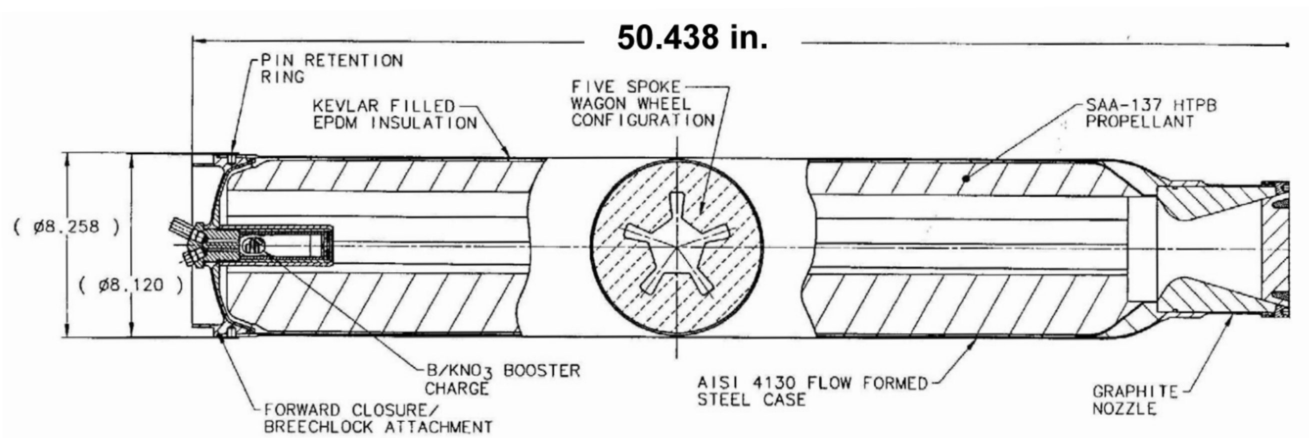
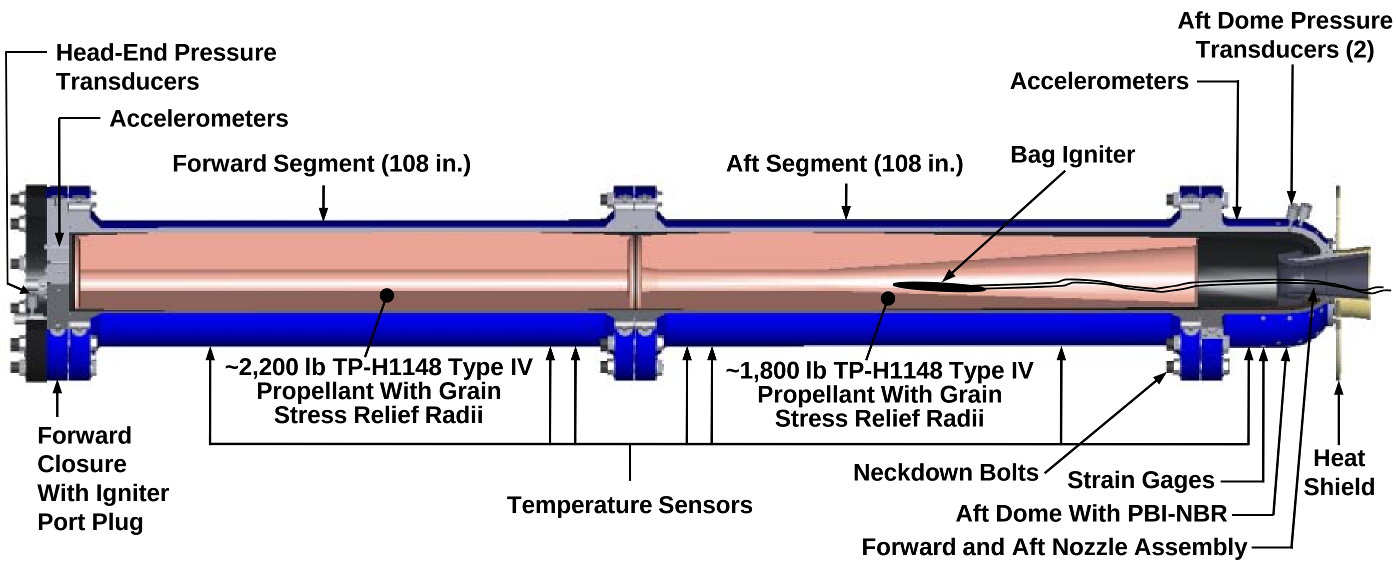


FIGURE 2-2
Location of East Test Area of Marshall Space Flight Center



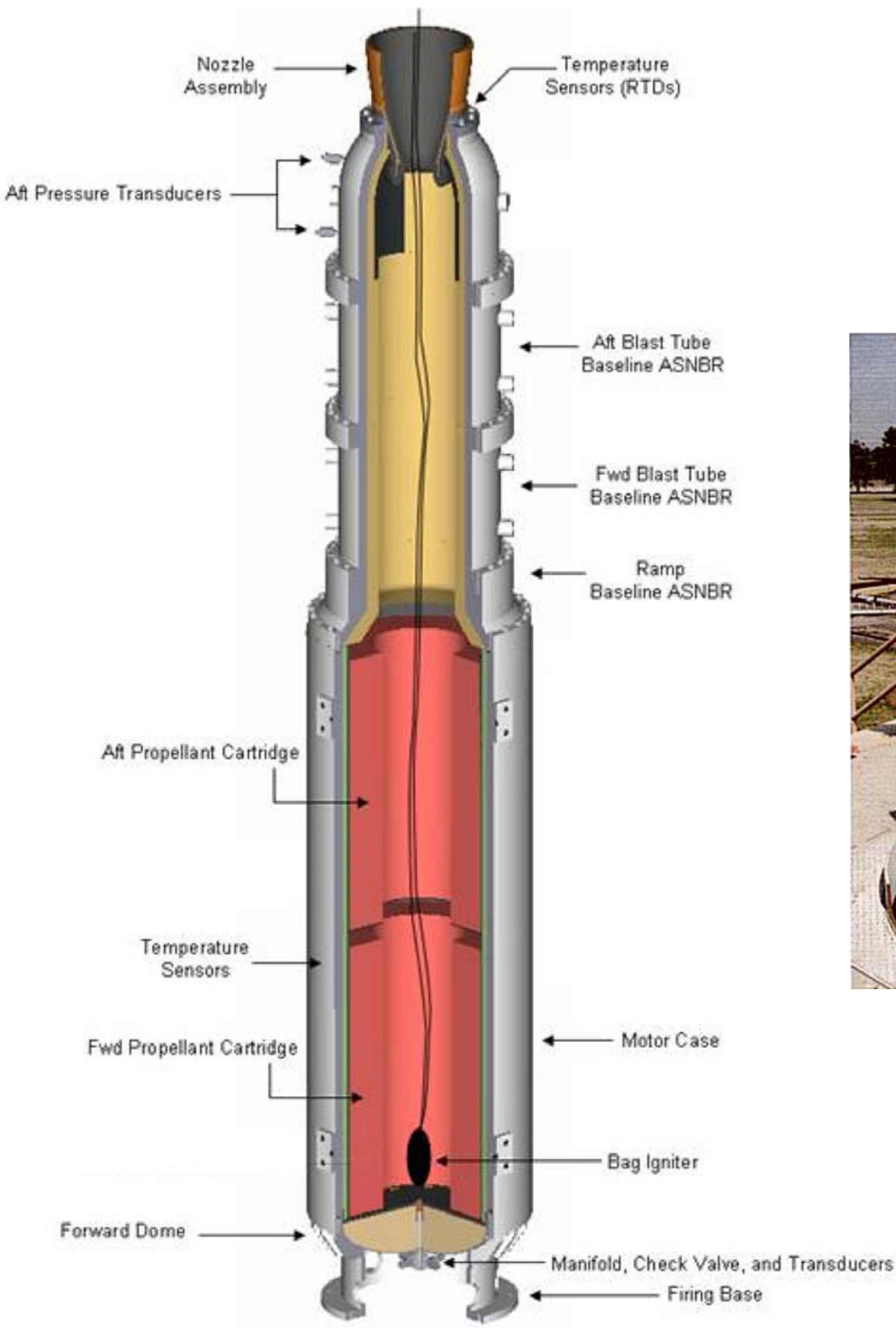
Total Length = 50.4 in
Diameter = 8.3 in
Motor Weight = 144 lb
Propellant Weight = 94.5 lb

FIGURE 2-3
Representative Model of the
RATO Solid Rocket Motor



Total Length = 140 in
Diameter = 24 in
Motor Weight = 8,400 lb
Propellant Weight = 4,000 lb

FIGURE 2-4
Representative Model of the 24-inch Solid Rocket Motor



Total Length = 323 in
Diameter = 48 in
Motor Weight = 52,392 lb
Propellant Weight = 12,400 lb

FIGURE 2-5
Representative Model of the 48-inch Solid Rocket Motor

Future static scale-model SRM testing at MSFC would be conducted at the following existing facilities that have been designed to support static scale-model SRM testing: Test Complex (TC) 500, TC 116, Test Stand (TS) 4520, and Building 4583 (Test and Data Recording Facility) (Figure 2-6). All of these facilities are currently operational and they do not require any structural, mechanical, or utility modifications to accommodate scale-model SRM testing.

TC 500 is located in the northwestern part of the East Test Area (see Figure 2-6). It consists of TS 500 (also referred to as Building 4522), Building 4523 (terminal building), Building 4524 (support building), and other control/storage structures (Figure 2-7). Building 4561, located to the southeast, serves as the control blockhouse for test activities at TC 500. A horizontal SRM test article mount designed to accommodate testing of medium-size SRMs (maximum thrust potential of 60,000 lbf), is located on the southeastern side of TS 500. This test mount is approximately 36 inches high, on concrete pavement, and partially enclosed by a metal shed. It is oriented to direct the SRM thrust to the east. The immediate area that the thrust is directed towards consists of concrete pavement which transitions into maintained grass further away from the mount.

TC 116 is located in the east central part of the East Test Area (see Figure 2-6). It consists of TS 116 (also referred to as Building 4540), Building 4539 (support building), Building 4542 (support building), and other control/storage structures (Figure 2-8). Building 4541, located to the southeast, serves as the control blockhouse for test activities at TC 116. An associated observation bunker (Building 4574) is located south of the blockhouse. TS 116 is 50 feet (ft) high and equipped with an underground terminal building. A 250-ft-radius, fan-shaped apron is located on the southern side of the test stand and is equipped with microphones for measuring and recording the simulated sonic environment of large rockets. Test parameters, including pressures, flow rates, temperatures, and vibrations, are obtained and recorded from 148 channels cabled from the test stand to the data system in Building 4583. TS 116 is designed to accommodate testing of scale-model SRMs that have maximum thrust potentials of 30,000 lbf. This test stand is designed to allow SRMs to be positioned at various heights, and orientated at various angles from vertical to horizontal to various angles in between. A horizontal SRM test article mount designed to accommodate testing of small SRMs (maximum thrust potential of 10,000 lbf), is located adjacent to the southeastern side of TS 116. This test mount is approximately 18 inches high, on concrete pavement, and not enclosed. It is oriented to direct the SRM thrust to the southeast. The immediate area that the thrust is directed towards consists of concrete pavement. A second horizontal SRM test article mount designed to accommodate testing of scale-model SRMs that have maximum thrust potentials of 30,000 lbf, is located southwest of Building 4542. This test mount is approximately 36 inches high, on concrete pavement, and within a three-walled test cell without a roof. It is oriented to direct the SRM thrust to the southeast. The immediate area that the thrust is directed towards consists of concrete pavement which transitions into maintained grass further away from the mount.

TS 4520 is located in the south central part of the East Test Area (see Figure 2-6). It is currently designated as the Solid Propulsion Test Article (SPTA) Facility and is designed to accommodate vertical testing of large SRMs such as 48-inch SRMs or similar (Figure 2-9).

FIGURE 2-6
Locations of SRM Testing Sites
at Marshall Space Flight Center

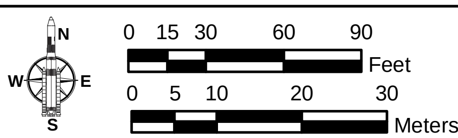
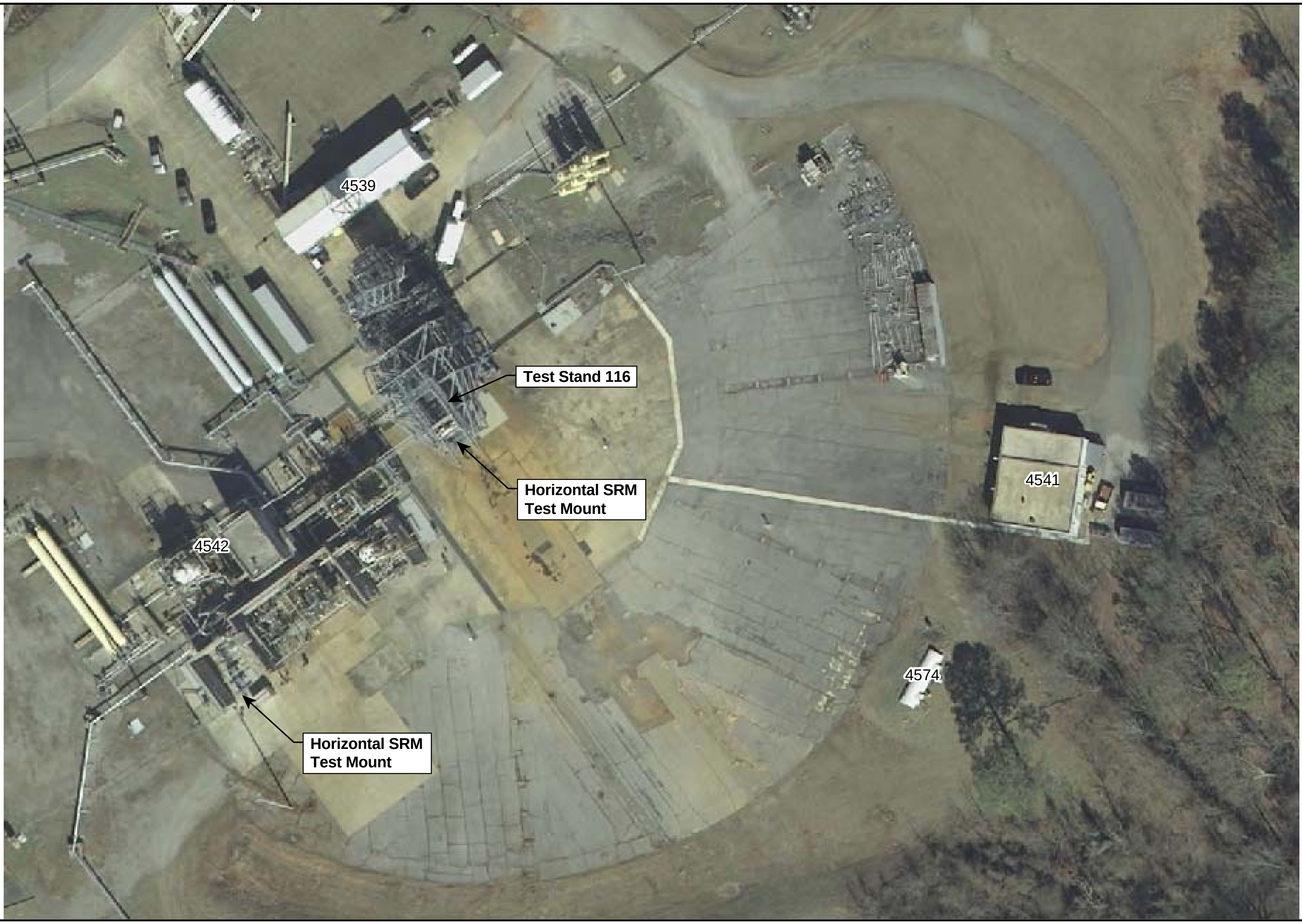


FIGURE 2-7
Aerial Photograph of
Test Complex 500

ES041310091754TPA F2-8 Aerial Photo of Test Complex 116.ai



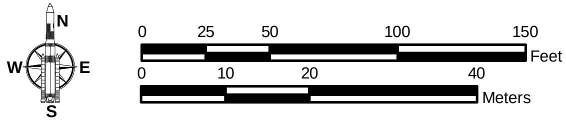


FIGURE 2-8
Aerial Photograph of
Test Complex 116

FIGURE 2-9
Aerial Photograph of Test Stand 4520

A horizontal SRM test article mount designed to accommodate testing of medium-size SRMs is located adjacent to the southern side of the test stand. This test mount is approximately 36 inches high, on concrete pavement, and partially enclosed by a metal shed. It is oriented to direct the SRM thrust to the south. The immediate area that the thrust is directed towards consists of gravel which transitions into maintained grass further away from the mount.

Building 4583 is located in the eastern part of the East Test Area (see Figure 2-6). It is currently designated as the Test and Data Recording Facility and it houses the control systems for TS 115, which is located to the southeast. The eastern and northern sides of the building contain numerous test cells for testing of small scale-model liquid motors and small scale-model SRMs that are significantly smaller than the RATO. Each test cell is enclosed by concrete walls, a concrete roof, and a retractable metal entrance door. The interior of the building houses instrumentation systems that support tests performed at TS 115 and the test cells. Building 4583 is used solely as a test facility and is not occupied by humans.

Table 2-1 presents general information on future scale-model SRM testing expected to be conducted at MSFC.

TABLE 2-1
Future Scale-Model SRM Testing Expected to be Conducted at MSFC
EA for Testing of Scale-Model SRMs at MSFC

Location	Scale-Model SRM	Firing Orientation
Test Complex 500		
Horizontal mount on SE side of Test Stand 500	Medium SRMs (24-inch or similar)	SRM fired horizontally.
Test Complex 116		
Test Stand 116 (BSM Test Position)	Small SRMs (RATO or similar) and SRMs up to 30,000 lbf (BSM or similar)	SRM fired vertically downward to horizontally (firing angle adjustable).
Horizontal mount SW of Building 4542 (Acoustics Model Test Position)	Small SRMs (RATO or similar) and SRMs up to 30,000 lbf (BSM or similar)	SRM fired horizontally
Horizontal mount adjacent to Test Stand 116 (USM Test Position)	Small SRMs (RATO or similar) and smaller SRMs up to 10,000 lbf (USM or similar)	SRM fired horizontally
Test Stand 4520		
Test Stand 4520 (48-inch Test Position)	Large SRMs (48-inch or similar)	SRM fired vertically upward
Horizontal mount adjacent to Test Stand 4520 (24-inch Test Position)	Medium SRMs (24-inch or similar)	SRM fired horizontally
Building 4583		
Test Cells	Very small SRMs	SRM fired horizontally

As indicated in Table 2-1, static testing of small SRMs, i.e., those that have maximum thrust potentials of 10,000 lbf, such as the RATO SRM, would be conducted at TC 116. TS 116 would be used for vertical testing of small SRMs (and testing at various angles between vertical and horizontal). The two horizontal test mounts at TC 116 would be used for horizontal testing of small SRMs. SRMs that are a little larger than small SRMs (up to 30,000), such as the BSM (20,000 lbf), can also be tested on TS 116 and the horizontal test mount southwest of Building 4542. The horizontal test mount adjacent to the southeastern side of TS 116 can accommodate testing of SRMs that are smaller than the RATO such as the USM (5,000 lbf). Very small SRMs, those that are significantly smaller than the RATO, would be tested in the test cells of Building 4583. The average duration of a future small SRM test would be approximately 4 seconds.

Static testing of medium SRMs, i.e., those that have maximum thrust potentials of 60,000 lbf, such as the 24-inch SRM, would be conducted on the horizontal test mounts at TC 500 and at the TS 4520 site. Static testing of large SRMs, i.e., those that have maximum thrust potential of 100,000 lbf, such as the 48-inch SRM, would be conducted on TS 4520. The average durations of a future medium SRM test and a future large SRM test would be approximately 20 seconds and 30 seconds, respectively.

The frequency of future small, medium, and large scale-model SRM testing at MSFC would be based on mission requirements and would be largely driven by cost and schedule. Based on the current goals of NASA's SRM R&D program, small SRMs such as the RATO are expected to be tested at a frequency of 35 times over a two year period. Medium SRMs such as 24-inch SRMs and large SRMs such as 48-inch SRMs are each expected to be tested once a year. Future testing frequencies are subject to change and may be lower or higher than current frequency projections. Although the upper bound of future testing frequencies cannot be ascertained at this time, maximum annual testing frequencies are expected to be 25 small SRM tests, five medium SRM tests, and two large SRM tests. Consideration of potential impacts that may be associated with future testing frequencies that are higher than current projections has been given in this EA and the potential for such impacts are addressed where applicable.

2.2 Alternatives to the Proposed Action

Under NEPA and 32 CFR Part 989 – Environmental Impact Analysis Process, this EA is required to address the potential environmental impacts of the Proposed Action, No-Action Alternative, and "reasonable" alternatives to the Proposed Action. Reasonable alternatives are those that meet the underlying purpose and need for the Proposed Action, are feasible from a technical and economic standpoint, and meet reasonable screening criteria (selection standards) that are suitable to a particular action. Screening criteria may include requirements or constraints associated with operational, technical, environmental, budgetary, and time factors. Alternatives that are determined to not be reasonable can be eliminated from detailed analysis in this EA.

2.2.1 Alternatives Eliminated from Detailed Analysis

MSFC is the primary NASA Center for SRM R&D, and the only Center that is currently capable of conducting static scale-model SRM testing. Several existing facilities at MSFC are designed specifically for static scale-model SRM testing. These facilities are all currently operational. They do not require any structural, mechanical, or utility modifications to accommodate testing and all applicable processes for testing are in place. Conducting static scale-model SRM testing at any other NASA Center would require new facility construction and/or existing facility modifications, resulting in significant costs and associated testing delays. In addition to its considerable cost, new facility construction at other NASA Centers would be complicated by land and environmental constraints as suitable sites for new development are limited. For these reasons, conducting scale-model SRM testing outside of MSFC is not a reasonable alternative and is not carried forward for detailed analysis in this EA.

Static scale-model SRM testing is integral to SRM R&D, and is critical to NASA's overall mission. Although much SRM research that does not involve scale-model SRM testing is conducted, SRM technology cannot be advanced without scale-model testing. Various non-testing techniques are used to develop motor design and evaluate material/instrumentation performance; however, these techniques alone are not sufficient as they do not simulate the environments of full-scale tests. There are no technical alternatives to actual scale-model testing that alone can provide the simulation of full-scale tests needed for development/qualification of new materials/ instrumentation or to conduct ballistic assessments and thermal analyses. With respect to acoustics testing, there are currently no noise-generating mechanisms that can simulate the noise generated by SRMs as accurately as scale model SRMs. For these reasons, there are no reasonable technical alternatives to conducting scale-model SRM testing; therefore, none are carried forward for detailed analysis in this EA.

Lastly, the scale-model SRM testing frequency currently proposed at MSFC is based on the current goals of NASA's SRM R&D program. The proposed testing frequency is largely driven by cost and schedule and, therefore, is limited to the minimum extent feasible by these factors. Conducting testing at a lower frequency would not adequately support NASA's current SRM R&D program. Although future testing frequencies are subject to be lower or higher, testing frequencies that are significantly lower than those currently proposed are not expected to adequately support future advancement of SRM technology. For these reasons, conducting scale-model SRM testing at lower frequencies than that which are currently proposed is not a reasonable alternative and, therefore, is not carried forward for detailed analysis in this EA.

In summary, the site, technical, and operational alternatives that were considered were determined to not be reasonable alternatives to the Proposed Action. Therefore, these alternatives are not carried forward for detailed analysis in this EA.

2.2.2 No-Action Alternative

Under the No-Action Alternative, scale-model SRM testing would not be conducted at MSFC. The No-Action Alternative is analyzed in Section 4 as a baseline against which the Proposed Action can be compared.

SECTION 3

Affected Environment

This section describes the existing environmental conditions potentially affected by the Proposed Action. In compliance with NEPA, CEQ guidelines, and 32 CFR Part 651, et seq., the description of the affected environment focuses on those resources and conditions potentially subject to impacts.

3.1 Air Quality

The Clean Air Act (CAA) requires the U.S. Environmental Protection Agency (USEPA) to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. USEPA has established NAAQS for the following six principal pollutants, which are called criteria pollutants: carbon monoxide (CO), lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide. Areas that meet the air quality standard for the criteria pollutants are designated as being “in attainment.” Areas that do not meet the air quality standard for one of the criteria pollutants may be subject to the formal rule-making process and designated as being “in nonattainment” for that standard. Areas that currently meet the air quality standard but previously were classified as nonattainment are “in maintenance” for that standard. The Huntsville/Madison County area is currently classified as being “in attainment" for all criteria pollutants stipulated under the NAAQS and is classified as a Class II air quality area.

MSFC is within an attainment area for all criteria pollutants. New or modified major stationary sources of air emissions at the Center are subject to Prevention of Significant Deterioration review to ensure that these sources are constructed without causing significant deterioration of regional air quality. A major new source is defined as one that has the potential to emit any pollutant regulated under the CAA in amounts equal to or exceeding specific major source thresholds. The scale-model SRM test sites at MSFC are not major stationary sources of air emissions.

MSFC operates under an Alabama Department of Environmental Management (ADEM) Title V Air Quality Operating Permit (Permit No. 709-0014). As part of the Title V CAA Permit regulations, MSFC conducts an annual air emission inventory.

3.2 Noise

Noise, in the context of this EA, refers to sounds generated by activities that could affect residents outside RSA or wildlife. Human hearing is best approximated by using an A-weighted decibel scale (dBA). Psychologically, most humans perceive a doubling of sound as an increase of 10 dBA (USEPA, 1974).

Noise level is often expressed as day-night averaged sound level (Ldn), which is the dBA sound level over a 24-hour day and night period. The Ldn also applies a 10-dBA penalty to nighttime sounds occurring between 10 pm and 7 am to account for the desirability of a quieter night than day. The U.S. Department of Housing and Urban Development and the

U.S. Department of Defense define outdoor Ldn levels up to 65 dBA as acceptable for residences.

At present, the primary sources of noise at MSFC are hot gas testing and scale-model SRM testing, both of which are conducted in the East Test Area. Hot gas testing involves propulsion of hydrogen and air, and it is conducted at a greater frequency than scale-model SRM testing. Past testing of liquid fuel engines in the Test Area have historically generated the highest noise levels of any activity at MSFC. There have been only three liquid engine tests at MSFC in the last 20 years and none are planned for the foreseeable future.

Scale-model SRM testing has been conducted at MSFC since the 1970's to support the Space Shuttle Program and more recently for the Constellation Program. The frequency of scale-model SRM testing at the Center has varied based on mission requirements and has largely been driven by cost and schedule. On average, large and medium scale-model SRMs have each been tested at MSFC once a year, and small scale-model SRMs have been tested at higher frequencies, ranging from 15 to 25 times a year. Scale-model SRM testing generates considerably less noise levels than liquid fuel engine testing (NASA, 1997). The noise levels generated by scale-model SRM testing are discussed in Section 4.2.1.

MSFC is located in the center of RSA, which provides an effective buffer zone between noise-producing activities at MSFC and the nearest residential area outside the Center, which are located within the Cities of Huntsville, Madison, and Triana. The nearest residential area to the East Test Area is located approximately 3.2 miles to the west. Residential and non-residential noise receptors are discussed in detail in Section 4.2.1.

3.3 Surface Water

The scale-model SRM test sites, as well as most of MSFC, are located within the Indian Creek drainage basin, which drains into the Tennessee River (MSFC, 2007). Indian Creek originates in the northwestern portion of Madison County and flows southward adjacent to the western boundary of MSFC. Indian Creek merges with Huntsville Spring Branch and then flows southward into the Tennessee River, approximately 3 miles southwest of MSFC. There are no rivers in the vicinity of MSFC that are protected under the Wild and Scenic Rivers Act (MSFC, 2007).

The nearest surface water body to TC 500 is Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Pond MSFC-008 (TC 500 Holding Pond), which is located approximately 225 ft southeast of the horizontal test mount at the site. Pond MSFC-008 is approximately 0.3 acre and has been dry since 1996. This pond outflows to CERCLA Ditch MSFC-069 which directs the flow northwestward to CERCLA Pond MSFC-010 (North Central Liquid Waste Disposal Pond).

The nearest surface water body to TC 116 is CERCLA Pond MSFC-009 (Southeast Liquid Waste Disposal Pond), which is located approximately 830 ft southeast of TS 116. Pond MSFC-009 is approximately 7.9 acres. CERCLA Ditch MSFC-063, which has several segments, directs stormwater runoff from TC 116 into Pond MSFC-009.

The nearest surface water body to the TS 4520 site is CERCLA Pond MSFC-012 (Detention Pond for Building 4572), which is located approximately 130 ft southeast of the horizontal test mount at the site. Pond MSFC-012 is approximately 0.9 acre and has an average depth of 2 ft.

3.4 Biological Resources

Biological resources, in the context of this EA, refer to vegetation, wetlands, wildlife, and listed species. The MSFC Natural Resources Management Plan (NRMP) provides guidance on the management of biological resources at the Center (NASA, 2006).

All of the scale-model SRM test sites at MSFC are developed, paved, and contain little or no vegetation. Vegetation in the immediate vicinities of test sites primarily consists of maintained grass and landscaping vegetation. The nearest natural vegetation communities to the test sites are the pine/deciduous forests located along the perimeter of the East Test Area (MSFC, 2007).

There are no wetlands within any of the scale-model SRM test sites. As discussed in Section 3.3, several CERCLA detention ponds and ditches are located in the general vicinities of the test sites. Although these ponds and ditches are man-made drainage systems, some are classified as federally jurisdictional wetlands. Of the CERCLA ponds and ditches in the vicinities of the test sites, the following are classified as jurisdictional wetlands: Pond MSFC-008, Pond MSFC-009, and Ditch MSFC-063. These systems are described in Section 3.3.

The scale-model SRM test sites and their immediate surroundings provide minimal wildlife habitat because they are located within the East Test Area. Wildlife species that utilize the East Test Area are adapted to the developed setting and high noise levels. The pine/deciduous forests located along the perimeter of the East Test Area provide suitable habitat for common wildlife species such as song birds, squirrels, raccoons, mice, and white-tailed deer. Some portions of this forest area fragmented and surrounded by development. Some of the CERCLA detention ponds and ditches in the East Test Area provide aquatic habitat for wading birds, waterfowl, small fish, amphibians, and reptiles; however, the overall quality of this aquatic habitat is relatively low (MSFC, 2007). The Wheeler National Wildlife Refuge (WNWR) extends into the southwestern part of MSFC (approximately 180 acres) and its boundary runs east/west outside the southern and southeastern boundaries of the East Test Area. The WNWR is approximately 34,500 acres and most of it provides high quality wildlife habitat, including important wintering habitat for migratory waterfowl (MSFC, 2007).

Based on the 2006 RSA Endangered Species Management Plan, three federally listed species have been documented to occur on or near MSFC: the Alabama cave shrimp (*Palaemonias alabamae)*, which is federally listed as Endangered, Price's potato bean (*Apios priceana*), which is federally listed as Threatened, and the gray bat (*Myotis grisescens*), which is federally listed as Endangered (RSA, 2006). Two other federally listed species that have the potential to occur on or near MSFC are the American alligator (*Alligator mississippiensis*), which is federally listed as Threatened and the Indiana bat (*Myotis sodalis*), which is federally listed as Endangered. The American alligator is federally listed due to its "similarity of appearance" to the federally Endangered American crocodile and the Indiana bat is considered to be a transient species on RSA (RSA, 2006). None of these listed species has been documented to occur or is expected to potentially occur in or near the East Test Area. The distances of the documented occurrences of listed species from the East Test Area are discussed in Section 4.4.1.

There are currently eight areas on RSA that are classified as ecologically sensitive areas (ESAs). Only one of these ESAs, the Williams Spring ESA, is located on MSFC, approximately 1.8 miles northwest of the East Test Area. The ESAs on RSA, including their distances from the East Test Area, are discussed in Section 4.4.1.

3.5 Cultural Resources

Federal agencies are required to protect and preserve cultural resources in cooperation with state and local governments under NEPA and the National Historic Preservation Act of 1966, as amended (16 U.S.C. 470, Public Law 95-515).

The area now designated as MSFC initially was purchased in 1941 by the Army as part of a 32,255-acre acquisition for the Chemical Warfare Service in response to the munitions requirements of World War II. Before the purchase, the land was largely farmed for cotton, corn, hay, and small grains, and also used as pasture.

The MSFC Integrated Cultural Resources Management Plan (ICRMP) was updated and published in 2009. It provides guidance on how to identify, evaluate, and treat cultural resources at the Center in compliance with NASA and state regulations. The two most recent archaeological surveys of MSFC were conducted in 2000 (Alexander, Thomson, and Williams, 2001) and 2005 (Alexander and Alvey, 2006). Combined, these surveys covered the entire MSFC property and identified a total of 22 archaeological sites. Of the sites identified, seven were determined to be ineligible for listing in the National Register of Historic Places (NRHP) and 15 were determined to be eligible or potentially eligible for NRHP listing (MSFC, 2009). One of the potentially eligible sites on MSFC was re-evaluated in 2008 and determined to be ineligible for the NRHP. None of the archaeological sites identified at MSFC are located within the scale-model SRM test sites. There is one archaeological site within the vicinity of TC 116 and Building 4583.

TC 500 consists of TS 500 (also referred to as Building 4522), Building 4523 (terminal building), Building 4524 (support building), and other control/storage buildings. TS 500 was constructed in 1964 and has supported the Saturn and Space Shuttle Main Engine testing programs (MSFC, 2007a). It is a multipurpose, dual-position test facility that was designed primarily for the hazardous testing of liquid hydrogen and liquid oxygen aerospace propulsion system components and subsystems. Since 1980, two tests have been conducted on 24-inch liquid/solid hybrid motors at TC 500, to evaluate the motor casing insulation and propellant grain distribution effects on motor thrust. The 2003 Historical Assessment of MSFC (NASA, 2003) recommended that TS 500, as well as its blockhouse (Building 4561), be re-evaluated for NRHP eligibility in ten years, i.e., around 2013. The horizontal SRM test article mount designed for testing medium SRMs is not physically connected to TS 500. All of the other buildings at TC 500 have been determined to be ineligible for NRHP listing (NASA, 2003; MSFC, 2009).

TC 116 consists of TS 116 (also referred to as Building 4540), Building 4539 (support building), Building 4542 (support building), and other control/storage structures. TS 116 was constructed in 1964 and has supported numerous NASA programs such as the Saturn/Apollo Program, Space Shuttle Program, and Advanced Launch System Program (MSFC, 2007a). It was designed as an acoustical research technology model test facility and has primarily supported scale-model rocket engine acoustics and overpressure testing since its construction. Scale-model testing at TC 116 has been conducted on various liquid engines and on SRMs that include the BSM and the USM for the Constellation Program. The 2003

Historical Assessment of MSFC (NASA, 2003) recommended that TS 116, as well as its blockhouse (Building 4541), be re-evaluated for NRHP eligibility in ten years, i.e., around 2013. All of the other buildings at TC 116 have been determined to be ineligible for NRHP listing (NASA, 2003; MSFC, 2009).

TS 4520 was constructed in 1989 as a Solid Pressure Test Area. It has primarily functioned as a scale-model SRM testing facility and is currently known at the SPTA Facility. NASA has used this test stand for testing various SRM propellants, insulations, and nozzles, primarily using the MNASA 48-inch SRM and 24-inch SRMs. TS 4520 has been determined to be ineligible for NRHP listing (NASA, 2003; MSFC, 2009).

Building 4583 was constructed in 1954 as the Guided Missile Components Test Laboratory. It has been used as a test facility for scale-model liquid propulsion engines of the Redstone, Jupiter, Juno, and Saturn, and for scale-model testing of the solid rocket booster of the Space Shuttle. The building is currently designated as the Test and Data Recording Facility and it houses the control systems for TS 115, which is located to the southeast. Building 4583 has been determined to be eligible for NRHP listing under Criteria A (for association with key missions at MSFC) and C (for association with leading aerospace architectural-engineering firms of the early Cold War years) (NASA, 2003, MSFC, 2009).

3.6 Public and Occupational Health and Safety

MSFC has an established physical security program for site facilities and operations. Protective security measures at MSFC include the use of physical barriers, electro-mechanical intrusion detection systems, protective lighting, warning notification, identification and badge recognition, and automated access control capability. The Medical Center at MSFC, located in Building 4249, maintains a staff of 21, including five industrial hygienists. Twenty-four-hour firefighting services, including hazardous materials response/mitigation and medical services, are provided to MSFC by four fire stations owned and operated by the Army. All significant MSFC buildings are connected to a central fire alarm and reporting system and each building has a fire alarm system that includes automatic smoke or heat detectors and manual pull stations.

Due to the fire hazard and risk of explosion, liquid and solid propellants must be stored and used at certain distances from inhabited buildings. The Quantity Distance (QD) is the distance that should separate a location where propellants are stored or used from an inhabited building. QDs have been established for locations at MSFC where propellants are stored and used. The QD for TS 4520 is based on usage of solid propellant (Class 1.3 Explosives). The QDs for the other scale-model SRM test sites are based on storage of liquid propellants in other portions of the sites and they sufficiently cover the hazard potential of solid propellant usage at the sites. The following QDs have been established for the scale-model SRM test sites:

- TC 500 – 600 ft
- TC 116 – 2,115 ft
- TS 4520 – 1,250 ft
- Building 4583 – 600 ft

MSFC has specific safety protocols, standard operating procedures (SOPs), and associated personnel training/certification requirements for scale-model SRM testing at the Center (see Section 4.6.1).

3.7 Hazardous Materials and Waste

3.7.1 Storage and Handling

A variety of hazardous materials are used at MSFC. Hazardous substances have been declared hazardous through federal listings including: Extremely Hazardous Substances (EHSs), listed in 40 CFR 355; those listed as hazardous if released, under CERCLA in 40 CFR 302.4; and by definition of hazardous chemicals by the Occupational Safety and Health Administration (OSHA), in 29 CFR 1910.1200. In addition to these substances defined as hazardous, pesticides and sources of radiation are regulated.

Sections 311 and 312 of the Emergency Planning and Community Right-to-Know Act require any user to submit a report, known as a Tier II, annually for any substance that is present at MSFC in the following quantities:

- Greater than or equal to 10,000 pounds at any one time for a hazardous chemical; and
- Greater than or equal to 500 pounds or the Threshold Planning Quantity, whichever is less, at any time, for EHSs.

Solid propellants used for static scale-model testing at MSFC are classified by the United Nations Organization Hazard Class and Division System as Class 1.3 Explosives. At present, no non-explosive hazardous materials are stored or handled at the scale-model SRM test sites at MSFC. Solid propellants (explosive hazardous materials) are always contained within the SRMs during testing operations at the sites, i.e., solid propellants are never removed from or added to SRMs during testing. Building 4563 (SRM Processing Facility) in the East Test Area is used for processing of scale-model SRMs, which primarily involves inspection, assembly, and application of instrumentation prior to testing. On a few occasions, scale-model SRMs delivered to MSFC for static testing have had excess propellant clung to the outside wall of the motor casing. In these cases, solid propellant trimming (removal of the excess propellant) was conducted in Building 4563.

3.7.2 Waste Management

MSFC is classified according to federal and state regulations as a large quantity hazardous waste generator. MSFC generates more than 1,000 kilograms of hazardous waste each month. Federal regulations on hazardous waste are contained in 40 CFR Parts 260 to 279, and are a result of Subtitle C of the Resource Conservation and Recovery Act (RCRA), which requires a program to track hazardous waste from generation to storage to transportation to disposal.

NASA maintains a comprehensive inventory of all RCRA-defined hazardous wastes and controlled wastes not regulated by RCRA. The collection and management of hazardous waste data are the responsibility of the Environmental Support Contractor (ESC). MSFC has established hazardous and controlled waste accumulation site inspection guidelines that serve to monitor the accumulation activities of each generating activity throughout MSFC. Full drums of wastes are stored temporarily in the Hazardous Waste Storage Facility (HWSF). Within a 60- to 70-day time period, the ESC arranges for shipment of the containers to an appropriate Treatment, Storage, and Disposal Facility, so that MSFC is not subject to regulation under RCRA as a hazardous waste storage facility. All similar waste is combined within a consolidation area in the HWSF. Hazardous wastes are disposed offsite at several hazardous waste disposal facilities approved by USEPA. Wastes are transported from MSFC by licensed hazardous waste transporters. Special wastes generated at MSFC include asbestos, industrial waste, petroleum-contaminated soil and water from spill cleanup, and medical waste.

At present, hazardous waste management is not conducted or needed at the scale-model SRM test sites at MSFC. Solid propellant trimmings, which have been generated on an infrequent basis in Building 4563, have been properly disposed of by RSA personnel.

3.7.3 Contaminated Areas

In 1994, MSFC was placed on the National Priorities List, which requires compliance with CERCLA. In response, MSFC conducted a surface media Remedial Investigation (RI) for the entire property in 1999 to assess the nature and extent of contamination, to evaluate public health risks, and to screen potential remedial actions. Contaminated areas were divided into operable units (OUs). OUs were then divided among media: surface soil, subsurface soil, surface water, sediment, and groundwater.

A substantial portion of MSFC is underlain by groundwater that is contaminated by chlorinated solvents because of the prevalent use of these compounds in the past. Most of the contamination is located in the rubble zone of the residuum layer. The primary contaminants in the rubble zone plumes are the chlorinated volatile organic compounds (CVOCs): tetrachloroethene, trichloroethene (TCE), dichloroethene, vinyl chloride, carbon tetrachloride, chloroform, and 1,1,2,2-tetrachloroethane. The following five major contamination plumes have been identified at MSFC (NASA, 2001a):

- Northwest Plume
- Northeast Plume
- Central Plume
- Southwest Plume
- Southeast Plume

The scale-model SRM test sites at MSFC are located within the boundaries of OU 1, which covers the East and West Test Areas of MSFC under NASA’s CERCLA program. OU 1 is classified as a “Restricted Area Boundary” and requires a CERCLA Site Access Checklist for proposed activities. An associated dig permit is required for all activities involving earthwork within OU 1. MSFC is currently conducting an RI for OU 1, which involves surface and subsurface soil sampling for CERCLA constituents.

Much of the East Test Area of MSFC lies within the boundaries of the Southeast Plume. CVOC contamination of the groundwater in this area has resulted from past engine testing solvent washings (TCE) as well as from other past operations at the test facilities. Natural attenuation mechanisms such as dilution, dispersion, chemical degradation, and sorption have been shown to be occurring in the plume. Ongoing pilot studies involving *in-situ* chemical oxidation using hydrogen peroxide and *in-situ* chemical reduction using zero-valent iron are being conducted at the source areas in the center of the plume to treat the contamination.

Several CERCLA detention ponds and ditches are located in the vicinities of the scale-model SRM test sites. These ponds and ditches have received storm water runoff and wastewaters from various facilities in the East Test Area, and they are currently being investigated under the OU 1 RI. These ponds and ditches are discussed in greater detail in Section 3.3.

None of the structures currently used to test scale-model SRMs contain lead-based paint (LBP), asbestos-containing materials (ACMs), or polychlorinated biphenyls (PCBs). Scale-model SRM testing does not involve the use of underground storage tanks (USTs) or aboveground storage tanks (ASTs).

3.7.4 Ordnance

A considerable amount of ordnance was developed at RSA during World War II. As a result, RSA contains areas of ordnance and explosives contamination and potential contamination. The area that is now leased from RSA by MSFC has been surveyed for ordnance activity and disposal areas. Ordnance is defined collectively as Munitions and Explosives of Concern (MEC) and includes unexploded ordnance, ordnance that has exploded, and ordnance that does not have explosive potential. MEC is managed at RSA by RSA's Military Munitions Response Program (MMRP). The following five categories for MEC have been designated at RSA:

- Probability 1 – Frequent
- Probability 2 - Will occur several times during proposed site activities
- Probability 3 – Occasional
- Probability 4 – Seldom
- Probability 5 - Unlikely

The scale-model SRM test sites are all located within areas that are designated as Probability 5 – Unlikely for MEC.

3.8 Environmental Justice and Protection of Children

On February 11, 1994, the President issued EO 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations*. This EO requires federal agencies to address disproportionate environmental and human health impacts from federal actions on minority populations and low-income populations. The President directed all federal agencies to analyze the environmental effects of their actions on minority and low-income communities, including human health, social, and economic effects. MSFC implements an Environmental Justice Plan (updated in 2003) in accordance with the requirements of EO 12898 and NASA's agency-wide Environmental Justice Strategy (MSFC, 2003)

Guidelines for the protection of children are specified in EO 13045, *Protection of Children from Environmental Health Risks and Safety Risk* (Federal Register: 23 April 1997, Volume 62, Number 78). This EO requires that federal agencies make it a high priority to identify and assess environmental health and safety risks that may disproportionately affect children, and ensure that policies, programs, and standards address disproportionate risks to children that result from environmental health or safety risks.

SECTION 4

Environmental Consequences

This section provides a detailed analysis of the potential environmental consequences associated with the implementation of the Proposed Action and the No-Action Alternative. The magnitude of the impact of an action is considered regardless of whether the impact is adverse or beneficial. The following terms are used to describe the magnitude of impacts:

- No Impact: No impacts are expected. The action would not cause a detectable change.
- Minimal: Impacts are not expected to be measurable, or are measurable but are too small to cause any change in the environment.
- Minor: Impacts are measurable but are within the capacity of the impacted system to absorb the change, or the impacts can be compensated for with little effort and resources so that the impact is not significant.
- Moderate: Impacts are measurable but are within the capacity of the impacted system to absorb the change, or the impacts can be compensated for with little effort and resources so that the impact is not significant. Moderate impacts have greater magnitudes than minor impacts.
- Major: Environmental impacts which individually or cumulatively could be significant. The significance of adverse and positive impacts is subject to interpretation and should be determined based on the final proposal. In cases of adverse impacts, the impact may be reduced to less than significant by mitigation, design features, and/or other measures that may be taken.

4.1 Air Quality

4.1.1 Proposed Action

Scale-model SRM testing generates the following types of air emissions: nitrogen oxides (NO_X), particulate matter less than 10 micrometers in aerodynamic diameter (PM_{10}), CO, hydrogen chloride (HCl), and carbon dioxide (CO_2). Air dispersion modeling was conducted for this EA to estimate the air emissions that would be generated by future scale-model SRM testing at MSFC, and to analyze the potential effects of the air emissions on air quality. The model used was the USEPA-approved version of CALPUFF, Version 5.8 (Scire et al, 2000). In the CALPUFF model, a sequence of puffs is used to approximate emissions at every time step and no steady-state approximations are made. These puffs are tracked in time on the computational grid. CALPUFF also has post-processing programs for determining downwind concentrations and deposition fluxes of material emitted from modeled sources. The CALPUFF modeling methodology and results are presented in a technical memorandum provided as Appendix C of this EA, and are summarized below.

The predicted air emission concentrations resulting from scale-model SRM testing were added to available measured background concentrations and compared to the NAAQS for the applicable criteria pollutants. Because there is no NAAQS for HCl, the Headquarters Air Force Space Command/Surgeon General (HQ AFSPC/SG) Air Quality Standards and the Office of Environmental Health Hazard Assessment Reference Exposure Levels (OEHHA REL) were used for comparison for this emission product.

Modeling was conducted for small, medium, and large SRMs, as they have been defined based on maximum thrust potential for the Proposed Action, i.e., 10,000 lbf, 60,000 lbf, and 100,000 lbf, respectively. Model and source (test site location) characteristic parameters were chosen to conservatively estimate the potential concentrations and deposition values. As a conservative estimate, the modeling assumed that all three types of SRMs are tested simultaneously at one location. TS 4520 was chosen as the source location because it is used to test medium and large SRMs. Moreover, TS 4520 is closest to the MSFC boundary; therefore, it represents the worst-case test location. For each type of SRM, the worst-case emission estimates include the estimated maximum emission products. These worst-case emission scenarios were based on the total amount of propellant spent, the expected maximum frequency of testing, and the emissions associated with each type of propellant. Emission parameters were provided by NASA and were based on solid propellant test data. The emission parameters used in the model and the emission rates estimated for each SRM type are provided in Appendix C.

To assess the potential effects of generated air emissions on receptors, a receptor grid network was used to locate the maximum ground-level emission concentrations at and beyond the ambient air boundary, which is the RSA boundary because public access is restricted within RSA. Pollutant concentrations were also estimated for discrete receptors, which included the nearest residential areas, WNWR, several ESAs, and two locations where the gray bat has been documented to occur. The nearest four residential areas to RSA were selected, the closest of which is located on Zierdt Road, approximately 3.2 miles west of source location (TS 4520). The other nearest residential areas are located outside the RSA boundary southwest, east, and northeast of the source location. The ESAs were selected based on their proximity to the source location and based on the habitat they provide for listed species (see Section 3.4). The locations of the receptors and their distances from the source location are provided in Appendix C.

The initial screening conservatively assumed a maximum of one test event per day for calculating results for 1-hour, 8-hour, and 24-hour averaging periods; each test event was assumed to involve testing of all three SRM types simultaneously. The assumptions were refined to reflect more realistic testing scenarios to calculate HCl concentrations in the WNWR. The refined analysis assumed that only one SRM would be tested per day. For the refined analysis, the SRM type that produced the maximum HCl concentration was used. To calculate the annual average results, the modeled annual average concentrations were scaled by the number of hours per year and the expected maximum annual testing frequency for each SRM type. The time-averaged results are based on the maximum continuous hours of emissions. The maximum pollutant concentrations for all averaging periods predicted at the ambient air boundary and at the discrete receptor sites are provided in Appendix C. Concentration contours for HCl and PM_{10} are also provided in Appendix C.

The predicted maximum pollutant concentrations outside the ambient air boundary are compared to applicable standards in Table 4-1. Areas outside the ambient air boundary include the ambient air boundary itself (RSA boundary) and the nearest residential areas. As indicated in Table 4-1, outside the ambient air boundary, the predicted pollutant concentrations are below the NAAQS and HCl standards.

TABLE 4-1
Comparison of Predicted Pollutant Concentrations Outside the Ambient Air Boundary to Applicable Standards
EA for Testing of Scale-Model SRMs at MSFC

Criteria Pollutant	Averaging Period	Background Concentration ($\mu g/m^3$)	Modeled Concentration ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	Standard ($\mu g/m^3$)	Exceeds Standard?
NO_X	1-hour [1]	94.07	1.99	96.06	188.14	No
	Annual	13.17	0.000003	13.17	99.71	No
CO	1-hour	7,329	306.30	7,636	40,082	No
	8-hour	5,153	7.33	5,161	10,307	No
PM_{10}	24-hour	64	3.98	68	150	No
HCl	1-hour [2]	0	670.70	671	3,033	No
	1-hour [3]	0	670.70	671	2,100	No
	Annual [3]	0	0.003	0.003	9	No

Notes:

[1] USEPA's new 1-hour NO_X standard requires the maximum background concentration summed with the 8th highest modeled concentration, averaged over the 3-year period, to be compared to the standard. As a conservative estimate, the maximum background concentration summed with the maximum modeled concentration was used for comparison.

[2] Standard from the Headquarters Air Force Space Command / Surgeon General Air Quality Standards.

[3] Standards from the Office of Environmental Health Hazard Assessment Reference Exposure Levels.

The predicted maximum pollutant concentrations at the discrete receptor sites inside the ambient air boundary are compared to applicable standards in Table 4-2. The discrete receptor sites inside the ambient air boundary include the ESAs, the WNWR, and two locations where the gray bat has been documented to occur. As indicated in Table 4-2, within the ambient air boundary, the predicted pollutant concentrations are below the NAAQS and HCl standards.

TABLE 4-2
Comparison of Predicted Pollutant Concentrations Inside the Ambient Air Boundary to Applicable Standards
EA for Testing of Scale-Model SRMs at MSFC

Criteria Pollutant	Averaging Period	Background Concentration ($\mu g/m^3$)	Modeled Concentration ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	Standard ($\mu g/m^3$)	Exceeds Standard?
NO_X	1-hour [1]	94.07	6.28	100.35	188.14	No
	Annual	13.17	0.00003	13.17	99.71	No
CO	1-hour	7,329	962.23	8,291	40,082	No
	8-hour	5,153	33.46	5,187	10,307	No
PM_{10}	24-hour	64	16.51	81	150	No

Criteria Pollutant	Averaging Period	Background Concentration ($\mu g/m^3$)	Modeled Concentration ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	Standard ($\mu g/m^3$)	Exceeds Standard?
HCl	1-hour [2, 4]	0	2,087.60	2,088	3,033	No
	1-hour [3]	0	2,087.60	2,088	2,100	No
	Annual [3]	0	0.02	0.022	9	No

Notes:

[1] USEPA's new 1-hour NO_X standard requires the maximum background concentration summed with the 8th highest modeled concentration, averaged over the 3-year period, to be compared to the standard. As a conservative estimate, the maximum background concentration summed with the maximum modeled concentration was used for comparison.

[2] Standard from the Headquarters Air Force Space Command / Surgeon General Air Quality Standards.

[3] Standards from the Office of Environmental Health Hazard Assessment Reference Exposure Levels.

[4] The modeled 1-hour HCl results are from the Wheeler National Wildlife Refuge and use the refined method, assuming that only one SRM can be tested per day; the result was taken as the maximum concentration produced by testing one of the three SRMs.

To assess the potential contribution that scale-model SRM testing at MSFC has on greenhouse gas emissions, the annual quantity of CO_2 emitted by SRM testing was calculated using engineering estimates based on the data provided by NASA. Table 4-3 presents the amount of CO_2 emitted by each type of SRM test and the total CO_2 emitted annually by all tests.

Although no CO_2 ambient air quality standards exist, the CEQ recently released draft guidelines on what may classify a project's greenhouse gas emissions as meaningful. According to the CEQ guidelines, a quantitative and qualitative assessment may be meaningful if the project's direct emissions are greater than 25,000 metric tons of CO_2-equivalent (CEQ, 2010). As indicated in Table 4-3, the estimated emissions are much lower than 25,000 metric tons of CO_2-equivalent.

TABLE 4-3
Annual CO_2 Emissions
EA for Testing of Scale-Model SRMs at MSFC

Pollutant	Large SRM	Medium SRM	Small SRM
Mass Fraction in Exhaust	0.084	0.084	0.138
Mass of Propellant Detonated (kg)	4636	1719	40
CO_2 Emitted per Test (kg)	388	144	6
Maximum Annual Testing Frequency	2	5	25
CO_2 Emitted per SRM (kg/year)	775	719	138
Total CO_2 Emitted (metric tons/year) = 1.63			

In summary, the air dispersion modeling conducted indicates that the pollutant concentrations from scale-model SRM testing at MSFC would be below applicable standards at the RSA boundary, nearest residential areas, nearest ESAs, and within the WNWR. These findings are based on conservative modeling assumptions for test location, emission rates, and testing frequency; therefore, the findings would apply to any expected future testing conditions at MSFC. Based on generated HCl concentration contours, the quantity of HCl that would be deposited would decrease significantly with distance from the source location (see Appendix C). Moreover, the predicted ambient air concentrations of HCl outside the RSA boundary, at the ESAs, and within the WNWR would be lower than the applicable standard. Therefore, HCl deposition resulting from scale-model SRM testing would have little or no impact on biological receptors at these distances from the test sites. The potential impacts of HCl deposition on biological resources are discussed in greater detail in Section 4.5.1. The predicted annual CO2 emissions that would be generated by scale-model SRM testing at MSFC would be approximately 1.63 metric tons per year. Based on draft CEQ guidelines, which has established a threshold of 25,000 metric tons of CO2-equivalent as being meaningful, future scale-model SRM testing at MSFC would have a negligible contribution to greenhouse gas emissions.

For these reasons, the Proposed Action would have a minor impact on air quality.

4.1.2 No-Action Alternative

Under the No-Action Alternative, scale-model SRM testing would not be conducted at MSFC. Therefore, the No-Action Alternative would have no impact on air quality.

4.2 Noise

4.2.1 Proposed Action

The noise analysis conducted for the Proposed Action is based on far field acoustic environment predictions developed using a computer program written by ER42-MSFC. Mr. Doug Counter/ER42-MSFC ran the computer program and documented the generated acoustic predictions in a memorandum that is provided as Appendix D of this EA. The computer program generated far field sound pressure level predictions based on the octave band power level of the SRM, distance from the source (test site), directivity index, and atmospheric attenuation. Several parameters were used to calculate the power level including type of motor, thrust, nozzle exit diameter, exit velocity, and acoustic efficiency (see Appendix D).

The far field acoustic predictions were developed for small, medium, and large SRMs, as they have been defined based on maximum thrust potential for the Proposed Action, i.e., 10,000 lbf, 60,000 lbf, and 100,000 lbf, respectively. The test sites and the type of scale-model SRM testing at each site that were analyzed are also consistent with how the Proposed Action has been described in this EA. Acoustic predictions were developed for the nearest MSFC boundary point, nearest MSFC office building outside the East Test Area, nearest RSA boundary point, nearest residential area, nearest WNWR boundary point, and within the WNWR near Decatur, Alabama. A residential area located on Zierdt Road south of RSA's Gate 7 was determined to be the nearest residential area to each of the test sites. This residential area is west of the test sites, at a distance ranging from approximately 5,100 meters to 5,300 meters, depending on the test site.

The overall sound pressure levels (OASPLs) predicted to be generated by each SRM test type at the target locations are presented in Tables 4-4 through 4-8. These OASPLs are the maximum levels predicted and are typically at the 50 or 60 degree angle from the direction of the SRM thrust. Sound level contour data for the small, medium, and large scale-model SRM tests are presented in Appendix D.

TABLE 4-4
OASPLs for the Small SRM in the Horizontal Firing Position at TC 116
EA for Testing of Scale-Model SRMs at MSFC

Location	Distance (Meters)	OASPL (dB)	A-weighted OASPL (dBA)
Nearest MSFC boundary point	270	120.4	116.3
Nearest MSFC office building outside East Test Area (Building 4666)	670	111.4	106.8
Nearest RSA boundary point	5300	85.1	73.4
Nearest residential area (Zierdt Road)	5300	85.1	73.4
Nearest WNWR boundary point	800	109.8	104.5
WNWR near Decatur, Alabama	25000	60.4	25

TABLE 4-5
OASPLs for the Small SRM in the Vertical Firing Position at TC 116
EA for Testing of Scale-Model SRMs at MSFC

Location	Distance (Meters)	OASPL (dB)	A-weighted OASPL (dBA)
Nearest MSFC boundary point	270	122.6	117.4
Nearest MSFC office building outside East Test Area (Building 4666)	670	113.8	108
Nearest RSA boundary point	5300	87.9	75.6
Nearest residential area (Zierdt Road)	5300	87.9	75.6
Nearest WNWR boundary point	800	112.3	105.7
WNWR near Decatur, Alabama	25000	60.6	28

TABLE 4-6
OASPLs for the Medium SRM in the Horizontal Firing Position at TS 4520
EA for Testing of Scale-Model SRMs at MSFC

Location	Distance (Meters)	OASPL (dB)	A-weighted OASPL (dBA)
Nearest MSFC boundary point	120	135.7	130.5
Nearest MSFC office building outside East Test Area (Building 4666)	610	120.5	114.4
Nearest RSA boundary point	5150	95.1	81.1
Nearest residential area (Zierdt Road)	5150	95.1	81.1
Nearest WNWR boundary point	500	122.4	116.6
WNWR near Decatur, Alabama	25000	70.5	33.9

TABLE 4-7
OASPLs for the Medium SRM in the Horizontal Firing Position at TC 500
EA for Testing of Scale-Model SRMs at MSFC

Location	Distance (Meters)	OASPL (dB)	A-weighted OASPL (dBA)
Nearest MSFC boundary point	380	125.1	119.5
Nearest MSFC office building outside East Test Area (Building 4666)	420	124.1	118.4
Nearest RSA boundary point	5100	95.3	81.3
Nearest residential area (Zierdt Road)	5100	95.3	81.3
Nearest WNWR boundary point	1200	113.5	106.3
WNWR near Decatur, Alabama	25000	70.5	33.9

TABLE 4-8
OASPLs for the Large SRM in the Horizontal or Vertical Firing Position at TS 4520
EA for Testing of Scale-Model SRMs at MSFC

Location	Distance (Meters)	OASPL (dB)	A-weighted OASPL (dBA)
Nearest MSFC boundary point	120	138.4	130.4
Nearest MSFC office building outside East Test Area (Building 4666)	610	123.5	114.5
Nearest RSA boundary point	5150	100.2	81.7
Nearest residential area (Zierdt Road)	5150	100.2	81.7
Nearest WNWR boundary point	500	125.4	116.6
WNWR near Decatur, Alabama	25000	76.8	38

Potential impacts from significantly high noise levels are typically health effects or structural damage. OSHA regulates permissible noise exposures without hearing protection. Maximum exposure to impulsive noise should never exceed 140 decibel (dB) peak sound pressure level (29 CFR 1910.95). Based on experience from testing engines at MSFC, NASA has estimated the chances for claims at structural damage versus OASPL. These predictions indicate a 1 in a thousand chance of structural damage claims occurring at levels of 111 dB and a 10 in a thousand chance at 119 dB (NASA, 1997).

As discussed in Section 3.2, human hearing is best approximated by using an A-weighted decibel scale (dBA). This adjusted sound pressure scale accounts for the insensitivity of the human ear to low frequencies. The acoustic energy generated by scale-model SRM testing is concentrated in the low-frequency range. High-frequency noise is attenuated (reduced) as distance from the noise increases and when obstructions such as trees and buildings exist between the noise generator and listener. The acoustic predictions developed for this EA did not take into account attenuation due to obstructions and, therefore, are conservative.

As shown in Tables 4-4 through 4-8, the maximum OASPLs predicted at the target locations vary among the SRM types and test sites. Based on the predictions, future testing of large SRMs at TS 4520 would generate the highest noise levels (among the SRM types and test sites) in the nearest residential area. Large SRM testing at TS 4520 is predicted to result in maximum OASPLs of 100.2 dB and 81.7 dBA in the nearest residential area. Medium SRM testing at TC 500 and medium SRM testing at TS 4530 are predicted to result in lower but relatively comparable maximum OASPLs in the nearest residential area (95.3 dB/ 81.3 dBA for TC 500 and 95.1 dB/ 81.1 dBA for TS 4520). Small SRM testing at TC 116 is predicted to result in relatively lower OASPLs in the nearest residential area (87.9 dB/75.6 dBA for vertical testing and 85.1 dB/73.4 dBA for horizontal testing). In comparison, past large liquid fuel engine testing at MSFC was predicted to result in maximum OASPLs of 119 dB and 97 dBA in the nearest residential area (NASA, 1997).

As discussed above, the maximum OASPL in the nearest residential area for a large SRM test is predicted to be 100.2 dB. At a noise level of 100.2 dB, the chance of structural damage claims would be less than 0.1 claims per 1,000 households (NASA, 1997). As such, testing of a large SRM would have an extremely low probability of damaging structures in this residential area. Testing of medium and small SRMs would have even lower probabilities of damaging structures in this residential area. This residential area is located just outside the western boundary of RSA. This location is the nearest part of the RSA boundary to the test sites. Therefore, any new residential or commercial development that may occur along any other part of the RSA boundary would have even less of a chance of structural damage from scale-model SRM testing.

The maximum A-weighted sound levels predicted in the nearest residential area would be very noticeable but would be a minor noise impact to residents because of the low frequency and short durations of future SRM tests. Based on the current goals of NASA's SRM R&D program, small SRMs are expected to be tested at a frequency of 35 times over a two year period, and medium and large SRMs are expected to be each tested once a year. Although the upper bound of future testing frequencies cannot be ascertained at this time, maximum annual testing frequencies are expected to be 25 small SRM tests, five medium SRM tests, and two large SRM tests. The average duration of a future small SRM test would be approximately 4 seconds. The average durations of a future medium SRM test and a future large SRM test would be approximately 20 seconds and 30 seconds, respectively. People are routinely exposed to noise levels that are as high as those that would be generated by scale-model SRM testing, e.g., noise from lawn mowers, aircraft, and thunder. As discussed in Section 4.4.1, future scale-model SRM testing is expected to have minimal noise impacts on wildlife and listed animal species.

For these reasons, the Proposed Action would have a minor noise impact.

4.2.2 No-Action Alternative

Under the No-Action Alternative, scale-model SRM testing would not be conducted at MSFC. Therefore, the No-Action Alternative would have no noise impact.

4.3 Surface Water

4.3.1 Proposed Action

As discussed in Section 3.3, several CERCLA detention ponds and ditches are located in the vicinities of the scale-model SRM test sites. These ponds and ditches have received storm water runoff and wastewaters from various facilities in the East Test Area, and they are currently being investigated under the OU 1 RI. Future scale-model SRM testing at MSFC would not involve construction or any other activity that would directly impact the CERCLA detention ponds and ditches.

During horizontal testing of small SRMs at TC 116 and medium SRMs at TC 500 and TS 4520, deluge water is used to cool the horizontal test mounts that support the SRMs. Deluge water is used as necessary and typically at a flow rate of approximately 100 gallons/minute. Quench water is also used during horizontal testing to cool the motor case if it exceeds a certain temperature. Quench water is typically applied at a flow rate of approximately 150 gallons/minute. Lastly, cooling water is used during vertical testing of small SRMs that are fired downward, such as the RATO, at TC 116. Cooling water is shot horizontally at the vertical thrust flame at a flow rate of approximately 2,000 gallons/minute.

Deluge, quench, and cooling water used during scale-model SRM testing flow into the CERCLA detention ponds and ditches in the vicinities of some of the test sites. Deluge and quench water used at TC 500 drain into concrete drainage trenches under the site which direct the flow into Pond MSFC-008. Outflow from this pond to Pond MSFC-010 to the northwest depends on water levels. Deluge, quench, and cooling water used at TC 116 drain into concrete drainage trenches under the site which direct the flow into one of two segments of Ditch MSFC-063 (063B or 063C). The flow is then directed by these ditches southeastward into Pond MSFC-009. Deluge and quench water used at the TS 4520 site drain via sheet flow to the south and do not enter Pond MSFC-012.

Deluge and quench water used during horizontal SRM testing do not come into contact with the SRM thrust flame. Therefore, deluge and quench water runoff that flows from the test sites does not contain any exhaust constituents that are emitted during testing, and has no potential to indirectly impact the water quality of the CERCLA detention ponds or ditches. Cooling water used during vertical testing of small SRMs that are fired downward at TC 116 does come into contact with the SRM thrust flame. Based on the relatively large volume of cooling water used, the concentrations of exhaust constituents, such as HCl, in the runoff is very low. Exhaust constituent concentrations decrease further when the runoff is diluted with the existing water in the receiving ditch (Ditch MSFC-063) and pond (Pond MSFC-009). No SRM exhaust constituents have been detected in water samples taken from Pond MSFC-009 to date. This pond is sampled on a regular basis under the OU1 RI. As such, cooling water used during SRM testing has very little potential to indirectly impact the water quality of the CERCLA detention ponds or ditches.

The Proposed Action was coordinated with USEPA through letter correspondence (see Appendix A). In a reply letter dated July 21, 2010, USEPA provided the following comments on the Proposed Action: "EPA recommends the EA discuss the consumption of water used for deluge, quench and cooling in context of cumulative effects of water resource availability and scarcity, particularly during long drought periods and in context of local community/government growth planning. Additionally, EPA recommends the EA explore alternatives for water conservation associated with these SRM testing functions. For example, can this water be captured, recycled, and reused again? Or can the volume of water used be reduced and still accomplish deluge, quench, and cooling functions" (see Appendix A). The comments received from USEPA are addressed as follows:

The source of deluge, quench, and cooling water used during scale-model SRM testing is industrial water, not potable water. Based on the expected average frequencies and durations of future scale-model SRM tests, and the manner in which deluge, quench, and cooling water would be used, approximately 1,200 gallons of deluge water and 2,400 gallons of cooling water would be used annually on average during future scale-model SRM testing at MSFC. During any given year, little or no quench water is expected to be used because quench water is needed only when the motor case exceeds a critical temperature, which is a situation that occurs only during a system failure. Given that future scale-model SRM testing at MSFC would consume on average approximately 3,600 gallons of industrial water annually, the Proposed Action would not have significant adverse direct or cumulative impacts on water resources in the region. Based on the manner in which scale-model SRM tests are conducted, the manner in which deluge, quench, and cooling water is used, and the amount of water that is used during tests, water that is used cannot be captured, recycled, or reused. NASA currently uses the minimum amount of water that can adequately meet the water needs of scale-model SRM tests at MSFC. NASA is currently evaluating alternative methods that would potentially result in more efficient storage and application of deluge water during horizontal SRM testing. If proven viable, an alternative method for deluge water usage that reduces water consumption during scale-model SRM testing at MSFC may be implemented in the future.

For these reasons, the Proposed Action would have a minimal impact on surface water.

4.3.2 No-Action Alternative

Under the No-Action Alternative, scale-model SRM testing would not be conducted at MSFC. Therefore, the No-Action Alternative would have no impact on surface water.

4.4 Biological Resources

4.4.1 Proposed Action

As discussed in Section 3.4, all of the scale-model SRM test sites at MSFC are developed, paved, and contain little or no vegetation. Pine/deciduous forests are located along the perimeter of the East Test Area and several CERCLA detention ponds and ditches, some of which are classified as federally jurisdictional wetlands, are located in the general vicinities of the test sites.

The scale-model SRM test sites and their immediate surroundings provide minimal wildlife habitat. The pine/deciduous forests located along the perimeter of the East Test Area provide suitable habitat for common terrestrial wildlife species and some of the CERCLA detention ponds/ditches in the East Test Area provide low-quality aquatic habitat. The WNWR, which extends into the southwestern part of MSFC and runs east/west outside the southern and southeastern boundaries of the East Test Area, provides relatively high-quality wildlife habitat.

As discussed in Section 3.4, three federally listed species have been documented to occur on or near MSFC: the Alabama cave shrimp, Price’s potato bean, and the gray bat. Two other federally listed species that have the potential to occur on or near MSFC are the American alligator and the Indiana bat. None of these listed species has been documented to occur or is expected to potentially occur in or near the East Test Area. There are currently eight areas on RSA that are classified as ESAs. Only one of these ESAs, the Williams Spring ESA, is located on MSFC. All of the ESAs on RSA are located relatively far from the East Test Area. The nearest ESA, which is the Williams Spring ESA, is located approximately 1.8 miles northwest of the East Test Area. The Bobcat Cave ESA, which is located approximately 4.1 miles northwest of the East Test Area, is the only area on RSA where the Alabama cave shrimp has been found. The only other known population of the Alabama cave shrimp in Madison County, Alabama is located approximately 14.2 miles east of the East Test Area. The Madkin-Weeden Mountain ESA, which is located approximately 2.9 miles northeast of the East Test Area, is the only area on RSA where Price's potato bean has been found. The only other known population of Price's potato bean in Madison County, Alabama is located approximately 10.4 miles northeast of the East Test Area. The Swan Pond-Bradford Sinks ESA, which is located approximately 3.3 southwest of the East Test Area, has been designated by RSA as an ESA for the gray bat. No gray bat colonies have been found within any of the caves on RSA; however, the gray bat has been recorded in two locations on RSA, approximately 3.5 miles northeast of the East Test Area, and approximately 1.7 miles northwest of the East Test Area.

Future scale-model SRM testing at MSFC would not involve construction or any other activity that would directly impact vegetation or wildlife habitat. As discussed in Section 4.3.1, cooling water runoff that flows from TC 116 has very little potential to indirectly impact the water quality of the receiving CERCLA detention ponds or ditches. During past horizontal testing of medium SRMs at TC 500 and the TS 4520 site, the thrust flame of the SRM occasionally caught the maintained grass in the immediate vicinity of the sites on fire. All past grass fires were quickly extinguished and any grass fires that may occur during future horizontal testing at these sites are also expected to be readily extinguished with no resulting impacts to natural vegetation further from the sites. MSFC personnel would inspect the grassy areas immediately after each SRM test and, if necessary, put out any fires with fire extinguishers.

Noise generated during future scale-model SRM testing has the potential to disturb wildlife species that occur within and in the vicinity of the East Test Area. However, the overall testing noise impact on wildlife is expected to be minor because the noise would be infrequent and of short duration. Wildlife species that occur within and in the vicinity of the East Test Area are adapted to relatively high noise levels such as those generated by hot gas testing, which is conducted at a greater frequency than scale-model SRM testing. Based on the far field acoustic environment predictions developed for this EA, future testing of large SRMs at TS 4520 would generate the highest noise levels (among the SRM types and test sites) within the WNWR (see Section 4.2.1). Testing of large SRMs at TS 4520 is predicted to generate a maximum noise level of 125.4 dB at the nearest WNWR boundary point. Noise levels experienced within the WNWR would decrease with increasing distance from the test site. Testing of large SRMs at TS 4520 is predicted to generate a maximum noise level of 76.8 dB within the portion of the WNWR located near Decatur, Alabama. The vast majority of the WNWR is located well outside RSA; therefore, high noise levels generated by scale-model SRM testing would be experienced in a relatively small portion of the refuge. Testing of large SRMs at TS 4520 as well as testing of medium SRMs, which would generate lower noise levels, are each expected to be conducted once a year on average. Future testing of small SRMs would be conducted at a higher frequency (18 times a year on average);

however, small SRM tests would generate considerably lower noise levels than would medium and large SRM tests. Regardless of the type of SRM tested and the location of the test site, any noise disturbance experienced by wildlife in the WNWR would be infrequent and of short duration. Based on the distances of the ESAs and documented occurrences of listed species from the test sites discussed above, future scale-model SRM testing is expected to have minimal noise impacts on wildlife and listed animal species that utilize the ESAs on RSA and on listed species that occur outside RSA.

As discussed in Section 4.1.1, the air dispersion modeling conducted for this EA indicates that the pollutant concentrations from scale-model SRM testing at MSFC would be below applicable standards at the ESAs discussed above, and within the WNWR. These findings are based on conservative modeling assumptions for test location, emission rates, and testing frequency; therefore, the findings would apply to any expected future testing conditions at MSFC. Exposure of plants and animals to HCl deposition from scale-model SRM testing would depend on prevailing weather conditions and their distance from test sites. Based on generated HCl concentration contours, the quantity of HCl that would be deposited would decrease significantly with distance from the source location (see Appendix C). Moreover, the predicted ambient air concentrations of HCl outside the RSA boundary, at the ESAs, and within the WNWR would be lower than the applicable standard. Therefore, HCl deposition resulting from scale-model SRM testing would have no impact on listed species and would have little potential to impact biological receptors within the WNWR. Depending on meteorological conditions, biological receptors closer to the tests sites may be affected by HCl deposition. However, the potential impact would be minor because the exposure potential would be temporary and infrequent given that small SRMs are expected to be tested on average approximately 18 times a year and medium and large SRMs are each expected to be tested on average only once a year. Moreover, the amount of HCl emitted from scale-model SRM testing is relatively small (see Section 4.1.1).

Correspondence with the U.S. Fish and Wildlife Service, WNWR, and other reviewing entities will be discussed here when completed.

For these reasons, the Proposed Action would have a minor impact on biological resources.

4.4.2 No-Action Alternative

Under the No-Action Alternative, scale-model SRM testing would not be conducted at MSFC. Therefore, the No-Action Alternative would have no impact on biological resources.

4.5 Cultural Resources

4.5.1 Proposed Action

None of the archaeological sites identified at MSFC are located within the scale-model SRM test sites. There is one archaeological site within the vicinity of TC 116 and Building 4583. Future scale-model SRM testing at MSFC would not involve construction or any other ground-disturbing activity and, therefore, does not have the potential to impact any archaeological site that has been identified or any artifacts that may not have been discovered.

As discussed in Section 3.5, the 2003 Historical Assessment of MSFC (NASA, 2003) recommended that TS 500 (Building 4522) and TS 116 (Building 4540), as well as their blockhouses be re-evaluated for NRHP eligibility in ten years, i.e., around 2013. In addition, Building 4583 has been determined to be eligible for NRHP listing under Criteria A (for association with key missions at MSFC) and C (for association with leading aerospace architectural-engineering firms of the early Cold War years) (NASA, 2003, MSFC, 2009). All of the other buildings associated with the proposed SRM test sites have been determined to be ineligible for NRHP listing (NASA, 2003; MSFC, 2009).

Future scale-model SRM testing at MSFC would not involve modifications to any of the facilities at the test sites. All of the test facilities are currently operational and they do not require any structural modifications to accommodate scale-model SRM testing. Operation of the facilities recommended for NRHP eligibility re-evaluation and Building 4583 would increase the historical significance of their structures and functions.

Under MSFC's Programmatic Agreement with the Alabama State Historic Preservation Office (SHPO) under Stipulation I, when proposed undertakings do not affect those qualities of structures identified as eligible, then no submittals, notifications, or consultations are required. The proposed actions at the identified locations fall under this Stipulation; therefore, no submittals, notifications, or consultations with SHPO are required. The Proposed Action was nonetheless coordinated with SHPO through letter correspondence (see Appendix A). In a reply letter dated July 7, 2010, SHPO stated the following regarding the Proposed Action: "We have determined that the project activities will have no effect on any known cultural resources listed on or eligible for the National Register of Historic Places. Therefore we concur with the proposed project activities" (see Appendix A).

For these reasons, the Proposed Action would have no impact on cultural resources.

4.5.2 No-Action Alternative

Under the No-Action Alternative, scale-model SRM testing would not be conducted at MSFC. Therefore, the No-Action Alternative would have no impact on cultural resources.

4.6 Public and Occupational Health and Safety

4.6.1 Proposed Action

Scale-model SRMs to be tested at MSFC will be shipped by truck from their manufacturing locations to RSA. Small and medium SRMs will be stored in Building 7325 at RSA and then transferred to Building 4563 (SRM Processing Facility) in the East Test Area for processing prior to being transported to the test sites. Large SRMs will be shipped directly to TS 4520 and will be processed at the test stand. Processing of SRMs will primarily involve inspection, assembly, and application of instrumentation prior to testing.

All personnel involved in the transportation, handling, and inspection of scale-model SRMs will be trained and certified as required by ET10-OW1-012, *Personnel Certification for Explosive Handling in Propulsion and Fluid Systems Test Division (ET 10)*, and MWI 3410.1, *Personnel Certification Program*, and will follow all applicable SOPs.

4563-SOP-001, *Solid Propellant Operations in Building 4563*, will be followed for processing of scale-model SRMs in Building 4563. This SOP covers inspection, assembly, and repair of SRMs and igniters in Building 4563, and includes safety procedures, personnel authorizations, building security, propellant residence times, building grounding systems, and emergency procedures.

Transportation of the scale-model SRMs from RSA to Building 4563 (or directly to TS 4520 for large SRMs) and from Building 4563 to the test sites at MSFC will be conducted in accordance with existing applicable MSFC SOPs. These SOPs cover pre-move preparation, trailer/truck loading, transportation, and trailer/truck offloading, and include safety procedures, weather requirements, personnel authorizations, and area warning notification/controls. 116-EI-1001, *Engineering Instruction for the Handling and Installation of the Ullage Settling Motor (USM) Heavy Wall Motor Test at TS 116*, will be followed for the transportation of small SRMs that will be tested at TC 116. SPT-EI-1027a, *Engineering Instruction for the Loading, Transportation, and Unloading of Solid Propellant Motor Components or Assemblies*, will be followed for the transportation of medium SRMs that will be tested at TC 500 or TS 4520, as well as for the transportation of large SRMs that will be tested at TS 4520. In addition, SPTA-SOP-001, *Electrostatic Discharge Control Plan for the 48-inch/24-inch MNASA Solid Rocket Motor*, will be followed to minimize risk associated with inadvertent electrostatic discharge during transportation of medium and large SRMs. All vehicles used to transport SRMs are required to be certified for such operations. RATO and larger SRMs will be transported on flatbed trailers and SRMs smaller than RATOs will be transported on pickup trucks.

As discussed in Section 3.6, QDs have been established for all the scale-model SRM test sites. The East and West Test Areas of MSFC are secured against unauthorized entry and area warning notification/controls are implemented during test operations. All activities associated with scale-model SRM testing at MSFC is conducted in close coordination with the MSFC Safety Office. For these reasons and because the safety protocols and SOPs specific to scale-model SRM testing would be followed, the potential for safety and occupational health impacts under the Proposed Action would be low. Future scale-model SRM testing at MSFC is not expected to significantly change the number of persons working at MSFC or living in the local area. Therefore, the demand for medical, police, and fire-fighting services at MSFC would remain at current levels under the Proposed Action. The potential effects of air emissions generated by scale-model SRM testing on public safety are discussed in Section 4.1.1.

For these reasons, the Proposed Action would have a minor impact on public and occupational health and safety.

4.6.2 No-Action Alternative

Under the No-Action Alternative, scale-model SRM testing would not be conducted at MSFC. Therefore, the No-Action Alternative would have no impact on public and occupational health and safety.

4.7 Hazardous Materials and Wastes

4.7.1 Proposed Action

Under the Proposed Action, small and medium scale-model SRMs will be processed in Building 4563 (SRM Processing Facility) prior to being transported to the test sites. Large SRMs will be shipped directly to TS 4520 and will be processed at the test stand. Processing of SRMs will primarily involve inspection, assembly, and application of instrumentation prior to testing. No cleaning of SRM components using hazardous cleaning agents will be conducted at MSFC. Propellants will not be manufactured , processed, or added to SRMs, and containerized propellants will not be removed from the motor casings at MSFC. Solid propellant trimming (removal of excess propellant clung to the outside walls of the motor casing) may be conducted at MSFC in association with future SRM testing, but is expected to be required on an infrequent basis. Propellant trimmings would be the only hazardous material/waste that would potentially be handled/generated under the Proposed Action. Propellant trimming will be conducted at MSFC by qualified personnel. Propellant trimmings will be properly disposed of by RSA personnel, by burning, explosion, or some other appropriate method. All of the propellants within the SRMs will be consumed during testing. Used SRMs will be shipped back to their manufacturing locations after testing is completed.

As discussed in Section 3.7.3 the scale-model SRM test sites are located within the boundaries of OU 1, which covers the East and West Test Areas of MSFC under NASA's CERCLA program. Much of the East Test Area of MSFC lies within the boundaries of the Southeast Plume (CVOC contamination of the groundwater). Several CERCLA detention ponds and ditches are located in the vicinities of the scale-model SRM test sites.

Testing of scale-model SRMs at MSFC would not involve withdrawals from, or discharges to, groundwater. The Proposed Action would not involve construction or any other activity that would directly or indirectly impact groundwater. Therefore, the Proposed Action would have no effect on the Southwest Plume. As discussed in Section 4.3.1, cooling water runoff that flows from TC 116 has very little potential to indirectly impact the water quality of the receiving CERCLA detention ponds or ditches.

None of the structures that would be used for future scale-model SRM testing at MSFC contain LBP, ACMs, or PCBs; therefore, future testing would not require management of these materials. Future scale-model SRM testing would not involve the use of USTs or ASTs. The scale-model SRM test sites are all located within areas that are designated as Probability 5 – Unlikely for MEC. Based on the locations of the scale-model SRM test sites and because testing would not involve any excavation or other type of subsurface intrusion, MEC sweeps would not be required for future testing.

For these reasons, the Proposed Action would have a minor impact on hazardous materials and wastes.

4.7.2 No-Action Alternative

Under the No-Action Alternative, scale-model SRM testing would not be conducted at MSFC. Therefore, the No-Action Alternative would have no impact on hazardous materials and wastes.

4.8 Environmental Justice and Protection of Children

4.8.1 Proposed Action

Future scale-model SRM testing at MSFC would have no effect, or only minor impacts, on the resources most relevant for assessing impacts on human populations, which are air quality, noise, groundwater, surface water, and hazardous materials/wastes. The minor impacts that scale-model SRM testing would have on these resources would not adversely affect human populations. Therefore, the Proposed Action would not have disproportionately high or adverse human health or environmental effects on minority or low-income populations. The scale-model SRM test sites at MSFC are secured against unauthorized entry; therefore, the Proposed Action would not result in environmental health or safety risks to children.

4.8.2 No-Action Alternative

Under the No-Action Alternative, scale-model SRM testing would not be conducted at MSFC. Therefore, the No-Action Alternative would have no impact on environmental justice or protection of children.

4.9 Cumulative Impacts

4.9.1 Proposed Action

A "cumulative impact" is defined in 40 CFR 1508.7 as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions." Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Future scale-model SRM testing at MSFC would occur entirely within the boundaries of the Center and would have little potential to interact with any private sector actions in the surrounding area. Scale-model SRM testing has been conducted at MSFC since the 1970's to support the Space Shuttle Program and more recently for the Constellation Program. The frequency of scale-model SRM testing at the Center has varied based on mission requirements and has largely been driven by cost and schedule. Future testing frequencies are expected to be comparable to past testing frequencies on average. During scale-model SRM testing, individual tests are separated in time, i.e., two or more tests are not conducted concurrently. Therefore, the noise generated by an individual SRM test is not combined with the noise of another SRM test. Temporal separation of individual tests likewise does not allow combination of test air emissions. As discussed in Sections 4.1.1 and 4.2.1, future small, medium, and large scale-model SRM tests at MSFC would individually result in minor impacts to air quality and noise levels. Given that individual tests would be separated in time, with temporal separation being weeks between individual small SRM tests and months between individual medium and large SRM tests, future testing, as a collective action, is not expected to result in significant cumulative impacts to air quality or noise levels. Based on the air dispersion modeling conducted for this EA, pollutant concentrations from scale-model SRM testing at MSFC would be below applicable standards at the RSA boundary, nearest residential areas, and nearest ESAs even if all three SRM types were tested simultaneously. The modeling that was conducted was based on conservative modeling assumptions for test location, emission rates, and testing frequency; therefore, the findings would apply to any expected future testing conditions at MSFC.

Activities that have been, and continue to be conducted in the Test Area of MSFC in addition to scale-model SRM testing primarily include vibration testing, cryogenic fluid management, hot gas testing, and research/development of low-cost propulsion technologies, advanced hydrocarbon fuels, and composite materials. Collectively, these activities have little to no impact on environmental resources. None of these activities impact air quality and only hot gas testing generates appreciable noise levels. Hot gas testing involves propulsion of hydrogen and air, and it is conducted at a greater frequency than scale-model SRM testing. Future scale-model SRM tests would not be conducted concurrently with hot gas tests; therefore, there would be no combination of noise levels from these two types of tests. High noise levels have been generated by past testing of liquid fuel engines in the Test Area. There have been only three liquid engine tests at MSFC in the last 20 years and none are planned for the foreseeable future. In the event that liquid engine testing is conducted at MSFC in the future, it would not be conducted concurrently with scale-model SRM testing. Therefore, the noise generated by a liquid engine test would not be combined with the noise generated by a scale-model SRM test.

Based on planning schedules, one or more of the Center development projects identified in the 2003 MSFC 20-Year Facilities Master Plan may be implemented during the same time that a future scale-model SRM test is conducted (NASA, 2003a). The majority of the foreseeable development projects at MSFC would involve construction/demolition for facilities, utilities, and other infrastructure in existing developed areas. Such projects would primarily result in temporary increases in noise, air emissions, and traffic. Most of the planned development projects would occur outside the Test Area, would generate relatively low noise levels that would not be audible outside the boundaries of the Center, and would have relatively low air emissions in the form of fugitive dust and construction vehicle/equipment exhaust emissions. Therefore, there is little potential for adverse cumulative impacts on noise or air emissions to occur if a future scale-model SRM test coincides with one or more of the planned development projects. Because future scale-model SRM testing at MSFC would have no effect on traffic flow, no cumulative traffic flow impacts would result if future scale-model SRM testing coincides with future planned development.

For these reasons, the Proposed Action would have no adverse cumulative impacts.

4.9.2 No-Action Alternative

Under the No-Action Alternative, scale-model SRM testing would not be conducted at MSFC. Therefore, the No-Action Alternative would have no adverse cumulative impacts.

SECTION 5

Summary of Environmental Consequences and Conclusions

5.1 Summary of Environmental Consequences

The potential environmental consequences of the Proposed Action and No-Action Alternative are summarized in Table 5-1.

TABLE 5-1
Summary of Environmental Consequences
EA for Testing of Scale-Model SRMs at MSFC

Resource	Proposed Action	No-Action Alternative
Air Quality	MINOR IMPACT	NO IMPACT
Noise	MINOR IMPACT	NO IMPACT
Surface Water	MINIMAL IMPACT	NO IMPACT
Biological Resources	MINOR IMPACT	NO IMPACT
Cultural Resources	NO IMPACT	NO IMPACT
Public and Occupational Health and Safety	MINOR IMPACT	NO IMPACT
Hazardous Materials and Wastes	MINOR IMPACT	NO IMPACT
Environmental Justice and Protection of Children	NO IMPACT	NO IMPACT
Adverse Cumulative Impacts	NO	NO

No Impact: No impacts are expected. The action would not cause a detectable change.

Minimal: Impacts are not expected to be measurable, or are measurable but are too small to cause any change in the environment.

Minor: Impacts are measurable but are within the capacity of the impacted system to absorb the change, or the impacts can be compensated for with little effort and resources so that the impact is not significant.

Moderate: Impacts are measurable but are within the capacity of the impacted system to absorb the change, or the impacts can be compensated for with little effort and resources so that the impact is not significant. Moderate impacts have greater magnitudes than minor impacts.

Major: Environmental impacts which individually or cumulatively could be significant. The significance of adverse and positive impacts is subject to interpretation and should be determined based on the final proposal. In cases of adverse impacts, the impact may be reduced to less than significant by mitigation, design features, and/or other measures that may be taken.

5.2 Conclusions

Based on the findings of this EA, future scale-model SRM testing at MSFC would not have a significant impact on the quality of the human or natural environment. No mitigation measures have been determined to be necessary for the Proposed Action. The findings of this EA are consistent with past RECs that have been prepared for specific scale-model SRMs, which concluded that static testing of the SRMs analyzed would not result in significant environmental impacts. This EA supports a Finding of No Significant Impact for the Proposed Action. Accordingly, preparation of an Environmental Impact Statement is not required.

SECTION 6

References

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SECTION 7

List of Preparers

Name	Organization	Primary Responsibility
Mark Bennett	CH2M HILL	Noise and Air Quality
Bruce Cole	GSE	GSE Project Manager
Doug Counter	NASA	Noise
Jason Glasgow	CH2M HILL	Hazardous Materials and Wastes
Donna Holland	NASA	NASA Project Manager
Gerald Neal	NASA	Public and Occupational Health and Safety
Tunch Orsoy	CH2M HILL	CH2M HILL Project Manager
Elyse Pieper	CH2M HILL	Air Quality
Dennis Strickland	NASA	Scale-Model SRM Testing Program
Andrea White	CH2M HILL	Air Quality

APPENDIX A

Regulatory Agency Correspondence

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
SAM NUNN
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA GEORGIA 30303-8960

July 21, 2010

Mr. Allen Elliott, Manager
Environmental Engineering and
Occupational Health Office
National Aeronautics and Space
Administration
Marshall Space Flight Center,
Alabama 35812

SUBJECT: EPA comments on draft Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) for the static testing of scale-model rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC).

Dear Mr. Elliott:

To fulfill EPA's Clean Air Act (CAA) § 309 and National Environmental Policy Act (NEPA) § 102 (2) (C) responsibilities, EPA has reviewed and encloses its review comments of the above identified draft EA/FNSI for NASA's proposed action: static testing of scale-model SRMs at MSFC.

Background

According to the EA, MSFC is the primary NASA Center for SRM Research & Development, and the only Center that is currently capable of conducting static scale-model SRM testing. MSFC has several existing facilities specifically designed for static scale-model SRM testing. These facilities are all currently operational and do not require any structural, mechanical, or utility modifications.

Proposed Action

The EA states static testing of scale-model SRMs is integral to SRM research and development, and is critical to NASA's overall mission. Static scale-model SRM testing allows NASA to reduce the risk and expense associated with the design of new SRMs and the selection/ qualification of new SRM materials prior to implementation of full-scale static tests. SRM technology cannot be advanced without scale-model testing.

Alternatives Analysis

The EA's alternative analysis was limited to the "no action" and the existing testing facility because conducting scale-model SRM testing outside of MSFC was deemed as an unreasonable alternative. Conducting static scale-model SRM testing at any other NASA Center would require new facility construction and/or existing facility modifications, resulting in significant costs and associated testing delays. Additionally, new facility construction at other NASA Centers would be complicated by land and environmental constraints as suitable sites for new development are limited.

Furthermore, the EA states there are no technical alternatives to actual scale-model testing that alone can provide the simulation of full-scale tests needed for development/ qualification of new materials/ instrumentation or to conduct ballistic assessments and thermal analyses.

Comments

Water resources: the EA states the Proposed Action would have a minimal impact on surface water from a contamination perspective including any potential contamination of deluge, quench, and cooling water used to during the testing of SRMs.

Additionally, the EA describes the volume of water (deluge, quench, and cooling) use associated with SRM testing. Deluge water is used to cool the horizontal test mounts that support the SRMs at a typical flow rate of approximately 100 gallons/minute. Quench water is to cool the motor case if it exceeds a certain temperature and typically applied at a flow rate of approximately 150 gallons/minute. Cooling water is also used during vertical testing of small SRMs and is shot horizontally at the vertical thrust flame at a flow rate of approximately 2,000 gallons/minute.

EPA recommends the EA discuss the consumption of water used for deluge, quench and cooling in context of cumulative effects of water resource availability and scarcity, particularly during long drought periods and in context of local community/government growth planning. Additionally, EPA recommends the EA explore alternatives for water conservation associated with these SRM testing functions. For example, can this water be captured, recycled, and reused again? Or can the volume of water used be reduced and still accomplish deluge, quench, and cooling functions.

Based upon our review of the information contained within this EA, we have no further comments. Thank you for the opportunity to review and provided comments. If you wish to discuss this matter further, please contact Beth Walls (404-562-8309 or walls.beth@epa.gov) of my staff.

Sincerely,

Mueller

Heinz J. Mueller, Chief
NEPA Program Office
Office of Policy and Management

STATE OF ALABAMA
ALABAMA HISTORICAL COMMISSION
468 SOUTH PERRY STREET
MONTGOMERY, ALABAMA 36130-0900

FRANK W. WHITE
EXECUTIVE DIRECTOR

TEL: 334-242-3184
FAX: 334-240-3477

July 7, 2010

Allen Elliott
NASA
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Re: AHC 10-0982
Static Testing of Scale-Model Rocket Motors
Madison County, Alabama

Dear Mr. Elliot:

Upon review of the above referenced project, we have determined that the project activities will have no effect on any known cultural resources listed on or eligible for the National Register of Historic Places. Therefore, we concur with the proposed project activities.

However, should artifacts or archaeological features be encountered during project activities, work shall cease and our office shall be consulted immediately. Artifacts are objects made, used or modified by humans. These include but are not limited to arrowheads, broken pieces of pottery or glass, stone implements, metal fasteners or tools, etc. Archaeological features are stains in the soil that indicate disturbance by human activity. Some examples are postholes, building foundations, trash pits and even human burials. This stipulation shall be placed on the construction plans to insure contractors are aware of it.

We appreciate your efforts on this project. Should you have any questions, please contact Greg Rhinehart at (334) 230-2662. Please have the AHC tracking number referenced above available and include it with any correspondence.

Truly yours,

Elizabeth Ann Brown

Elizabeth Ann Brown
Deputy State Historic Preservation Officer

EAB/GCR/gcr

1	Mr. Terry Hazle AMSAM-RA-DEM Building 4488 Redstone, Arsenal, AL 35898
2	Honorable Paul Finley Mayor of Madison 100 Hughes Road Madison, AL 35758
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7	Honorable Mary Caudle Mayor of Trina 640 Sixth Street Triana, AL 35758
8	Congressman Parker Griffith 5th Congressional District of Alabama 2101 Clinton Avenue, West STE 302 Huntsville, AL 35805
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10	Stanley Meiburg, Regional Administrator Environmental Protection Agency Region IV 61 Forsyth St., SW Atlanta, GA 30303
11	Honorable Mike Gillespie, Chairman Madison County Commission Madison County Courthouse Huntsville, AL 35801
12	Senator (District 8) Lowell Barron P.O. Box 65 Fyffe, AL 35971

13	NASA/MSFC Mail Code CS20 ATTN: Mr. Mike Wright MSFC, AL 35812
14	Refuge Manager USFWS Wheeler Wildlife Refuge Rt. 4 Box 35603 Decatur, AL 35603
15	NASA/MSFC Mail Code CS20 ATTN: Mr. Dom Amatore MSFC, AL 35812
16	Representative (District 25) Mac McCutcheon P.O. Box 370 Capshaw, AL 35742
17	Onis "Trey" Glenn III, Director Alabama Department of Environmental Management 1400 Coliseum Blvd. Montgomery, AL 36110-2059
18	Representative (District 20) Howard Sanderford 908 Tannahill Dr SE Huntsville, AL 35802
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20	Senator Jeff Sessions 7550 Halcyon Summit Dr., STE 150 Montgomery, AL 36117
21	Representative (District 19) Laura Hall P.O. Box 3367 Huntsville, AL 35810
22	Senator (District 2) Tom Butler 136 Harrington Drive Madison, AL 35758
23	Representative (District 10) Mike Ball P.O. Box 6302 Huntsville, AL 35824
24	Senator (District 3) Arthur Orr P.O. Box 305 Decatur, AL 35602
25	Senator (District 7) Paul Sanford 218 Westchester Avenue Huntsville, Alabama 35801

26	Senator Richard Shelby 1118 Greensboro Ave #240 Tuscaloosa, AL 35401
27	Representative (District 22) Butch Taylor 224 Taylor Ave New Hope, AL 35760

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of: AS10 (119-10)

Onis "Trey" Glenn III, Director
Alabama Department of Environmental Management
1400 Coliseum Blvd.
Montgomery, AL 36110-2059

Dear Onis Glenn:

The draft Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) for the static testing of scale-model solid rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC) have been prepared and are being made available to the public and to federal, state, and local entities for a 30-day review and comment period. Please find enclosed a CD containing electronic copies of the documents.

As NASA's principal propulsion research center, MSFC has the lead role of conducting SRM research and development, and is the only NASA Center currently capable of conducting scale-model SRM testing. Static scale-model SRM testing allows NASA to reduce the risk and expense associated with the design of new SRMs and the selection/qualification of new SRM materials prior to implementation of full-scale static tests. The EA that has been prepared broadly analyzes the conceivable scope of future scale-model SRM testing that could occur at MSFC.

To receive hardcopies or additional electronic copies of the draft EA and draft FONSI, please contact AS10/Ms. Donna Holland, Environmental Engineering and Occupational Health Office, NASA Marshall Space Flight Center, AL 35812, phone: (256) 544-7201, e-mail: Donna.L.Holland@nasa.gov or CS30/Ms. Sharon Cobb, Manager, External Relations Office, NASA Marshall Space Flight Center, AL 35812, phone: (256) 544-7791, e-mail: Sharon.Cobb@nasa.gov. Comments on the draft EA and draft FONSI must be provided in writing by mail or e-mail to Mr. Donna Holland or to Ms. Sharon Cobb, and must be postmarked within 30 days from the date of this letter.

Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of: AS10 (119-10)

Representative (District 10) Mike Ball
P.O. Box 6302
Huntsville, AL 35824

Dear Representative Ball:

The draft Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) for the static testing of scale-model solid rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC) have been prepared and are being made available to the public and to federal, state, and local entities for a 30-day review and comment period. Please find enclosed a CD containing electronic copies of the documents.

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Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of: AS10 (119-10)

Honorable Tommy Battle
Mayor of Huntsville
P.O. Box 308
308 Fountain Circle
Huntsville, AL 35801

Dear Mayor Battle:

The draft Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) for the static testing of scale-model solid rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC) have been prepared and are being made available to the public and to federal, state, and local entities for a 30-day review and comment period. Please find enclosed a CD containing electronic copies of the documents.

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Sincerely,
Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of

AS10 (119-10)

Honorable Mary Caudle
Mayor of Trina
640 Sixth Street
Triana, AL 35758

Dear Mayor Caudle:

The draft Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) for the static testing of scale-model solid rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC) have been prepared and are being made available to the public and to federal, state, and local entities for a 30-day review and comment period. Please find enclosed a CD containing electronic copies of the documents.

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Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of: AS10 (119-10)

Honorable Paul Finley
Mayor of Madison
100 Hughes Road
Madison, AL 35758

Dear Mayor Finley:

The draft Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) for the static testing of scale-model solid rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC) have been prepared and are being made available to the public and to federal, state, and local entities for a 30-day review and comment period. Please find enclosed a CD containing electronic copies of the documents.

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Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:

AS10 (119-10)

Honorable Mike Gillespie, Chairman
Madison County Commission
Madison County Courthouse
Huntsville, AL

Dear Mike Gillespie:

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Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:

AS10 (119-10)

Alabama State Clearinghouse
Department of Economic and Community
P.O. Box 2929
3645 Norman Bridge Road
Montgomery, AL 36105-0939

Dear Clearinghouse:

The draft Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) for the static testing of scale-model solid rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC) have been prepared and are being made available to the public and to federal, state, and local entities for a 30-day review and comment period. Please find enclosed a CD containing electronic copies of the documents.

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Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:

AS10 (119-10)

Senator (District 2) Tom Butler
136 Harrington Drive
Madison, AL 35758

Dear Senator Butler:

The draft Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) for the static testing of scale-model solid rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC) have been prepared and are being made available to the public and to federal, state, and local entities for a 30-day review and comment period. Please find enclosed a CD containing electronic copies of the documents.

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Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:

AS10 (119-10)

Senator (District 8) Lowell Barron
P.O. Box 65
Fyffe, AL 35971

Dear Senator Barron:

The draft Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) for the static testing of scale-model solid rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC) have been prepared and are being made available to the public and to federal, state, and local entities for a 30-day review and comment period. Please find enclosed a CD containing electronic copies of the documents.

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Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:

AS10 (119-10)

Mr. Dom Amatore
NASA/MSFC
Mail Code CS20
MSFC, AL 35812

Dear Dom Amatore:

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Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of: AS10 (119-10)

Senator (District 7) Paul Sanford
218 Westchester Avenue
Huntsville, Alabama 35801

Dear Senator Sessions:

The draft Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) for the static testing of scale-model solid rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC) have been prepared and are being made available to the public and to federal, state, and local entities for a 30-day review and comment period. Please find enclosed a CD containing electronic copies of the documents.

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Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:
AS10 (119-10)

Representative (District 19) Laura Hall
P.O. Box 3367
Huntsville, AL 35810

Dear Representative Hall:

The draft Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) for the static testing of scale-model solid rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC) have been prepared and are being made available to the public and to federal, state, and local entities for a 30-day review and comment period. Please find enclosed a CD containing electronic copies of the documents.

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Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of: AS10 (119-10)

Representative (District 21) Randy Hinshaw
100 St. Clair Ave., STE A
Huntsville, AL

Dear Representative Hinshaw:

The draft Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) for the static testing of scale-model solid rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC) have been prepared and are being made available to the public and to federal, state, and local entities for a 30-day review and comment period. Please find enclosed a CD containing electronic copies of the documents.

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Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:
AS10 (119-10)

Stanley Meiburg, Regional Administrator
Environmental Protection Agency
Region IV
61 Forsyth St., SW
Atlanta, GA 30303

Dear Stanley Meiburg:

The draft Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) for the static testing of scale-model solid rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC) have been prepared and are being made available to the public and to federal, state, and local entities for a 30-day review and comment period. Please find enclosed a CD containing electronic copies of the documents.

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Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:

AS10 (119-10)

Senator (District 3) Arthur Orr
P.O. Box 305
Decatur, AL 35602

Dear Senator Orr:

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Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:

AS10 (119-10)

Representative (District 20) Howard Sanderford
908 Tannahill Dr SE
Huntsville, AL 35802

Dear Representative Sanderford:

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Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of: AS10 (119-10)

Refuge Manager
USFWS Wheeler Wildlife Refuge
Rt. 4 Box 35603
Decatur, AL 35603

Dear Refuge Manager:

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Allen Elliott

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Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:

AS10 (119-10)

Senator (District 9) Hinton Mitchem
412-A Gunter Avenue
Guntersville, AL 35897

Dear Senator Mitchem:

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Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of: AS10 (119-10)

Representative (District 25) Mac McCutcheon
P.O. Box 370
Capshaw, AL 35742

Dear Representative McCutcheon:

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Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:

AS10 (119-10)

Mr. Terry Hazle
AMSAM-RA-DEM
Building 4488
Redstone Arsenal, AL 35898

Dear Terry Hazle:

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Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of: AS10 (119-10)

Congressman Parker Griffith
5th Congressional District of Alabama
2101 Clinton Avenue, West STE 302
Huntsville, AL

Dear Congressman Griffith:

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Allen Elliott

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Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:

AS10 (119-10)

Mr. Mike Wright
NASA/MSFC
Mail Code CS20
MSFC, AL 35812

Dear Mike Wright:

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Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:

AS10 (119-10)

Senator Richard Shelby
1118 Greensboro Ave #240
Tuscaloosa, AL 35401

Dear Senator Shelby:

The draft Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) for the static testing of scale-model solid rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC) have been prepared and are being made available to the public and to federal, state, and local entities for a 30-day review and comment period. Please find enclosed a CD containing electronic copies of the documents.

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Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:

AS10 (119-10)

Representative (District 22) Butch Taylor
224 Taylor Ave
New Hope, AL 35760

Dear Representative Taylor:

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Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:

AS10 (119-10)

Representative (District 6) Phil Williams
2185 Old Monrovia Road
Huntsville, AL 35806

Dear Representative Williams:

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Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:

AS10 (119-10)

Elizabeth Ann Brown, Deputy SHPO
Alabama Historical Commission
468 South Perry Street
Montgomery, AL 36130-0900

Dear Elizabeth Ann Brown:

The draft Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) for the static testing of scale-model solid rocket motors (SRMs) at George C. Marshall Space Flight Center (MSFC) have been prepared and are being made available to the public and to federal, state, and local entities for a 30-day review and comment period. Please find enclosed a CD containing electronic copies of the documents.

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Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

June 25, 2010

Reply to Attn of:

AS10 (119-10)

Senator Jeff Sessions
7550 Halcyon Summit Dr., STE 150
Montgomery, AL 36117

Dear Senator Sessions:

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Sincerely,

Allen Elliott

Allen Elliott
Manager
Environmental Engineering and Occupational Health Office

Enclosure

APPENDIX B

Public Involvement

The Huntsville Times

Account Number
0110846

Order Number
0000174534

Date
June 28, 2010

Advertising Affidavit

Ch2m Hill
Legals
4350 W Cypress Street Ste 600
Tampa, FL 33607

Date	Position	Description	P.O. Number	Ad Size	Total Cost
06/27/2010	Legal	NOTICE OF PUBLIC COMMENT PERIOD FOR THE	Marshall Space	1 x 132 L	236.12

NOTICE OF PUBLIC COMMENT PERIOD FOR THE DRAFT ENVIRONMENTAL ASSESSMENT AND DRAFT FINDING OF NO SIGNIFICANT IMPACT
Testing of Scale-Model Solid Rocket Motors at George C. Marshall Space Flight Center

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER

The U.S. National Aeronautics and Space Administration, George C. Marshall Space Flight Center (MSFC) announces publication of the draft Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) for the static testing of scale-model solid rocket motors at MSFC.
The draft EA and draft FONSI are available for public review at the NASA External Relations Office at MSFC, and at the following brenches of the Huntsville-Madison County Public Library:

• Main Branch - 915 Monroe St., Huntsville, AL 35801, Phone: (256) 532-5940
• Madison Branch - 130 Plaza Blvd., Madison, AL 35758, Phone: (256) 461-0046
• Triana Branch - 280 Zierdt Rd., Madison, AL 35758, Phone: (256) 772-3677

To receive copies of the draft EA and draft FONSI, contact AS10/Ms. Donna Holland, Environmental Engineering and Occupational Health Office, NASA Marshall Space Flight Center, AL 35812, phone: (256) 544-7201, e-mail: Donna.L.Holland@nasa.gov. or CS30/Ms. Sharon Cobb, Manager, External Relations Office, NASA Marshall Space Flight Center, AL 35812, phone: (256) 544-7791, e-mail: Sharon.Cobb@nasa.gov. Comments for consideration by NASA on the draft EA and draft FONSI should be provided in writing by mail or e-mail to Ms. Donna Holland or to Ms. Sharon Cobb. These documents will have a 30-day comment period, which will start on June 26, 2010 and end on July 25, 2010. Written substantive comments received within the review period will be addressed.

June 27, 2010

STATE OF ALABAMA
MADISON COUNTY

Before me, Brandi Cook , a Notary Public in and for Said State and County, personally appeared Mecia Carlson, known to me, who being by me first duly sworn, deposes and said person is a Legal Advertising Representative of the Huntsville Times, a newspaper published and printed at Huntsville, Madison County, Alabama, and that the attached legal notice was published in said newspaper on:

06/27/2010

Mecia Carlson
Legal Advertising Representative

Sworn to before me this the

28th day of June 2010

Brandi W. Cook
Notary Public

My Commission expires October 17, 2010

APPENDIX C

Air Dispersion Modeling Memorandum

CALPUFF Modeling of Scale-Model SRM Testing at MSFC

PREPARED FOR: National Aeronautics and Space Administration

PREPARED BY: CH2M HILL

DATE: May 10, 2010

This technical memorandum presents the findings of air dispersion modeling conducted for scale-model solid rocket motor (SRM) testing at Marshall Space Flight Center (MSFC) in Huntsville, Alabama. Air dispersion modeling was conducted to estimate concentrations of nitrous oxide (NO_X), carbon monoxide (CO), particulate matter less than 10 micrometers in aerodynamic diameter (PM_{10}), and hydrogen chloride (HCl) emitted during testing of three types of SRMs: small, medium, and large, which are defined as having maximum thrust potentials, measured in pounds force (lbf), of 10,000 lbf, 60,000 lbf, and 100,000 lbf, respectively. Concentrations of carbon dioxide (CO_2) were not modeled, but were determined using engineering estimates. The methodology and results of the modeling are discussed below.

Model Methodology

The three types of SRMs were modeled using the U.S. Environmental Protection Agency (USEPA)-approved version of CALPUFF, version 5.8 (Scire et al, 2000). The CALPUFF model is a Gaussian puff model. In CALPUFF, a sequence of puffs is used to approximate emissions at every time step and no steady-state approximations are made. These puffs are tracked in time on the computational grid.

CALPUFF also has post processing programs for determining downwind concentrations and deposition fluxes of material emitted from modeled sources. USEPA's Open Burn / Open Detonation Model (OBODM) is the traditional model used for evaluating air quality impacts of the open burning and detonation of obsolete munitions and solid propellants (Bjorklund et al, 2003). However, various studies have shown that CALPUFF delivers better results by offering the following benefits over OBODM:

- It is a non-steady state Puff Model.
- It accounts for causality.
- It accounts for stagnation flows.
- It is standard to use with the Diagnostic Meteorological Model (CALMET).

- It includes special options for time varying buoyant area sources (including sophisticated algorithms that do not use the Boussinesq[1] approximation for buoyancy-driven flows).

Source Parameters

Air dispersion modeling was conducted for the three scale-model SRM test sites at MSFC: Test Stand 4520, Test Complex 116, and Test Complex 500. Test Stand 4520 is used to test large and medium SRMs, Test Complex 116 is used to test small SRMs, and Test Complex 500 is used to test medium SRMs. As a conservative estimate, the modeling assumed that all three types of SRMs are tested simultaneously at one location. Because Test Stand 4520 is used to test medium and large SRMs, this test site was chosen as the source location. Moreover, Test Stand 4520 is closest to the MSFC boundary; therefore, it represents the worst-case location for test operations.

For each type of SRM, the worst-case emission estimates include the maximum estimated emission products. These worst-case emission scenarios were based on the total amount of propellant spent, the frequency of testing, and the emissions associated with each type of propellant. Emission parameters were provided by NASA and were based on solid propellant test data. Model inputs representing the worst-case modeling scenarios for each type of SRM are presented in Table 1.

Sensitivity studies have shown that modeling results are insensitive to the emission source area. Therefore, in the absence of more specific data, the emission source area was assumed to be 10x10 meters. The effective release height for each SRM was calculated to account for the test stand orientations. Refer to Attachment 1 for a more detailed description of the calculations and assumptions made regarding the source parameters.

TABLE 1
Test Area Data

Parameter	Large SRM	Medium SRM	Small SRM
Propellant per test (g)	4,636,000	1,719,000	40,000
Propellant Heat Content (Cal/g)	518	518	447
Burn Time (s)	30	20	4
Nozzle Orientation	Vertical, Nozzle Up	Horizontal	Vertical, Nozzle Down to Flame Bucket
Burn Area [1]		10x10 meters	
Source Height (m)	10	1.5	0.5
Source Elevation (m) [3]		190	
Plume Temperature (K) [3]		416.38	
Effective Rise Velocity (m/s) [3]	2.16	2.33	0.35

[1] The Boussinesq approximation simplifies the plume rise equations by assuming that the plume density is close enough to the ambient density that density variations, other than in the buoyancy term, can be neglected (Scire et al, 2000).

TABLE 1
Test Area Data

Effective Plume Radius (m) [3]	21.3	15.3	4.2
Effective Release Height (m) [3, 4]	20.67	7.66	2.08
Sigma Z (m) [3]	19.2	7.1	1.9
Maximum Annual Testing Frequency	2	5	25

[1] Burn Area was assumed to be 10x10 meters due to lack of site-specific data. This value is consistent with burn areas for similar burn and detonation events. Modeling results are insensitive to this parameter.

[2] Source Elevation was taken as the elevation of Test Stand 4520.

[3] These parameters are only required for modeling a variable, buoyant area source in CALPUFF. CH2M HILL calculated values for each of these parameters based on the intrinsic properties of the propellant as well as assumed parameters and equations utilized by OBODM. Some equations from OBODM were used to compute parameters specific to open burning and detonation events required as input to CALPUFF

[4] For the small and medium SRMs, the effective release height was assumed to be the midpoint of the effective plume radius because the rockets are fired horizontally or downwards. For the large SRM, the effective release height was assumed to be the midpoint of the effective plume radius plus the source height to account for the vertical release of the material.

Emissions Data

The pollutant emission rates were calculated based on the total mass of propellant burned, the propellant burn time, the source area, and the mass fraction of pollutant measured in the exhaust. The mass fraction of pollutant in the exhaust was used to calculate the emission rate. The mass fractions provided by NASA and the calculated emission rates are presented in Table 2.

To accurately determine the NO_X concentrations resulting from the SRM tests, hourly ozone files were included to allow for chemical transformation between similar pollutants. The pollutants emitted are listed in Table 2.

The pollutants were modeled as emitted from buoyant area sources because the emissions are not released from the stack of a point source. CALPUFF's buoyant area source option is a better model, ensuring that pollutant mass is conserved throughout the testing activity. It was also assumed that one emission "puff" is released each hour to account for the short burn times.

TABLE 2
Pollutant Data

Pollutant	Large SRM [1]	Medium SRM [1]	Small SRM [1]
NO_X			
Mass Fraction in Exhaust	6.5 E-04	6.5 E-04	2.6 E-07
Burn Rate (g/s) [3]	1.0 E+02	5.58 E+01	2.6 E-03
Emission Rate ($g/s/m^2$) [4]	1.0 E+00	5.58 E-01	2.6 E-05

TABLE 2
Pollutant Data

Pollutant	Large SRM [1]	Medium SRM [1]	Small SRM [1]
PM_{10} [2]			
Mass Fraction in Exhaust	3.0 E-01	3.0 E-01	1.3 E-01
Burn Rate (g/s) [3]	4.7 E+04	2.6 E+04	1.3 E+03
Emission Rate ($g/s/m^2$) [4]	4.7 E+02	2.6 E+02	1.3 E+01
CO			
Mass Fraction in Exhaust	9.7 E-02	9.7 E-02	1.6 E-01
Burn Rate (g/s) [3]	1.5 E+04	8.3 E+03	1.6 E+03
Emission Rate ($g/s/m^2$) [4]	1.5 E+02	8.3 E+01	1.6 E+01
HCl			
Mass Fraction in Exhaust	2.1 E-01	2.1 E-01	2.4 E-01
Burn Rate (g/s) [3]	3.3 E+04	1.8 E+04	2.4 E+03
Emission Rate ($g/s/m^2$) [4]	3.3 E+02	1.8 E+02	2.4 E+01

[1] Values are approximate and rounded.

[2] PM_{10} was modeled using the molecular weight of aluminum oxide (Al_2O_3), a major constituent of the emissions of ammonimum perchlorate-based solid rocket propellant considered representative of the particulates released during the testing events.

[3] Burn Rates were derived from the Propellant per test (g) and Burn Time (s) presented in Table 1, scaled by the Mass Fraction in Exhaust listed above.

[4] Emission Rates were derived from the burn rate by dividing by the test area, assumed to be 10x10 meters.

Meteorological Data

Three years (2001 through 2003) of 3-dimensional meteorological data from the Diagnostic Meteorological Model, provided by the Alabama Department of Environmental Management (ADEM), were used in the CALPUFF model. This data extends from near ground level to 4,000 meters above ground. This is another advantage over OBODM, which uses surface data measured at 10 meters. During the preparation of this data, the following assumptions were made:

- Wind speeds less than 1 meter per second were set equal to 1 meter per second.
- Calm wind speeds (0 meter per second) were utilized to indicate when slugs are immobile.
- No restrictions were placed on wind direction.
- Precipitation events were included.

A complete list of CALPUFF inputs is included in Attachment 2.

Receptor Grids

A receptor grid network was used to locate the maximum ground-level concentrations resulting from SRM testing emissions at or beyond the ambient air boundary. The ambient air boundary is the property boundary of Redstone Arsenal (RSA). This is the appropriate boundary for ambient air because public access is restricted within this area. Receptors were placed along the ambient air boundary at 50-meter spacing.

Discrete receptors were also included to assess potential effects on residential areas, ecologically sensitive areas (ESAs), and Wheeler National Wildlife Refuge (WNWR). The receptor locations are shown on Figure 1. Table 3 presents the discrete receptors and their relative distance to the source location.

The elevation data for the receptors were derived from United States Geological Survey (USGS) Digital Elevation Model (DEM) data.

TABLE 3
Discrete Receptors

Location	Distance from Test Area
Residential West [1]	3.2 miles west
Residential Southwest [1]	5.07 miles southwest
Residential East [1]	4.19 miles east
Residential Northeast [1]	4.21 miles northeast
Bobcat Cave ESA [2, 4]	3.9 miles northwest
Swan Pond-Bradford Sinks ESA [2, 5]	3.6 miles southeast
Madkin-Weeden Mountain ESA[2, 6]	2.5 miles northeast
Gray Bat (East) [2]	3.6 miles east
Gray Bat (West) [2]	1.6 miles northwest
Williams Spring ESA [2]	1.7 miles northwest
Wheeler National Wildlife Refuge [3]	0.5 miles south

[1] One receptor was placed at each residential area.

[2] Five receptors were placed at each ESA, one in the center and 4 at the corners bounding the ESA.

[3] A grid of receptors spaced at 50 meters was placed within the Wheeler National Wildlife Refuge boundary.

[4] Habitat for Alabama cave shrimp.

[5] Habitat for gray bat.

[6] Habitat for Price’s potato bean.

Modeling Results

Each pollutant concentration or deposition was calculated using the appropriate time averaging period based on the applicable standard of comparison. NO_X was calculated on a 1-hour and annual basis; CO was calculated on a 1-hour and 8-hour basis; PM_{10} was calculated on a 24-hour basis; HCl concentration was calculated on a 1-hour and annual basis; HCl deposition was calculated on an annual basis.

The initial screening conservatively assumed a maximum of 1 test event per day for calculating results for 1-hour, 8-hour, and 24-hour averaging periods; each test event was assumed to involve testing of all three SRMs simultaneously. The time-averaged concentrations were calculated by dividing the modeled results, which assume 1 test per hour for each SRM, by the number of hours in the applicable averaging period. For the 1-hour and 8-hour averaging periods, the daily testing event was assumed to occur during the averaging period.

Using the above conservative assumptions, total impacts to the ambient air boundary, ESAs, and residential areas were below the significance thresholds. However, the assumptions were refined to reflect more realistic testing scenarios to calculate the concentrations in the WNWR. The refined method assumed that only one SRM would be tested per day given the limited work force, instrumentation, safety personnel, and amount of preparation required for each test event. For the refined analysis, the concentration used for comparison was taken as the maximum concentration produced by one of the three SRMs tested. The refined screening method was used for HCl (1-hour averaging period) in the WNWR.

To calculate the annual average results, the modeled annual average concentrations were scaled by the number of hours per year and the annual testing frequency for each SRM. The time-averaged results are based on the maximum continuous hours of emissions.

The maximum pollutant concentrations for all averaging periods predicted by CALPUFF are summarized in Tables 4 through 6. These tables list the concentrations for the ambient air boundary, each residential area, and each ESA (including the WNWR). The detailed results are included in Attachment 3.

TABLE 4
Maximum Concentrations Along the Ambient Air Boundary

Criteria Pollutant	Averaging Period	Modeled Concentration ($\mu g/m^3$)
NO_X	1-hour	1.99
	Annual	0.000003
CO	1-hour	306.30
	8-hour	7.33
PM_{10}	24-hour	3.98
HCl	1-hour	670.70
	Annual	0.003

TABLE 5
Maximum Concentrations in Residential Areas

Criteria Pollutant	Averaging Period	Residential West (µg/m^3)	Residential East (µg/m^3)	Residential Northeast (µg/m^3)	Residential Southwest (µg/m^3)
NO_X	1-hour	1.21	0.54	0.61	0.53
	Annual	0.000001	0.000001	0.000003	0.000001
CO	1-hour	190.13	95.47	93.39	81.23
	8-hour	4.46	4.44	2.56	2.56
PM_{10}	24-hour	1.72	1.74	3.35	1.40
HCl	1-hour	416.16	202.83	204.75	177.89
	Annual	0.001	0.001	0.002	0.001

TABLE 6
Maximum Concentrations in Ecologically Sensitive Areas

Criteria Pollutant	Averaging Period	Bobcat Cave (µg/m^3)	Gray Bat East (µg/m^3)	Gray Bat West (µg/m^3)	Madkin-Weeden Mountain (µg/m^3)	Swan Pond-Bradford Sinks (µg/m^3)	William Springs (µg/m^3)	WNWR (µg/m^3)
NO_X	1-hour	1.05	0.67	1.37	2.67	1.30	1.50	6.28
	Annual	0.000003	0.000002	0.000005	0.00001	0.000001	0.000005	0.00003
CO	1-hour	173.19	104.75	219.29	404.47	201.78	224.30	962.23
	8-hour	5.00	4.26	8.14	15.57	4.27	7.59	33.46
PM_{10}	24-hour	3.23	2.27	4.86	7.32	1.93	4.96	16.51
HCl	1-hour [1]	369.21	229.41	465.01	886.72	442.21	491.73	2,087.60
	Annual	0.003	0.001	0.005	0.01	0.001	0.01	0.02

Note:

[1] The 1-hour HCl results for the Wheeler National Wildlife Refuge Area use the refined method, assuming that only one SRM can be tested per day; the result was taken as the maximum concentration produced by one of the three SRMs tested.

Concentration contours of the 1-hour averaging period for HCl and the 24-hour averaging period for PM_{10} are shown on Figures 2 and 3, respectively, to illustrate the location of impacts. The 1-hour and 24-hour averaging periods were chosen to demonstrate both short and longer-term impacts. As demonstrated by the contours, the maximum 1-hour impacts primarily occur along the western boundary while the 24-hour impacts occur along the southeastern boundary. The annual HCl impacts also occur along the southeastern boundary. Although not depicted in a contour, the maximum 8-hour impacts occur along the southeastern boundary and the annual NO_X results occur along the northeastern boundary.

Because HCl deposition has historically driven the impacts to biological receptors near actual launches and testing of SRMs, a deposition contour for the annual average HCl is also included in Figure 4. A full list of the modeled deposition results is included in Attachment 3.

Comparison to Ambient Air Quality Standards

For determining compliance with the NAAQS, the methodology from 40 Code of Federal Regulation Part 51 Appendix W was followed by adding modeled ground-level concentrations of NO_X, CO, and PM_{10} to local background concentrations before comparing to the standards. For each averaging period, the highest modeled concentration was added to the highest background concentration for comparison with the standards.

Typically, local background concentrations of criteria pollutants are monitored in areas where each particular pollutant presents a viable concern. The local background concentration data for PM_{10} was taken from the monitoring station located at 2201 Airport Road in Huntsville, Alabama for the years 2006 through 2008 (USEPA, 2010). The local background concentration data for CO was also taken from this monitoring station for the years 1998 through 2000 (USEPA, 2010). This was the most recent representative CO monitoring data available in this region of Alabama. Similarly, due to a lack of more recent data, the local background concentration data for NO_X was taken from the monitoring station located at Wilson Dam Road in Muscle Shoals, Alabama for 2003 and Widows Creek in Jackson County, Alabama for 2004 and 2005 (USEPA, 2010).

One-hour HCl concentrations were compared to the Headquarters Air Force Space Command/Surgeon General (HQ AFSPC/SG) Air Quality Standards and the Office of Environmental Health Hazard Assessment Reference Exposure Levels (OEHHA REL). Annual HCl concentrations were compared to the OEHHA REL. The HQ AFSPC/SG does not have an annual standard for HCl. The 1-hour OEHHA standard is based on acute REL while the annual standard is based on chronic REL. There are no background concentration data available for HCl; therefore, the modeled ground-level concentrations were compared directly to the standards.

The predicted maximum pollutant concentrations outside the ambient air boundary are compared to applicable standards in Table 7. Areas outside the ambient air boundary include the ambient air boundary itself (RSA boundary) and the nearest residential areas. As indicated in Table 7, outside the ambient air boundary, the predicted pollutant concentrations are below the NAAQS and HCl standards.

TABLE 7
Comparison of Predicted Pollutant Concentrations Outside the Ambient Air Boundary to Applicable Standards

Criteria Pollutant	Averaging Period	Background Concentration ($\mu g/m^3$)	Modeled Concentration ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	Standard ($\mu g/m^3$)	Exceeds Standard?

NO_X	1-hour [1]	94.07	1.99	96.06	188.14	No
	Annual	13.17	0.000003	13.17	99.71	No
CO	1-hour	7,329	306.30	7,636	40,082	No
	8-hour	5,153	7.33	5,161	10,307	No
PM_{10}	24-hour	64	3.98	68	150	No
HCl	1-hour [2]	0	670.70	671	3,033	No
	1-hour [3]	0	670.70	671	2,100	No
	Annual [3]	0	0.003	0.003	9	No

Note:

[1] USEPA's new 1-hour NO_X standard requires the maximum background concentration summed with the 8th highest modeled concentration, averaged over the 3-year period, to be compared to the standard. As a conservative estimate, the maximum background concentration summed with the maximum modeled concentration was used for comparison.

[2] Standard from the Headquarters Air Force Space Command / Surgeon General Air Quality Standards.

[3] Standards from the Office of Environmental Health Hazard Assessment Reference Exposure Levels.

The predicted maximum pollutant concentrations at the discrete receptor sites inside the ambient air boundary are compared to applicable standards in Table 8. The discrete receptor sites inside the ambient air boundary include the ESAs, the WNWR, and two locations where the gray bat has been documented to occur. As indicated in Table 8, within the ambient air boundary, the predicted pollutant concentrations are below the NAAQS and HCl standards.

TABLE 8
Comparison of Predicted Pollutant Concentrations Inside the Ambient Air Boundary to Applicable Standards

Criteria Pollutant	Averaging Period	Background Concentration ($\mu g/m^3$)	Modeled Concentration ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	Standard ($\mu g/m^3$)	Exceeds Standard?
NO_X	1-hour [1]	94.07	6.28	100.35	188.14	No
	Annual	13.17	0.00003	13.17	99.71	No
CO	1-hour	7,329	962.23	8,291	40,082	No
	8-hour	5,153	33.46	5,187	10,307	No
PM_{10}	24-hour	64	16.51	81	150	No
HCl	1-hour [2, 4]	0	2,087.60	2,088	3,033	No
	1-hour [3]	0	2,087.60	2,088	2,100	No
	Annual [3]	0	0.02	0.022	9	No

Note:

[1] USEPA's new 1-hour NO_X standard requires the maximum background concentration summed with the 8th

highest modeled concentration, averaged over the 3-year period, to be compared to the standard. As a conservative estimate, the maximum background concentration summed with the maximum modeled concentration was used for comparison.

[2] Standard from the Headquarters Air Force Space Command / Surgeon General Air Quality Standards.

[3] Standards from the Office of Environmental Health Hazard Assessment Reference Exposure Levels.

[4] The modeled 1-hour HCl results are from the Wheeler National Wildlife Refuge Area and use the refined method, assuming that only one SRM can be tested per day; the result was taken as the maximum concentration produced by testing one of the three SRMs.

Carbon Dioxide Emissions

To assess the potential cumulative greenhouse gas impacts from scale-model SRM testing at MSFC, the annual quantity of CO_2 emitted by SRM testing was calculated using engineering estimates based on the data provided by NASA. Table 9 presents the amount of CO_2 emitted by each type of SRM test and the total CO_2 emitted annually by all tests.

Although no CO_2 ambient air quality standards exist, the Council of Environmental Quality (CEQ) recently released draft guidelines on what may classify a project’s greenhouse gas emissions as meaningful. According to the CEQ guidelines, a quantitative and qualitative assessment may be meaningful if the project’s direct emissions are greater than 25,000 metric tons of CO_2-equivalent (CEQ, 2010). As indicated in Table 9, the estimated emissions are much lower than 25,000 metric tons of CO_2-equivalent.

TABLE 9
Annual CO_2 Emissions

Pollutant	Large SRM	Medium SRM	Small SRM
Mass Fraction in Exhaust	0.084	0.084	0.138
Mass of Propellant Detonated (kg)	4636	1719	40
CO_2 Emitted per Test (kg)	388	144	6
Maximum Annual Testing Frequency	2	5	25
CO_2 Emitted per SRM (kg/year)	775	719	138
Total CO_2 Emitted (metric tons/year) = 1.63			

Conclusions

Based on the conservative modeling assumptions and refined modeling analysis, there are no areas evaluated that had air concentrations greater than the applicable standards.

Although the NAAQS are designed to evaluate the ambient air outside of a property boundary, they were conservatively used in this analysis to evaluate the potential effect of SRM testing on the air quality in the identified ESAs and the WNWR. Using the NAAQS as the conservative threshold, the criteria pollutants modeled are still below the threshold level.

The potential increase in concentrations of HCl in the ambient air was orders of magnitude lower than the OEHHA REL standards and much lower than the HQ AFSPC/SG standard.

References

Bjorklund, Jay R. et al. 1998. *Open Burn / Open Detonation Dispersion Model (OBODM) User's Guide, Volume 1, User's Instructions, DPG Document No. DPG-TR-96-008a.* Prepared for U.S. Army Dugway Proving Ground, West Desert Test Center. Meteorology & Obscurants Division. February. Model revision May 15, 2003.

Council of Environmental Quality (CEQ). 2010. *Draft NEPA Guidance on Consideration of the Effects of Climate Change and GHG Emissions*. February 18, 2010.

Scire, Joseph S. et al. 2000. *A User's Guide for CALPUFF Dispersion Model (Version 5)*. Earth Tech, Inc.

United States Environmental Protection Agency (USEPA). 2010. *US EPA, Monitor Values Report, Criteria Air Pollutants, Air Data.* http://www.epa.gov/air/data/monvals.html?st~AL~Alabama. Accessed April 30, 2010.

Figure 1: Receptor Grid

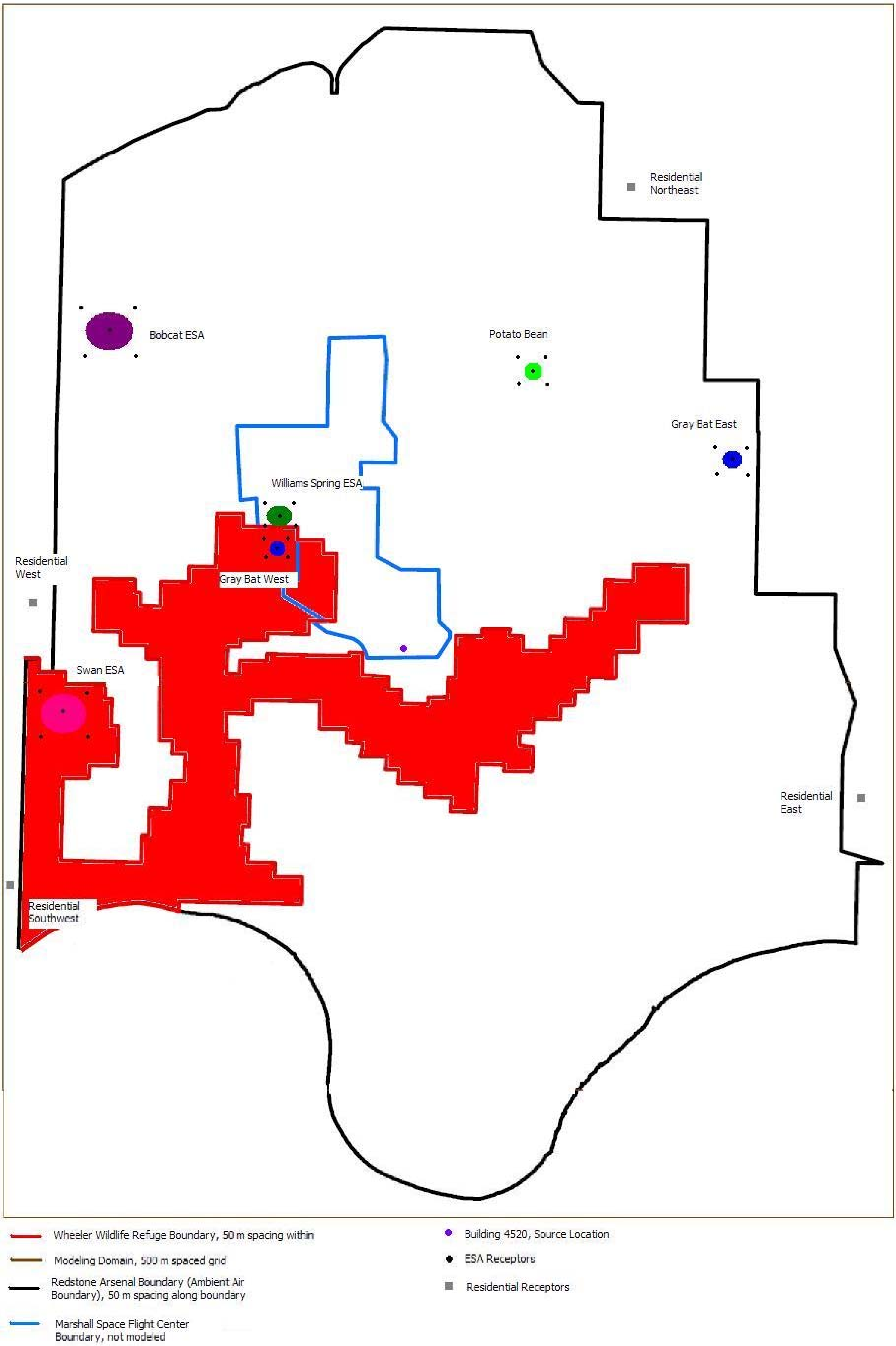


Figure 2: 1-hour HCl Concentration Contour

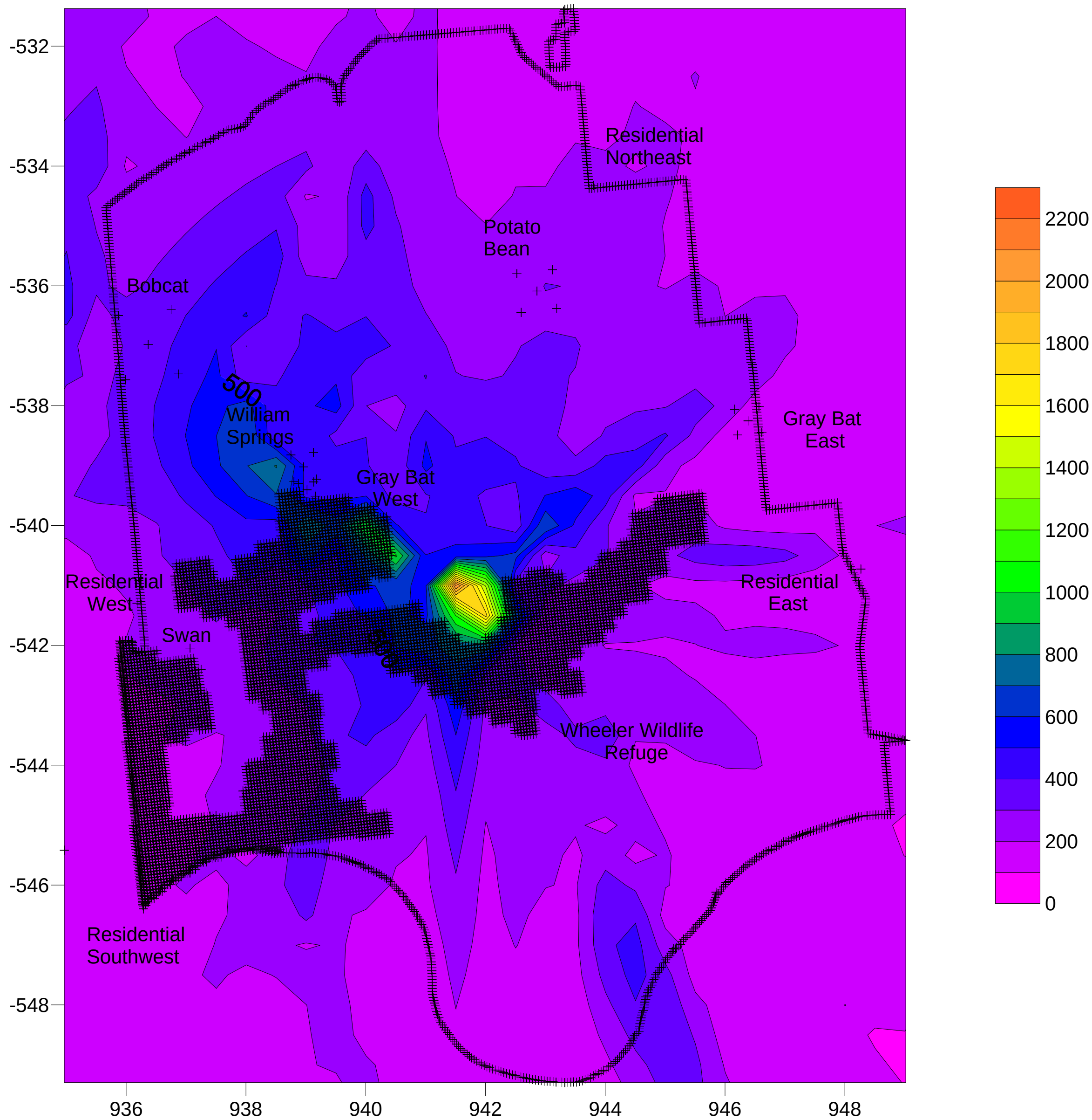


Figure 3: 24-hour PM_{10} Concentration Contour

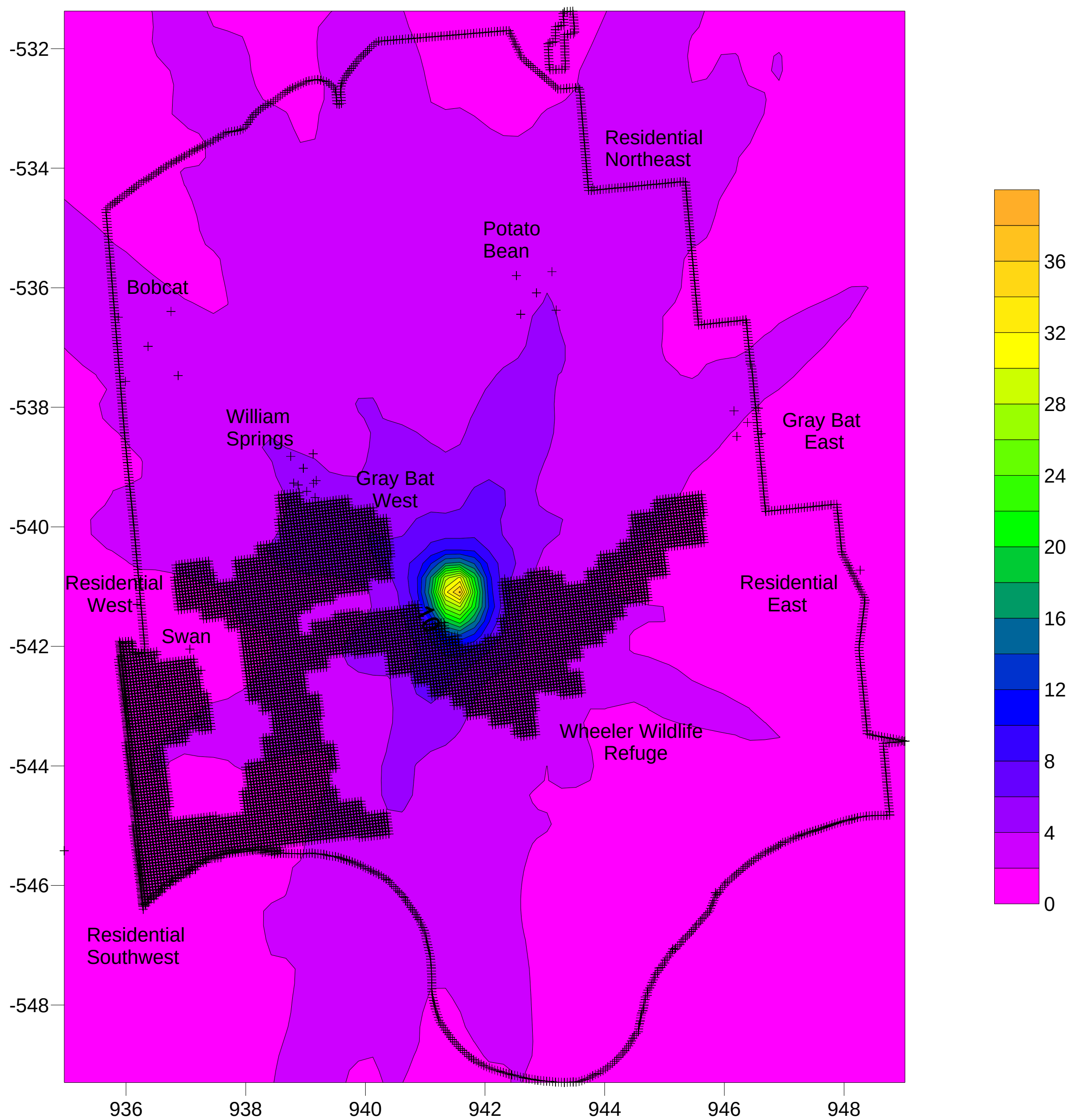
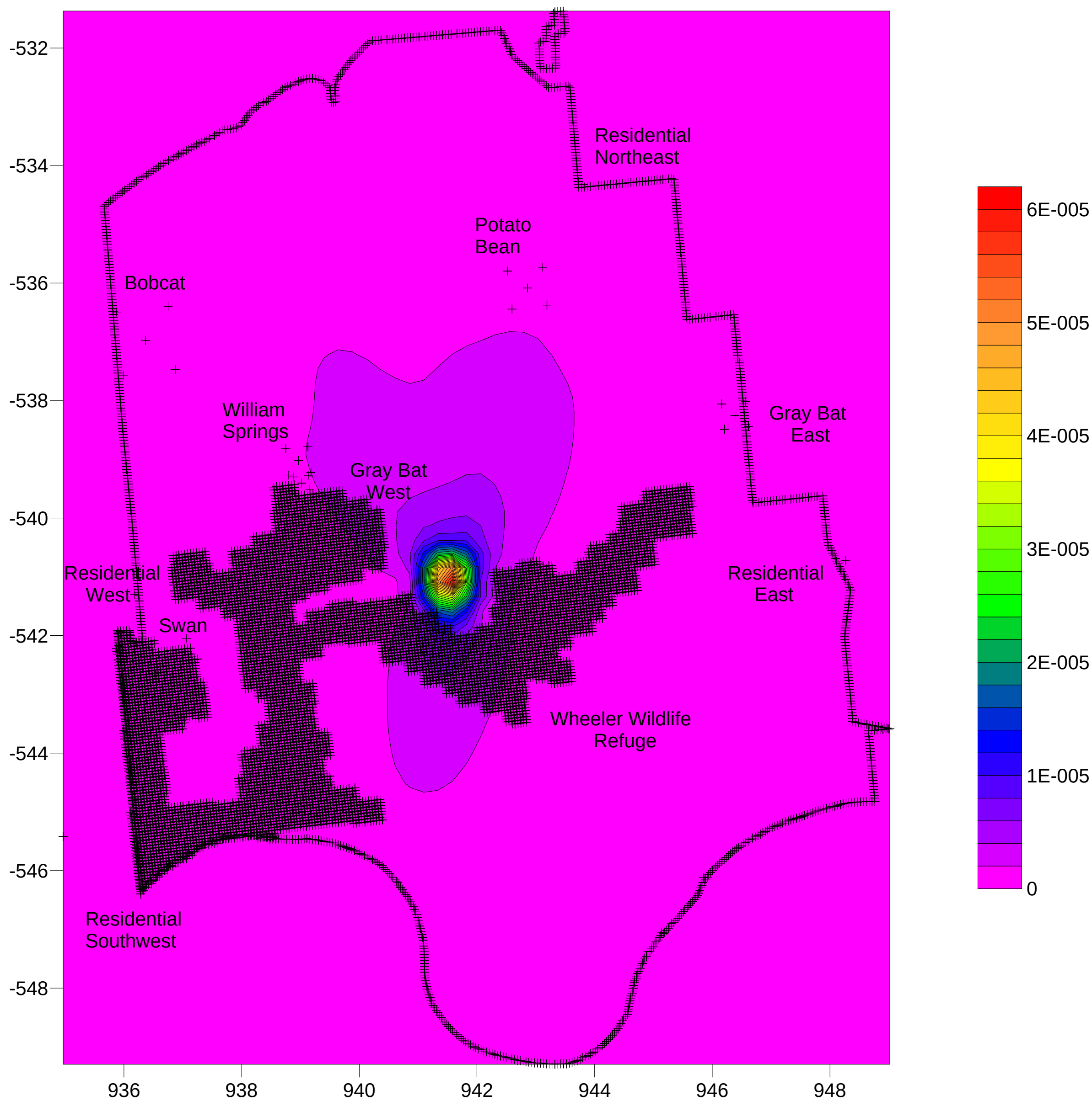


Figure 4: Annual HCl Deposition Contour



Note: The results presented in this contour assume 1 test event per year. The actual results, scaled by the annual testing frequency of each rocket, are expected to be higher. For actual results, please refer to Tables 4 through 6.

Attachment 1: BAEMARB Inputs

BAEMARB Input

Parameter	Code	Value	Methodology	Reference
Site Data				
Version of the Run	VRS	5	Version expected by CALPUFF.	-
Project Name	LABEL	MSFC	Modeling performed for Marshall Field.	-
UTM Zone	IUTMZ	16	Location of Redstone Arsenal (RSA).	-
Beginning Hour of Burn Event	IHRON	0	Burn events are not restricted.	-
Ending Hour of Burn Event	IHROFF	23	Burn events are not restricted.	-
Meteorological Data				
Beginning Year	IBYR	2001	Meteorological Data	Provided by ADEM.
Beginning Julian Day	IBJUL	1	Meteorological Data	Provided by ADEM.
Beginning Hour	IBHR	0	Meteorological Data	Provided by ADEM.
Ending Year	IEYR	2003	Meteorological Data	Provided by ADEM.
Ending Julian Day	IEJUL	365	Meteorological Data	Provided by ADEM.
Ending Hour	IEHR	23	Meteorological Data	Provided by ADEM.

Parameter	Code	Values			Methodology	Reference
Source Information						
Number of Sources	NSRC	3			Have 3 test stands used for rocket testing.	Provided by NASA (SRMData_Final.xlsx).
		Source 1	**Source 2**	**Source 3**		
Source Name	CID	LSRM	MSRM	SSRM	Large SRM (48-inch), Medium SRM (24-inch), Small SRM (RATO)	Provided by NASA (SRMData_Final.xlsx).
Source Height (m)	HT	10	1.5	0.5	Vertical dimension of source, provided by NASA.	Provided by NASA (SRMData_Final.xlsx).
Source Elevation (m)	ELEV	190	190	190	Building 4520 Elevation. Assumed site for testing	Building_xyz_UTM.xlsx
Plume Temperature (K)	TK	416.38	416.38	416.38	Calculated using Equation 2-75 from the OBODM User's Manual, which accounts for the conservation of energy. (TK = 1.44 x Ambient T).	Bjorklund, J., et. al. 1998. Open Burn / Open Detonation Dispersion Model (OBODM) User's Guide. Volume II. Technical Description.
Effective Rise Velocity (m/s)	WEFF	2.16	2.33	3.17	Calculated by Equation 6 of Scire's paper. (w = $(8.8*10^{-6}*Qh*Ts)/(g*(Ts-Ta)*r^2)$)	Scire's Paper.
Effective Plume Radius (m)	REFF	21.3	15.3	4.2	Calculated by Equation 2-75 of OBODM User's Manual, adjusted by a factor of $2^{1/3}$ to account for the plume being a hemisphere. (r = $.89[(3HCWD)/(4C\rho\rho\pi\ Ta)]^{1/3}$)	Bjorklund, J., et. al. 1998. Open Burn / Open Detonation Dispersion Model (OBODM) User's Guide. Volume II. Technical Description.
Effective Release Height (m)	-	20.67	7.66	2.08	For the small and medium rockets, the effective release height is assumed to be the midpoint of the initial vertical spread. This is because the rockets are not released vertically but rather horizontally or downwards. For the large rocket, the effective release height is assumed to be the midpoint of the initial vertical spread plus the source height to account for the vertical release of the material. The vertical spread is assumed to be equal to the horizontal spread so the midpoint will equal half of the effective plume radius.	Bennett, Mark/CH2M HILL. Personal communication with White, Andrea/CH2M HILL and Pieper, Elyse/CH2M HILL. April 16, 2010.
Sigma Z	SIGZ	19.2	7.1	1.9	Calculated by the following equation: SIGZ = (Effective Release Height x 2) / 2.15.	Bennett, Mark/CH2M HILL. Personal communication with White, Andrea/CH2M HILL. December 10, 2006.
Annual Number of Test Events	-	2	5	25	Assumed that all rockets are tested simultaneously.	Provided by NASA (SRMData_Final.xlsx).
X Coord of SW Corner (LCC, km)	X	941.5304			Building corners. All sources were modeled at Building 4520. This building is the only location that tests all 3 rockets. Of the 3 testing locations, Building 4520 is the furthest south. Used LCC Projection to match the projection of the ADEM-provided Met Data.	Building_xyz_UTM.xlsx
X Coord of NW Corner (LCC, km)	X	941.5298				Building_xyz_UTM.xlsx
X Coord of NE Corner (LCC, km)	X	941.5352				Building_xyz_UTM.xlsx
X Coord of SE Corner (LCC, km)	X	941.5357				Building_xyz_UTM.xlsx
Y Coord of SW Corner (LCC, km)	Y	-541.1581				Building_xyz_UTM.xlsx
Y Coord of NW Corner (LCC, km)	Y	-541.1526				Building_xyz_UTM.xlsx
Y Coord of NE Corner (LCC, km)	Y	-541.1520				Building_xyz_UTM.xlsx
Y Coord of SE Corner (LCC, km)	Y	-541.1573				Building_xyz_UTM.xlsx
Area of Source (m2)	-	100			Assumed a 10 m x 10 me area for all rocket tests based roughly on the building area.	Bennett, Mark/CH2M HILL. Personal communication with White, Andrea/CH2M HILL and Pieper, Elyse/CH2M HILL. April 16, 2010.

Parameter	Code	Values								Methodology	Reference
Pollutant Data											
Number of Pollutants	NSE	8								Modeled HCl, CO, PM10, and NOx. CO2 will be estimated using the mass fraction provided by NASA instead of modeled. Remaining exhaust components were deemed negligible and non-toxic. As such, they have not been modeled.	Bennett, Mark/CH2M HILL. Personal communication with White, Andrea/CH2M HILL and Pieper, Elyse/CH2M HILL. April 16, 2010.
Pollutant Name	CSLST	SO2	SO4	NOX	HNO3	NO3	PM10	HCl	CO	Assumed all Clx pollutants were HCl. Denoted Al2O3 as PM10 to allow proper deposition calculations in CALPUFF. SO2, SO4, HNO3, and NO3 were only included here to allow for chemical transformation within CALPUFF.	Bennett, Mark/CH2M HILL. Personal communication with White, Andrea/CH2M HILL and Pieper, Elyse/CH2M HILL. April 16, 2010.
Pollutant Molecular Weight (g/mole)	XMWEM	64.06	96.06	46.00	63.00	62.00	101.96	36.5	28.00	Used the Al2O3 molecular weight for PM10.	Bennett, Mark/CH2M HILL. Personal communication with White, Andrea/CH2M HILL and Pieper, Elyse/CH2M HILL. April 16, 2010.
Source = LSRM											
Mass Fraction of Pollutant in Exhaust	-	0.000E+00	0.000E+00	6.500E-04	0.000E+00	0.000E+00	3.019E-01	2.123E-01	9.686E-02	-	Provided by NASA (SRMData_Final.xlsx).
Pollutant Emission Rate (g/s/m2)	Q	0.0000E+00	0.0000E+00	1.0045E+00	0.0000E+00	0.0000E+00	4.6657E+02	3.2814E+02	1.4968E+02	Calculated by the following equation: Q = Total Mass Detonated (g) x Mass Fraction of Pollutant in Exhaust / Burn Rate (s) / Area of Source (m2)	
Source = MSRM											
Mass Fraction of Pollutant in Exhaust	-	0.000E+00	0.000E+00	6.500E-04	0.000E+00	0.000E+00	3.019E-01	2.123E-01	9.686E-02	-	Provided by NASA (SRMData_Final.xlsx).
Pollutant Emission Rate (g/s/m2)	Q	0.0000E+00	0.0000E+00	5.5868E-01	0.0000E+00	0.0000E+00	2.5950E+02	1.8251E+02	8.3251E+01	Calculated by the following equation: Q = Total Mass Detonated (g) x Mass Fraction of Pollutant in Exhaust / Burn Rate (s) / Area of Source (m2)	
Source = SSRM											
Mass Fraction of Pollutant in Exhaust	-	0.000E+00	0.000E+00	2.601E-07	0.000E+00	0.000E+00	1.323E-01	2.382E-01	1.623E-01	-	Provided by NASA (SRMData_Final.xlsx).
Pollutant Emission Rate (g/s/m2)	Q	0.0000E+00	0.0000E+00	2.6012E-05	0.0000E+00	0.0000E+00	1.3233E+01	2.3818E+01	1.6228E+01	Calculated by the following equation: Q = Total Mass Detonated (g) x Mass Fraction of Pollutant in Exhaust / Burn Rate (s) / Area of Source (m2)	

Attachment 2: CALPUFF Inputs

Attachment 2

CALPUFF Input

			Value / File	QC Check	IWAQM Default Value	Notes
		Verify CALPUFF Version	5.8		EPA Approved Version 5.8, level 070623	CALPUFF Version used to generate MET files also.
Input Group: 0	**Input and Output Files Names**					
	Metdata Type:	CALMET	Y		Y	
		ISCMET			-	
		PLMMET			-	
		PROFILE			-	
		SURFACE			-	
		RESTART	Y		-	
	Required Outputs:	Concentration	Y		Y	
		Dry Flux	Y		Y	Running Concentration for all gaseous particles and dry flux to calculate the deposition of HCL.
		Wet Flux	N		Y	
		Visibility Data	N		Y	
	External Emission Files:	Ptemarb			-	If external emission files being used have they been QA'd and that they are for the correct year modeled, also verify appropriate switch is turned on for input groups 13 - 16
		Volemarb			-	
		Baemarb	Y		-	
		Lnemarb			-	
	Other Input Files:	Hourly ozone	Y		Y	If external ozone file is marked yes - verify Input Group 11 MOZ = 1 and see QA output files
		Coastline data			-	
		Other….			-	
Input Group 1:	**General Run Control Parameters**					
		Run Duration / Start Time	8670 / 1		8760 / 0	Start at hour 1 to allow compatability with BAEMARB file.
		Check base time zone	5		No Default	Site located in Alabama.
		# species modeled	8		8	All species as being emitted, but SO2, SO4, HNO3, and NO3 all have emission rates of 0. All species were listed as emitted to allow compatability with the BAEMARB file.
		# species emitted	8		6	
		Met Data Format	1		1 = CALMET File	Verify corresponds with data format indicated in Input Group 0
Input Group 2:	**Technical Options**					Ensure technical options are consistent with regulatory requirement of location of study
		Vertical Distribution MGAUSS	1		Gaussian = 1	
		Terrain Adj. MCTADJ	3		Partial Plume Adj. = 3	
		Sub grid scale complex terrain MCTSG	0		Not Modeled = 0	
		Near-field Puffs Elongated MSLUG	1		not modeled as slugs = 0	Model as slugs since more accurate for OB runs
		Transitional plume rise MTRANS	1		Modeled = 1	
		Stack Tip Downwash MTIP	1		Modeled = 1	
		Method to simulate building downwash, MBDW	1		ISC method = 1	
		Vertical wind shear above stack top, MSHEAR	0		Not Modeled = 0	
		Puff Splitting, MSPLIT	0		Not Allowed = 0	
		Chemical Mechanism, MCHEM	1		Transformation via MESOPUFF II scheme = 1	Requires the following chemical species to be inputted in this order: SO2, SO4, NOX, HNO3, NO3, PM10
		Aqueous Phase Transformation, MAQCHEM	0		Not Modeled = 0	
		Wet Removal, MWET	0		Modeled = 1	Wet deposition not modeled since events will not occur during precipitation events
		Dry Deposition, MDRY	1		Modeled = 1	Requires particle size information, See input Group 9
		Method for dispersion coefficients, MDISP	3		PG for rural areas = 3	
		Sigma-v/sigma-theta, sigma-w, MTURBVW			Not applicable	Only for MDISP 1 or 5
		Back-up Method for dispersion, MDISP2			Not applicable	Only for MDISP 1 or 5
		PG sigma-y,z adj, MROUGH	0		Not adj for roughness = 0	
		Partial Plume penetration, MPARTL	1		Modeled = 1	
		Temp. Inversion strength in PROFILE.DAT, MTINV	0		No, computed from measured/default gradients = 0	
		PDF used in convective cond., MPDF	0		Not Used = 0	
		Sub-Grid TIBL used for shoreline, MSGTIBL	0		Not Used = 0	
		Boundary Conditions Modeled, MBCON	0		Not Modeled = 0	
		Include FOG Model Output	0		Not Modeled = 0	
		Test Options against regulatory req., MREG	0		Perform Checks = 1	
Input Group 3:	**Species List**					
	Species Modeled	SO2	1, 1		emitted = 1, gas deposited = 1	
		SO4	1, 2		emitted = 1, particle deposited = 2	
		NOx	1, 1		emitted = 1, gas deposited = 1	
		HNO3	1, 1		not emitted = 0, gas deposited = 1	Identify species to be modeled, the order these are specified dictates the sequence of the emission rates in Group 13. Verify whether contaminants are to be emitted, deposited, or aggregated into groups for output.
		NO3	1, 2		not emitted = 0, particle deposited = 2	
		PM10, PMF, PMC	1, 2		emitted = 1, particle deposited = 2	
		SOA	0		emitted = 1, particle deposited = 2	
		EC	0		emitted = 1, particle deposited = 2	
		Other….	HCl: 1, 1; CO: 1, 1		emitted = 1, particle deposited = 2	
Input Group 4:	**Map Projection and Grid Control Parameters**					
		Projection, Datum, SW corner	LCC, See Below		No default	Verify that consistent with CALMET file
		X,Y of LL corner / X,Y of UR corner	See Below		No default	Verify location on map and consistency with requirements below
		Met Grid and Computational Grid	See Below		No default	
		Size of Cell	4		(km)	Calculated based on domain size (only for CAL-lite runs)
		Nesting factor - sample grid	8			500 m grid spacing; restricted by allowable array size in CALPUFF.
		Include Gridded Receptors (Y/N)	Y		No default	Included for areas of interest, WNRA, Biological areas, and nearby residents
Input Group 5:	**Output Options**					
		Verify switches are consistent w/ Input Group 0	-		No default	Don't print results only write to file indicated in Input Group 0
		Diagnostic Options used (Y/N)	N		No default	Usually use Diagnostic options only if troubleshooting
		Ensure IQAPLOT set to 1 for diagnostic output	1		IQAPLOT = 1	Usually use Diagnostic options only if troubleshooting
Input Group: 6 Sub grid Scale Complex Terrain Inputs						
		Option Used (Y/N)	N		No default	If used verify data from external file
Input Group: 7 Chemical Parameters for Dry Deposition of Gases						
		Option Used (Y/N)	Y		No default	Check gas dry deposition parameters for accuracy
		SO2	Default for NOX; Values not utilized since not calculating SO2 deposition			Diff.=0.1656, alpha.=1, reactivity=8, meso.=5, Henry's=3.5
		NOX	Default			Diff.=0.1656, alpha.=1, reactivity=8, meso.=5, Henry's=3.5
		HNO3	Default for NOX; Values not utilized since not calculating HNO3 deposition			Diff.=0.1656, alpha.=1, reactivity=8, meso.=5, Henry's=3.5
		HCL	Default for NOX due to lack of better data			Diff.=0.1656, alpha.=1, reactivity=8, meso.=5, Henry's=3.5
		CO	Default for NOX; Values not utilized since not calculating CO deposition			Diff.=0.1656, alpha.=1, reactivity=8, meso.=5, Henry's=3.5
Input Group: 8 Size Parameters Dry Deposition of Particles						
		Option Used (Y/N)	Y		No default	Check gas dry deposition parameters for accuracy
		SO4	0.48 um, STD = 2; Values not utilized since not calculating SO4 deposition		See Notes for Example	Geo Mass Mean=0.48, STD=2.
		NO3	0.48 um, STD = 2; Values not utilized since not calculating NO3 deposition		See Notes for Example	Geo Mass Mean=0.48, STD=2.
		PM10	1.40 um, STD = 3.6; Values consistent with open burn / open detonation activities		Usually consistent with EC	Varies: based on fuel type, species modeled, control technology
Input Group: 9 Miscellaneous dry deposition parameters						

Attachment 2

CALPUFF Input

		Value / File	QC Check	IWAQM Default Value	Notes
	CALPUFF Default Values Used (Y/N)	N		-	Check particle dry deposition parameters for accuracy, Defaults are used unless the site-specific information is available; provide reference in report
Input Group: 10 Wet Deposition Chemical Parameters					
	Option Used (Y/N)	N			Check for accuracy, only used with wet deposition
Input Group: 11 Chemistry Parameters					
	Chemistry Parameters Used (Y/N)	Y		-	-
	Ozone Input Option, MOZ	1, 80		Hourly values from file = 1	Ozone files typically used with CALMET, ensure that input option is correctly switched to 1. If ozone data not available use switch to '0' and input average monthly ozone starting with January.
	Monthly Ammonia Concentrations, BCKNH3	10		10 ppb	If MCHEM is used verify that background NH3 is representative of land use
	If MCHEM does not Equal 3 or 0	NA		No Default	Review other input option requirements
Input Group: 12 Misc. Dispersion and Computational Parameters					
	CALPUFF Default Values Used (Y/N)	Y		-	Use defaults unless site-specific information is available
	If in Input Group 1 Met Format = 2, 3, or 4	-		-	Verify location and parameters associated with met station
Input Group: 13 Point Source Parameters					
	Point Sources Used (Y/N)	N		-	Verify emissions are in the same order as the pollutants listed in the above group
Input Group: 14-16 Area, Line, Volume Source Parameters					
	Area Sources Used (Y/N)	Y		-	Verify emissions are in the same order as the pollutants listed in the above group
	Variable Sources (Y/N)	Y		-	Ensure correct file read-in in Input Group 0, Turn Switch on
	Line Sources Used (Y/N)	N		-	Verify emissions are in the same order as the pollutants listed in the above group
	Variable Sources (Y/N)			-	Ensure correct file read-in in Input Group 0, Turn Switch on
	Volume Sources Used (Y/N)	N		-	Verify emissions are in the same order as the pollutants listed in the above group
	Variable Sources (Y/N)			-	Ensure correct file read-in in Input Group 0, Turn Switch on
Input Group: 17 Non-Gridded, Discrete Receptors					
	Option Used (Y/N)	Y			
	Plot receptors	Y			Verify source location in relation to Class I areas

For Meteorological Grid:

Parameter	X Coordinate	Y Coordinate
SW Corner	718.005	-1214.003
Number of Grid Cells	248	257
Grid Size (km)	4	4
NW Corner	1710.005	-186.003

For Computational Grid:

Parameter	X Coordinate	Y Coordinate	Notes
SW Corner	907	-575	Gridded Receptor Domain + 25 km buffer
NE Corner	975	-505	Gridded Receptor Domain + 25 km buffer
Index of LL Corner	47	160	
Index of UR Corner	64	177	

For the Gridded Receptor Domain:

Parameter	X Coordinate	Y Coordinate	Notes
SW Corner	932	-550	RSA Boundary + 50 m buffer
NE Corner	950	-530	RSA Boundary + 50 m buffer
Spacing (km)	0.5	0.5	Spacing limited to 100 m by CALPUFF. Went larger as a first pass.
Index of LL Corner	53	166	Subset of the computational grid based on the desired domain.
Index of UR Corner	59	172	Subset of the computational grid based on the desired domain. Extended the UR Corner 1 additional grid cell to catch any outlying discrete receptors.
Number of Grid Cells	6	6	Y is the max and will define the grid.
Distance (km)	68	70	Based on computational grid.
Mesh	-	8	Determine nesting grid mesh size by (Met Grid Size / Spacing).

For the Discrete Receptors:
Please refer to the documents maintained in the following directory: D:\SRM\402483_aw\Maps
Have discrete receptors for: Fenceline, ESA Areas, Wheeler Wildlife National Refuge, and Residential Areas.

Attachment 3: Modeling Results

MSFC: Modeling Results

Ambient Background Summary

Criteria Pollutant	Averaging Period	2003		2004		2005		Max [d]
		ppm	µg/m^3	ppm	µg/m^3	ppm	µg/m^3	µg/m^3
NO_X [a]	1-hr	0.041	77.14	0.050	94.07	0.027	50.80	94.07
	annual [b]	0.007	13.17	0.004	7.53	0.005	9.41	13.17
		1998		**1999**		**2000**		**Max [d]**
Criteria Pollutant	**Averaging Period**	**ppm**	**µg/m^3**	**ppm**	**µg/m^3**	**ppm**	**µg/m^3**	**µg/m^3**
CO [c]	1-hr	6.4	7,329	4.7	5,382	3.2	3,665	7,329
	8-hr	3.3	3,779	4.5	5,153	2.5	2,863	5,153
		2006		**2007**		**2008**		**Max [d]**
Criteria Pollutant	**Averaging Period**	**ppm**	**µg/m^3**	**ppm**	**µg/m^3**	**ppm**	**µg/m^3**	**µg/m^3**
PM_{10} [c]	24-hr	-	50	-	64	-	40	64

Note:

[a] 2003 Data from the Wilson Dam Road / 2nd Street, Muscle Shoals, Colbert County monitoring station; 2004 - 2005 Data from the Tva Widows Creek, Jackson County monitoring station.

[b] Annual Arithmetic Mean.

[c] Data from the 2201 Airport Road, Huntsville, Madison County monitoring station.

[d] All background values obtained from USEPA's website (http://www.epa.gov/air/data/monvals.html).

Unit conversion:

1 ppm NO_X: 1881.39 µg/m^3

1 ppm CO: 1145.19 µg/m^3

To convert concentrations in air (at 25°C and 1 atm) from ppm to mg/m3: mg/m^3 = (ppm) × (molecular weight)/(24.45). 24.45 L/gram-mol is the molar volume at 25°C.

To convert concentrations in air from µg/m^3 to mg/m^3: mg/m^3 = (µg/m^3) × (1 mg/1,000 µg).

[e] Data from the 13112 Hwy. 68, Crossville, DeKalb County monitoring station.

MSFC: Modeling Results

Air Quality Standards

Criteria Pollutant	Averaging Period	Concentration ppm	Concentration µg/m³
NO_X [a]	1-hr	0.100	188.14
	annual	0.053	99.71
CO [a]	1-hr	35	40,082
	8-hr	9.0	10,307
PM_{10} [a]	24-hr	-	150
HCl	1-hr [b]	-	3,033
	1-hr [c]	-	2,100
	annual [c]	-	9

Note:

[a] Standards are the National Ambient Air Quality Standards obtained from USEPA's website (http://www.epa.gov/air/criteria.html).

[b] Standard from the Headquarters Air Force Space Command / Surgeon General Air Quality Standards.

[c] Standards from the Office of Environmental Health Hazard Assessment Reference Exposure Levels.

Unit conversion:

1 ppm NOx: 1881.39 µg/m³

1 ppm CO: 1145.19 µg/m³

To convert concentrations in air (at 25°C and 1 atm) from ppm to mg/m3: mg/m³ = (ppm) × (molecular weight)/(24.45). 24.45 L/gram-mol is the molar volume at 25°C.

To convert concentrations in air from µg/m³ to mg/m³: mg/m³ = (µg/m³) × (1 mg/1,000 µg).

MSFC: Modeling Results

Raw Modeling Results

Receptor Area	CO		HCl		HCl Deposition	NO_X			PM_{10}	
	1-hr (µg/m³)	8-hr (µg/m³) [g]	1-hr (µg/m³)	Annual (µg/m³) [c]	Annual (µg/m³) [c]	1-hr (µg/m³) [a]	1-hr (µg/m³) [b]	Annual (µg/m³) [c]	24-hr (µg/m³) [d]	Annual (µg/m³) [c]
2001										
Bobcat ESA	1.66E+02	5.00E+00	3.62E+02	3.24E-03	9.38E-06	7.46E-01	1.05E+00	2.79E-06	3.23E+00	2.54E-03
Gray Bat East ESA	9.68E+01	4.10E+00	2.12E+02	1.33E-03	4.46E-06	3.75E-01	6.47E-01	1.76E-06	2.27E+00	0.00E+00
Gray Bat West ESA	2.00E+02	8.14E+00	4.39E+02	4.90E-03	1.50E-05	9.78E-01	1.32E+00	4.54E-06	4.86E+00	1.31E-03
Potato Bean ESA	4.04E+02	1.56E+01	8.87E+02	5.62E-03	1.47E-05	1.13E+00	2.67E+00	8.28E-06	7.32E+00	1.87E-03
Swan ESA	1.04E+02	4.27E+00	2.29E+02	1.20E-03	3.47E-06	5.14E-01	6.94E-01	1.40E-06	1.93E+00	7.41E-04
William Springs ESA	2.01E+02	7.59E+00	4.40E+02	5.05E-03	1.55E-05	9.10E-01	1.33E+00	4.61E-06	4.96E+00	3.87E-03
Wheeler Wildlife Refuge [e]	9.62E+02	3.35E+01	2.09E+03	2.17E-02	6.72E-05	4.06E+00	6.28E+00	2.76E-05	1.56E+01	4.74E-03
Resident West	1.90E+02	4.01E+00	4.16E+02	1.37E-03	3.63E-06	4.04E-01	1.21E+00	1.20E-06	1.47E+00	6.36E-04
Resident East	5.84E+01	2.27E+00	1.28E+02	8.95E-04	2.89E-06	2.07E-01	3.79E-01	8.63E-07	9.14E-01	3.17E-03
Resident Northeast	9.34E+01	6.91E+00	2.05E+02	2.38E-03	6.51E-06	4.19E-01	6.14E-01	3.44E-06	3.35E+00	5.16E-04
Resident Southwest	6.09E+01	2.56E+00	1.33E+02	1.07E-03	2.85E-06	2.93E-01	3.80E-01	1.17E-06	1.40E+00	1.55E-04
Fenceline	2.20E+02	7.33E+00	4.64E+02	3.36E-03	1.06E-05	1.24E+00	1.34E+00	3.39E-06	3.98E+00	1.36E-03
2002										
Bobcat ESA	9.66E+01	4.36E+00	2.05E+02	2.84E-03	8.46E-06	4.38E-01	5.68E-01	2.69E-06	2.32E+00	2.44E-03
Gray Bat East ESA	9.88E+01	4.26E+00	2.15E+02	1.19E-03	4.17E-06	4.55E-01	6.26E-01	1.56E-06	2.05E+00	1.21E-03
Gray Bat West ESA	1.68E+02	6.80E+00	3.53E+02	4.98E-03	1.60E-05	6.36E-01	9.70E-01	4.07E-06	3.84E+00	4.04E-03
Potato Bean ESA	2.49E+02	1.32E+01	5.45E+02	4.73E-03	1.28E-05	1.03E+00	1.62E+00	7.45E-06	4.93E+00	4.91E-03
Swan ESA	1.25E+02	3.80E+00	2.73E+02	1.29E-03	4.00E-06	6.02E-01	7.96E-01	1.37E-06	1.54E+00	1.21E-03
William Springs ESA	1.74E+02	6.64E+00	3.66E+02	5.11E-03	1.63E-05	6.38E-01	1.01E+00	4.41E-06	3.63E+00	3.97E-03
Wheeler Wildlife Refuge [e]	6.31E+02	2.90E+00	9.26E+02	1.93E-02	5.85E-05	2.07E+00	2.46E+00	2.41E-05	1.40E+01	1.80E-02
Resident West	1.24E+02	2.64E+00	2.67E+02	1.39E-03	3.87E-06	3.01E-01	7.18E-01	1.17E-06	1.65E+00	1.19E-03
Resident East	6.79E+01	2.55E+00	1.49E+02	8.29E-04	2.64E-06	2.61E-01	4.04E-01	8.69E-07	1.39E+00	7.89E-04
Resident Northeast	8.19E+01	3.50E+00	1.79E+02	2.01E-03	5.50E-06	3.59E-01	5.24E-01	2.91E-06	1.72E+00	2.05E-03
Resident Southwest	8.12E+01	1.86E+00	1.78E+02	1.03E-03	2.80E-06	2.57E-01	5.28E-01	1.01E-06	9.15E-01	9.40E-04
Fenceline	1.86E+02	6.62E+00	4.08E+02	1.97E-03	8.00E-06	1.17E+00	1.23E+00	2.91E-06	3.18E+00	2.02E-03
2003 [f]										
Bobcat ESA	1.73E+02	4.49E+00	3.69E+02	2.72E-03	8.11E-06	5.45E-01	1.03E+00	2.50E-06	1.90E+00	2.16E-03
Gray Bat East ESA	1.05E+02	3.49E+00	2.29E+02	1.37E-03	4.86E-06	3.66E-01	6.70E-01	1.57E-06	2.24E+00	1.35E-03
Gray Bat West ESA	2.19E+02	7.47E+00	4.65E+02	4.75E-03	1.48E-05	9.65E-01	1.37E+00	4.22E-06	3.06E+00	3.98E-03
Potato Bean ESA	2.39E+02	1.08E+01	5.24E+02	4.05E-03	1.10E-05	8.28E-01	1.58E+00	6.36E-06	4.29E+00	4.21E-03
Swan ESA	2.02E+02	3.94E+00	4.42E+02	1.14E-03	3.24E-06	4.58E-01	1.30E+00	1.08E-06	1.32E+00	1.01E-03
William Springs ESA	2.24E+02	7.39E+00	4.92E+02	4.70E-03	1.48E-05	8.25E-01	1.50E+00	4.34E-06	2.96E+00	3.99E-03
Wheeler Wildlife Refuge [e]	5.17E+02	2.80E+01	5.49E+02	1.81E-02	5.59E-05	2.31E+00	3.39E+00	2.43E-05	1.65E+01	1.75E-02
Resident West	9.57E+01	4.46E+00	2.07E+02	1.26E-03	3.28E-06	4.08E-01	5.54E-01	1.06E-06	1.72E+00	1.09E-03
Resident East	9.55E+01	4.44E+00	2.03E+02	1.01E-03	3.70E-06	2.61E-01	5.40E-01	1.12E-06	1.74E+00	1.03E-03
Resident Northeast	7.74E+01	3.93E+00	1.69E+02	1.94E-03	5.42E-06	3.30E-01	4.57E-01	2.87E-06	1.96E+00	2.01E-03
Resident Southwest	5.64E+01	2.52E+00	1.23E+02	8.64E-04	2.35E-06	2.55E-01	3.45E-01	8.07E-07	1.33E+00	7.94E-04
Fenceline	3.06E+02	7.02E+00	6.71E+02	3.20E-03	9.60E-06	1.83E+00	1.99E+00	2.93E-06	3.25E+00	2.67E-03

MSFC: Modeling Results

Raw Modeling Results

Receptor Area	CO 1-hr (µg/m³)	CO 8-hr (µg/m³) [g]	HCl 1-hr (µg/m³)	HCl Annual (µg/m³) [c]	HCl Deposition Annual (µg/m³) [c]	NO_X 1-hr (µg/m³) [a]	NO_X 1-hr (µg/m³) [b]	NO_X Annual (µg/m³) [c]	PM_{10} 24-hr (µg/m³) [d]	PM_{10} Annual (µg/m³) [c]
Maximum										
Bobcat ESA	1.73E+02	5.00E+00	3.69E+02	3.24E-03	9.38E-06	5.76E-01	1.05E+00	2.79E-06	3.23E+00	2.54E-03
Gray Bat East ESA	1.05E+02	4.26E+00	2.29E+02	1.37E-03	4.86E-06	3.99E-01	6.70E-01	1.76E-06	2.27E+00	1.35E-03
Gray Bat West ESA	2.19E+02	8.14E+00	4.65E+02	4.98E-03	1.60E-05	8.60E-01	1.37E+00	4.54E-06	4.86E+00	4.04E-03
Potato Bean ESA	4.04E+02	1.56E+01	8.87E+02	5.62E-03	1.47E-05	9.96E-01	2.67E+00	8.28E-06	7.32E+00	4.91E-03
Swan ESA	2.02E+02	4.27E+00	4.42E+02	1.29E-03	4.00E-06	5.24E-01	1.30E+00	1.40E-06	1.93E+00	1.21E-03
William Springs ESA	2.24E+02	7.59E+00	4.92E+02	5.11E-03	1.63E-05	7.91E-01	1.50E+00	4.61E-06	4.96E+00	3.99E-03
Wheeler Wildlife Refuge [e]	9.62E+02	3.35E+01	2.09E+03	2.17E-02	6.72E-05	2.81E+00	6.28E+00	2.76E-05	1.65E+01	1.80E-02
Resident West	1.90E+02	4.46E+00	4.16E+02	1.39E-03	3.87E-06	3.71E-01	1.21E+00	1.20E-06	1.72E+00	1.19E-03
Resident East	9.55E+01	4.44E+00	2.03E+02	1.01E-03	3.70E-06	2.43E-01	5.40E-01	1.12E-06	1.74E+00	3.17E-03
Resident Northeast	9.34E+01	6.91E+00	2.05E+02	2.38E-03	6.51E-06	3.70E-01	6.14E-01	3.44E-06	3.35E+00	2.05E-03
Resident Southwest	8.12E+01	2.56E+00	1.78E+02	1.07E-03	2.85E-06	2.68E-01	5.28E-01	1.17E-06	1.40E+00	9.40E-04
Fenceline	3.06E+02	7.33E+00	6.71E+02	3.36E-03	1.06E-05	1.42E+00	1.99E+00	3.39E-06	3.98E+00	2.67E-03

Note:

[a] 1-hr NO_X values are the 8th highest value. The "Max" for this averaging period is the average of the 8th highest values for the 3 years. These values were pulled for informational purposes but are not used in the analysis against the standards.

[b] 1-hr NO_X values are the 1st highest value. The "Max" for this averaging period is the maximum of the 1st highest values for the 3 years.

[c] Annual results were modeled assuming 1 event per hour. To scale the results to account for the actual number of test events per year, the contribution from each source was determined and multiplied by each source's annual testing frequency and divided by the number of hours in the averaging period. The resulting concentrations for each source were summed to compute the actual annual emissions.

[d] 24-hr PM_{10} results were modeled assuming 1 event per hour. To scale the results to assume 1 event per averaging period, each result was divided by 24 hours.

[e] 1-hr HCl results were modeled assuming 1 event per 1 hour where each event includes the firing of 3 rockets. The resulting concentrations were particularly high for the Wheeler Wildlife Refuge. To capture a more realistic scenario, testing was limited to 1 rocket per event per hour. The "Max" for this averaging period is the maximum concentration resulting from testing any of the 3 rocket types.

[f] Due to the hours of available meteorological data, the annual averages for 2003 were only processed over 8,736 hours (instead of 8,760).

[g] 8-hour results were modeled assuming 1 event per hour. To scale the results to assume 1 event per averaging period, each result was divided by 8 hours.

MSFC: Modeling Results

Annual Modeling Results by Source at Maximum Impact Receptors

	HCl (µg/m^3)				HCl Deposition (µg/m^3)				NO_X (µg/m^3)				PM_{10} (µg/m^3)			
Receptor Area	**Receptor**	**LSRM**	**MSRM**	**SSRM**	**Receptor**	**LSRM**	**MSRM**	**SSRM**	**Receptor**	**LSRM**	**MSRM**	**SSRM**	**Receptor**	**LSRM**	**MSRM**	**SSRM**
Number of Events per Year	**-**	**2**	**5**	**25**	**-**	**2**	**5**	**25**	**-**	**2**	**5**	**25**	**-**	**2**	**5**	**25**
2001																
Bobcat ESA	10429	1.35E+00	1.25E+00	7.78E-01	10429	4.41E-03	3.82E-03	2.17E-03	10432	3.57E-03	3.46E-03	6.69E-07	10432	1.96E+00	1.83E+00	3.70E-01
Gray Bat East ESA	10443	1.25E+00	7.79E-01	2.12E-01	10443	4.39E-03	2.71E-03	6.69E-04	10443	3.03E-03	1.87E-03	1.90E-07	10443	1.77E+00	1.11E+00	1.17E-01
Gray Bat West ESA	10449	2.14E+00	2.04E+00	1.14E+00	10449	6.78E-03	6.33E-03	3.47E-03	10449	5.80E-03	5.62E-03	1.14E-06	10449	3.04E+00	2.89E+00	6.28E-01
Potato Bean ESA	10436	4.37E+00	3.44E+00	9.32E-01	10436	1.22E-02	9.23E-03	2.34E-03	10436	1.21E-02	9.66E-03	9.34E-07	10436	6.20E+00	4.88E+00	5.17E-01
Swan ESA	10457	8.74E-01	6.42E-01	2.21E-01	10457	2.83E-03	1.91E-03	6.07E-04	10457	2.10E-03	1.62E-03	2.08E-07	10457	1.24E+00	9.13E-01	1.23E-01
William Springs ESA	10442	2.20E+00	2.07E+00	1.18E+00	10442	6.97E-03	6.43E-03	3.60E-03	10442	5.94E-03	5.70E-03	1.18E-06	10442	3.11E+00	2.93E+00	6.52E-01
Wheeler Wildlife Refuge	4674	1.50E+01	1.14E+01	4.11E+00	4674	4.91E-02	3.64E-02	1.24E-02	4674	4.16E-02	3.17E-02	4.12E-06	4674	2.13E+01	1.61E+01	2.28E+00
Resident West	1	6.77E-01	5.91E-01	3.06E-01	1	2.06E-03	1.67E-03	7.75E-04	1	1.56E-03	1.47E-03	2.96E-07	1	9.64E-01	8.40E-01	1.70E-01
Resident East	2	5.87E-01	4.28E-01	1.81E-01	2	2.05E-03	1.49E-03	5.50E-04	2	1.33E-03	9.77E-04	1.64E-07	2	8.34E-01	6.07E-01	1.00E-01
Resident Northeast	3	1.97E+00	1.51E+00	3.75E-01	3	5.75E-03	4.23E-03	9.74E-04	3	5.04E-03	4.01E-03	3.61E-07	3	2.79E+00	2.14E+00	2.08E-01
Resident Southwest	4	7.29E-01	5.58E-01	2.05E-01	4	2.34E-03	1.66E-03	4.80E-04	4	1.70E-03	1.37E-03	1.98E-07	4	1.04E+00	7.94E-01	1.14E-01
Fenceline	277	1.86E+00	1.48E+00	7.33E-01	274	6.16E-03	4.89E-03	2.23E-03	850	4.98E-03	3.95E-03	3.57E-07	277	2.64E+00	2.10E+00	4.05E-01
2002																
Bobcat ESA	10429	1.41E+00	1.20E+00	6.43E-01	10429	4.56E-03	3.75E-03	1.85E-03	10429	3.71E-03	3.23E-03	6.46E-07	10429	2.00E+00	1.70E+00	3.54E-01
Gray Bat East ESA	10446	1.06E+00	6.95E-01	1.92E-01	10443	3.67E-03	2.39E-03	6.90E-04	10446	2.58E-03	1.69E-03	1.64E-07	10446	1.50E+00	9.86E-01	1.06E-01
Gray Bat West ESA	10449	2.25E+00	1.73E+00	1.22E+00	10449	7.41E-03	5.61E-03	3.89E-03	10449	6.13E-03	4.67E-03	1.21E-06	10449	3.19E+00	2.45E+00	6.72E-01
Potato Bean ESA	10436	4.01E+00	3.04E+00	7.28E-01	10436	1.17E-02	8.60E-03	1.83E-03	10436	1.12E-02	8.56E-03	7.34E-07	10436	5.68E+00	4.31E+00	4.03E-01
Swan ESA	10454	9.65E-01	6.08E-01	2.54E-01	10454	3.14E-03	2.02E-03	7.48E-04	10454	2.34E-03	1.46E-03	2.38E-07	10454	1.37E+00	8.63E-01	1.41E-01
William Springs ESA	10442	2.28E+00	1.78E+00	1.25E+00	10442	7.50E-03	5.76E-03	3.97E-03	10439	6.20E-03	5.25E-03	1.08E-06	10439	3.23E+00	2.71E+00	5.93E-01
Wheeler Wildlife Refuge	4674	1.33E+01	9.59E+00	3.79E+00	4674	4.22E-02	3.01E-02	1.11E-02	4674	3.76E-02	2.72E-02	3.89E-06	4674	1.89E+01	1.36E+01	2.09E+00
Resident West	1	7.51E-01	5.53E-01	3.15E-01	1	2.44E-03	1.74E-03	8.15E-04	1	1.78E-03	1.34E-03	3.09E-07	1	1.07E+00	7.85E-01	1.75E-01
Resident East	2	6.12E-01	4.22E-01	1.57E-01	2	2.11E-03	1.44E-03	4.70E-04	2	1.39E-03	9.65E-04	1.36E-07	2	8.69E-01	6.00E-01	8.69E-02
Resident Northeast	3	1.67E+00	1.25E+00	3.19E-01	3	5.04E-03	3.61E-03	8.02E-04	3	4.37E-03	3.35E-03	3.14E-07	3	2.36E+00	1.77E+00	1.76E-01
Resident Southwest	4	6.73E-01	4.82E-01	2.10E-01	4	2.16E-03	1.46E-03	5.17E-04	4	1.53E-03	1.16E-03	2.05E-07	4	9.53E-01	6.84E-01	1.16E-01
Fenceline	850	1.65E+00	1.23E+00	3.10E-01	274	4.79E-03	3.39E-03	1.74E-03	795	4.45E-03	3.31E-03	2.40E-07	850	2.34E+00	1.75E+00	1.71E-01
2003																
Bobcat ESA	10432	1.36E+00	1.09E+00	6.24E-01	10432	4.31E-03	3.45E-03	1.80E-03	10429	3.68E-03	2.90E-03	4.94E-07	10429	2.02E+00	1.57E+00	2.79E-01
Gray Bat East ESA	10443	1.15E+00	7.41E-01	2.37E-01	10443	4.12E-03	2.78E-03	8.13E-04	10443	2.65E-03	1.68E-03	2.00E-07	10443	1.63E+00	1.05E+00	1.31E-01
Gray Bat West ESA	10449	2.31E+00	1.82E+00	1.11E+00	10449	7.29E-03	5.77E-03	3.45E-03	10449	6.18E-03	4.90E-03	1.10E-06	10449	3.27E+00	2.58E+00	6.13E-01
Potato Bean ESA	10436	3.46E+00	2.59E+00	6.21E-01	10436	9.68E-03	7.17E-03	1.65E-03	10436	9.64E-03	7.25E-03	6.15E-07	10436	4.91E+00	3.67E+00	3.44E-01
Swan ESA	10457	7.32E-01	4.75E-01	2.44E-01	10457	2.34E-03	1.47E-03	6.51E-04	10454	1.52E-03	1.28E-03	1.99E-07	10457	1.04E+00	6.76E-01	1.36E-01
William Springs ESA	10442	2.38E+00	1.86E+00	1.08E+00	10442	7.52E-03	5.91E-03	3.39E-03	10442	6.39E-03	5.02E-03	1.06E-06	10442	3.37E+00	2.64E+00	5.96E-01
Wheeler Wildlife Refuge	4674	1.35E+01	9.79E+00	3.31E+00	4674	4.23E-02	3.00E-02	1.01E-02	4674	3.76E-02	2.75E-02	3.31E-06	4674	1.91E+01	1.39E+01	1.83E+00
Resident West	1	6.83E-01	5.16E-01	2.84E-01	1	2.02E-03	1.46E-03	6.92E-04	1	1.56E-03	1.22E-03	2.72E-07	1	9.73E-01	7.34E-01	1.58E-01
Resident East	2	8.63E-01	6.17E-01	1.59E-01	2	3.43E-03	2.37E-03	5.44E-04	2	1.71E-03	1.27E-03	1.25E-07	2	1.23E+00	8.78E-01	8.80E-02
Resident Northeast	3	1.70E+00	1.21E+00	3.01E-01	3	4.99E-03	3.48E-03	8.00E-04	3	4.48E-03	3.23E-03	2.88E-07	3	2.40E+00	1.72E+00	1.66E-01
Resident Southwest	4	5.50E-01	4.12E-01	1.76E-01	4	1.80E-03	1.24E-03	4.30E-04	4	1.18E-03	9.39E-04	1.62E-07	4	7.83E-01	5.87E-01	9.75E-02
Fenceline	274	1.68E+00	1.30E+00	7.25E-01	274	5.53E-03	4.10E-03	2.09E-03	868	4.54E-03	3.30E-03	2.95E-07	277	2.42E+00	1.88E+00	3.61E-01

MSFC: Modeling Results

1hr HCl Modeling Results by Source at Maximum Impact Receptors

	HCl (µg/m^3)			
Receptor Area	Receptor	LSRM	MSRM	SSRM
Number of Events per Year	-	2	5	25
2001				
Wheeler Wildlife Refuge	3481	2.80E+02	2.09E+03	1.35E+02
2002				
Wheeler Wildlife Refuge	5892	2.50E+02	1.49E+02	9.26E+02
2003				
Wheeler Wildlife Refuge	3062	5.49E+02	2.83E+02	1.35E+02

MSFC: Modeling Results

Maximum Impact Along the Fenceline

Criteria Pollutant	Averaging Period	Receptor	X-Coordinate km	Y-Coordinate km	Modeled Ground Concentration µg/m^3
NO_X	1-hr	499	936.1651	-540.3672	1.99
	annual	850	943.7302	-534.3719	0.000003
CO	1-hr	499	936.1651	-540.3672	306.30
	8-hr	277	940.0907	-545.7478	7.33
PM_{10}	24-hr	277	940.0907	-545.7478	3.98
HCl	1-hr	499	936.1651	-540.3672	670.70
	annual	277	940.0907	-545.7478	0.003

Maximum Impact in Residential Areas

Criteria Pollutant	Averaging Period	Residential West Concentration µg/m^3	Residential East Concentration µg/m^3	Residential Northeast Concentration µg/m^3	Residential Southwest Concentration µg/m^3
NO_X	1-hr	1.21	0.54	0.61	0.53
	annual	0.000001	0.000001	0.000003	0.000001
CO	1-hr	190.13	95.47	93.39	81.23
	8-hr	4.46	4.44	2.56	2.56
PM_{10}	24-hr	1.72	1.74	3.35	1.40
HCl	1-hr	416.16	202.83	204.75	177.89
	annual	0.001	0.001	0.002	0.001

Maximum Impact in Ecologically Sensitive Areas

Criteria Pollutant	Averaging Period	Bobcat Concentration µg/m^3	Gray Bat East Concentration µg/m^3	Gray Bat West Concentration µg/m^3	Potato Bean Concentration µg/m^3	Swan Concentration µg/m^3	William Springs Concentration µg/m^3
NO_X	1-hr	1.05	0.67	1.37	2.67	1.30	1.50
	annual	0.000003	0.000002	0.000005	0.00001	0.000001	0.000005
CO	1-hr	173.19	104.75	219.29	404.47	201.78	224.30
	8-hr	5.00	4.26	8.14	15.57	4.27	7.59
PM_{10}	24-hr	3.23	2.27	4.86	7.32	1.93	4.96
HCl	1-hr	369.21	229.41	465.01	886.72	442.21	491.73
	annual	0.003	0.001	0.005	0.01	0.001	0.01

Maximum Impact in Wheeler Wildlife Refuge

Criteria Pollutant	Averaging Period	Receptor	X-Coordinate km	Y-Coordinate km	Modeled Ground Concentration µg/m^3
NO_X	1-hr	3481	942.3275	-540.8723	6.28
	annual	4674	941.3140	-541.6009	0.00003
CO	1-hr	3481	942.3275	-540.8723	962.23
	8-hr	5366	941.5419	-541.8247	33.46
PM_{10}	24-hr	4674	941.3140	-541.6009	16.51
HCl	1-hr [a]	3481	942.3275	-540.8723	2,087.60
	annual	4674	941.3140	-541.6009	0.02

Note:

[a] The modeled 1-hour HCl results use the refined method, assuming that only one rocket can be tested per day; the result was taken as the maximum concentration produced by one of the three rocket motors tested.

MSFC: Modeling Results

Total Impact Outside of Property

Criteria Pollutant	Averaging Period	Background Concentration µg/m^3	Modeled Ground Concentration [d] µg/m^3	Total Impact µg/m^3	Standard µg/m^3	Exceeds Standard?
NO_X	1-hr [e]	94.07	1.99	96.06	188.14	No
	annual	13.17	0.000003	13.17	99.71	No
CO	1-hr	7,329	306.30	7,636	40,082	No
	8-hr	5,153	7.33	5,161	10,307	No
PM_{10}	24-hr	64	3.98	68	150	No
HCl [a]	1-hr [b]	0	670.70	671	3,033	No
	1-hr [c]	0	670.70	671	2,100	No
	annual [c]	0	0.003	0.003	9	No

Note:

[a] HCl is not considered a criteria pollutant and is, therefore, not monitored regularly. As a result, there are no background concentration data available for this pollutant.

[b] Standard from the Headquarters Air Force Space Command / Surgeon General Air Quality Standards.

[c] Standards from the Office of Environmental Health Hazard Assessment Reference Exposure Levels.

[d] Areas outside the property boundary include the fenceline and the residential areas.

[e] USEPA's new 1-hour NOX standard requires the 8th highest modeled concentration, averaged over the 3-year period, to be compared to the standard. As a conservative estimate, the maximum modeled concentration was used for comparison.

Total Impact Inside of Property

Criteria Pollutant	Averaging Period	Background Concentration µg/m^3	Modeled Ground Concentration [d] µg/m^3	Total Impact µg/m^3	Standard µg/m^3	Exceeds Standard?
NO_X	1-hr [f]	94.07	6.28	100.35	188.14	No
	annual	13.17	0.00003	13.17	99.71	No
CO	1-hr	7,329	962.23	8,291	40,082	No
	8-hr	5,153	33.46	5,187	10,307	No
PM_{10}	24-hr	64	16.51	81	150	No
HCl [a]	1-hr [b, e]	0	2,087.60	2,088	3,033	No
	1-hr [c, e]	0	2,087.60	2,088	2,100	No
	annual [c]	0	0.02	0.022	9	No

Note:

[a] HCl is not considered a criteria pollutant and is, therefore, not monitored regularly. As a result, there are no background concentration data available for this pollutant.

[b] Standard from the Headquarters Air Force Space Command / Surgeon General Air Quality Standards.

[c] Standards from the Office of Environmental Health Hazard Assessment Reference Exposure Levels.

[d] Areas inside the property boundary include the ecologically sensitive areas and the Wheeler Wildlife Refuge.

[e] The modeled 1-hour HCl results are from Wheeler Wildlife Refuge Area and use the refined method, assuming that only one rocket can be tested per day; the result was taken as the maximum concentration produced by one of the three rocket motors tested.

[f] USEPA's new 1-hour NOX standard requires the 8th highest modeled concentration, averaged over the 3-year period, to be compared to the standard. As a conservative estimate, the maximum modeled concentration was used for comparison.

MSFC: Modeling Results

CO_2 Emissions

Criteria Pollutant	LSRM	MSRM	SSRM
Mass Fraction in Exhaust	0.084	0.084	0.138
Mass of Propellant Detonated (kg)	4636	1719	40
CO_2 Emitted per Test (kg)	388	144	6
Annual Frequency of Tests	2	5	25
CO2 Emitted per Rocket (kg/year)	775	719	138
Total CO_2 Emitted (tons/year)	1.63		

APPENDIX D

Acoustic Predictions Memorandum

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

May 6, 2010

Reply to Attn of:

ER42 (10-026)

TO: AS10/ Donna Holland
THRU: ER42/Doug Counter JLW

FROM: ER42/Lisa Griffin

SUBJECT: Predicted Acoustic Environments for Solid Rocket Motor Testing at Marshall Space Flight Center

The predicted far field acoustic environment for solid rocket motor testing at Marshall Space Flight Center (MSFC) is documented in this memo. A computer program written by ER42/MSFC was used to make the predictions. The program makes far field sound pressure level predictions based on the octave band power level of the motor, distance away from the source, directivity index, and atmospheric attenuation. Several parameters are used to calculate the power level including type of motor, thrust, nozzle exit diameter, exit velocity, and acoustic efficiency.

Far field acoustic predictions were made for three different motor sizes. The motor sizes are 10000 lb., 60000 lb., and 100,000 lb. thrust. The motor parameters used in this analysis are shown in Table 1. Figure 1 shows the Marshall Space Flight Center Location and Vicinity Map. Figure 2 shows the locations of the solid rocket motor test sites at MSFC. The small motors are tested at test stand 116. The medium motors can be tested at test stand 4520 and test complex 500. The large motors are tested at test stand 4520. Predictions were made at the closest distances to the MSFC boundary, the nearest office building outside of the MSFC test area, Redstone Arsenal boundary, nearest residential area, and Wheeler Wildlife Refuge. The nearest residential areas are on Zierdt Road south of Gate 7 of the Redstone Arsenal. The overall sound pressure levels (OASPL) shown in Tables 2-6 are the maximum levels predicted and are typically at the 50 or 60 degree angle from the direction of the thrust. Table 2 shows the overall sound pressure levels in dB and dB(A) for the 10,000 lb. thrust motor in the horizontal position at Test Stand 116 for the specific locations mentioned above. Table 3 shows the overall sound pressure levels for the 10,000 lb. thrust motor in the vertical position at Test Stand 116 for specific locations. Table 4 shows the overall sound pressure levels for the 60,000 lb. thrust motor in the horizontal position at Test Stand 4520 for specific locations. Table 5 shows the overall sound pressure levels for the 60,000 lb. thrust motor in the horizontal position at Test Complex 500 for specific locations. Table 6 shows the overall sound pressure levels for the 100,000 lb. thrust motor in the horizontal/vertical position at Test Stand 4520 for specific locations. Tables 7, 8, 9 and 10 provide the sound level contour data for 10000 lb., 60000 lb., and 100,000 lb. thrust motors.

Any questions or comments should be directed to Doug Counter by phone at (256) 544-1539 or by email at douglas.d.counter@nasa.gov.

for Lisa Griffin
Branch Chief
Fluid Dynamics Branch

cc:
ER01/Tom Williams
ER40/Stan Tieman
ET10/ Dennis Strickland
EV93/Allison Lee

Motor Size	**Small**	**Medium**	**Large**
Sea Level Thrust	10,000 lbf	60,000 lbf	100,000 lbf
Exit Velocity	8,200 ft/sec	8,150 ft/sec	8,040 ft/sec
Exit Diameter	8 inches	12 inches	24 inches
Acoustic Efficiency	0.5%	0.5%	0.5%

Table 1 – Motor Parameters

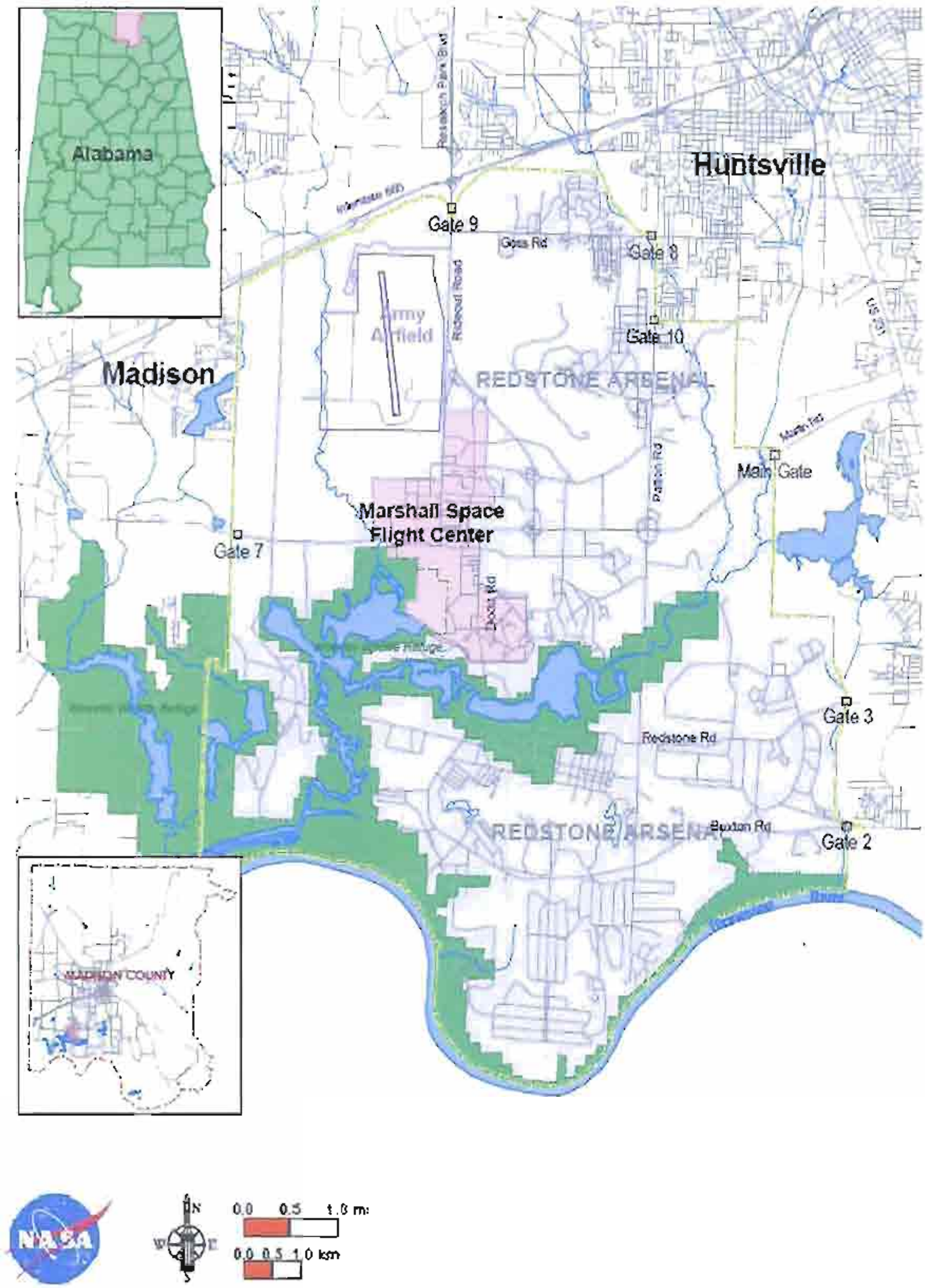


Figure 1- Marshall Space Flight Center Location and Vicinity Map

Figure 2- Location of Solid Rocket Motor Test Sites at Marshall Space Flight Center

10,000 lbs (Horizontal) at Test Stand 116			
Location	**Distance (Meters)**	**OASPL (dB)**	**A-weighted OASPL (dB(A))**
MSFC border (300)	270	120.4	116.3
Nearest Office Building out of Test Area MSFC Building 4666	670	111.4	106.8
Redstone Border	5300	85.1	73.4
Nearest Residential Area (Zierdt Road)	5300	85.1	73.4
Wheeler Wildlife Refuge minimum distance	800	109.8	104.5
Wheeler Wildlife Refuge near Decatur	25000	60.4	25

Table 2 – Overall Sound Pressure Levels for 10,000 lb Thrust Motor in Horizontal Position for Specific Locations

Note: dB, RE: 0.00002 N/m^2

10,000 lbs (Vertical) at Test Stand 116			
Location	**Distance (Meters)**	**OASPL (dB)**	**A-weighted OASPL (dB(A))**
MSFC border	270	122.6	117.4
Nearest Office Building out of Test Area MSFC Building 4666	670	113.8	108
Redstone Border	5300	87.9	75.6
Nearest Residential Area (Zierdt Road)	5300	87.9	75.6
Wheeler Wildlife Refuge minimum distance	800	112.3	105.7
Wheeler Wildlife Refuge near Decatur	25000	60.6	28

Table 3 – Overall Sound Pressure Levels for 10,000 lb Thrust Motor in Vertical Position for Specific Locations

Note: dB, RE: 0.00002 N/m^2

60,000 lbs (Horizontal) at Test Stand 4520			
Location	**Distance (Meters)**	**OASPL (dB)**	**A-weighted OASPL (dB(A))**
MSFC border	120	135.7	130.5
Building 4666 (Nearest Office Building out of MSFC Test Area)	610	120.5	114.4
Redstone Border	5150	95.1	81.1
Nearest Residential Area (Zierdt Road)	5150	95.1	81.1
Wheeler Wildlife Refuge minimum distance	500	122.4	116.6
Wheeler Wildlife Refuge near Decatur	25000	70.5	33.9

Table 4 – Overall Sound Pressure Levels for 60,000 lb Thrust Motor in Horizontal Position at Test Stand 4520 for Specific Locations

Note: dB, RE: 0.00002 N/m^2

60,000 lbs (Horizontal) at Test Complex 500			
Location	**Distance (Meters)**	**OASPL (dB)**	**A-weighted OASPL (dB(A))**
MSFC border	380	125.1	119.5
Building 4666 (Nearest Office Building out of MSFC Test Area)	420	124.1	118.4
Redstone Border	5100	95.3	81.3
Nearest Residential Area (Zierdt Road)	5100	95.3	81.3
Wheeler Wildlife Refuge minimum distance	1200	113.5	106.3
Wheeler Wildlife Refuge near Decatur	25000	70.5	33.9

Table 5 – Overall Sound Pressure Levels for 60,000 lb Thrust Motor in Horizontal at Test Complex 500 for Specific Locations

Note: dB, RE: 0.00002 N/m^2

100,000 lbs ((Horizontal/Vertical) at Test Stand 4520			
Location	**Distance (Meters)**	**OASPL (dB)**	**A-weighted OASPL (dB(A))**
MSFC border	120	138.4	130.4
Building 4666 (Nearest Office Building out of MSFC Test Area)	610	123.5	114.5
Redstone Border	5150	100.2	81.7
Nearest Residential Area (Zierdt Road)	5150	100.2	81.7
Wheeler Wildlife Refuge minimum distance	500	125.4	116.6
Wheeler Wildlife Refuge near Decatur	25000	76.8	38

Table 6 – Overall Sound Pressure Levels for 100,000 lb Thrust Motor in Horizontal/Vertical Position at Test Stand 4520 for Specific Locations

Note: dB, RE: 0.00002 N/m^2

	Constant Sound Level Radii (meters)					
Angle (Degree)	65 dB	75 dB	85 dB	95 dB	105 dB	115 dB
0	12419	5614	2589	1091	412	139
10	14276	6518	3067	1319	508	175
20	15769	7496	3672	1660	665	234
30	16574	8201	4141	1929	797	289
40	17247	8974	4670	2265	964	360
50	17076	9523	5107	2527	1097	414
60	16739	9631	5323	2715	1215	472
70	14522	8875	5055	2630	1189	462
80	12395	7575	4314	2200	965	368
90	11910	7278	4104	2072	900	339
100	11440	6991	3943	1951	839	310
110	11022	6668	3685	1805	753	273
120	10077	6036	3303	1586	655	237
130	8855	5251	2873	1379	570	206
140	8924	5233	2778	1307	524	186
150	8509	4990	2649	1222	485	170
160	8419	4795	2495	1139	443	154
170	8172	4655	2422	1095	426	147
180	8016	4565	2328	1042	401	138

Table 7 – Sound Level Contour Data for 10,000 lb Thrust Motor for Horizontal Firing

Note: dB, RE: 0.00002 N/m^2

	Constant Sound Level Radii (meters)					
Angle (Degree)	65 dB	75 dB	85 dB	95 dB	105 dB	115 dB
0	11845	6226	3207	1509	630	228
10	12574	6675	3474	1651	689	252
20	14590	7983	4281	2076	884	327
30	16614	9456	5174	2560	1123	424
40	19872	11666	6513	3321	1517	590
50	17812	10562	6077	3226	1503	596
60	15190	9171	5277	2801	1292	513
70	13215	7995	4647	2442	1104	429
80	11612	7025	4001	2082	932	355
90	10617	6295	3586	1829	810	306
100	10203	5870	3310	1671	733	277
110	9323	5254	2875	1437	612	226
120	7877	4397	2358	1132	463	166
130	7274	3980	2092	984	394	140
140	6785	3675	1912	882	346	122
150	6520	3497	1801	814	317	109
160	6266	3360	1714	759	289	99
170	6081	3261	1614	701	264	89
180	6021	3197	1582	687	254	87

Table 8 – Sound Level Contour Data for 10,000 lb Thrust Motor for Vertical Firing

Note: dB, RE: 0.00002 N/m^2

	Constant Sound Level Radii (meters)						
Angle (Degree)	65 dB	75 dB	85 dB	95 dB	105 dB	115 dB	125 dB
0	33406	13520	5754	2449	971	345	115
10	37270	15391	6751	2961	1198	434	145
20	39171	17009	7767	3546	1509	564	194
30	38399	17711	8419	4042	1755	682	238
40	36536	18262	9313	4609	2083	835	296
50	32748	17918	9706	5000	2329	952	342
60	29352	17405	9815	5211	2477	1044	386
70	23751	14809	8781	4853	2354	1002	370
80	19882	12508	7471	4018	1929	797	289
90	18908	11908	7061	3825	1800	743	267
100	18163	11439	6715	3601	1695	686	244
110	17623	11083	6441	3385	1561	613	216
120	16262	10038	5775	2975	1345	528	184
130	14401	8713	4913	2531	1133	440	153
140	14560	8809	4918	2483	1089	411	142
150	13971	8368	4671	2312	1004	379	129
160	13986	8293	4538	2223	946	350	118
170	13522	8036	4397	2132	908	332	112
180	13435	7966	4272	2051	864	316	106

Table 9 – Sound Level Contour Data for 60,000 lb Thrust Motor for Horizontal Firing

Note: dB, RE: 0.00002 N/m^2

	Constant Sound Level Radii (meters)						
Angle (Degree)	65 dB	75 dB	85 dB	95 dB	105 dB	115 dB	125 dB
0	67002	26847	10543	4140	1546	538	178
10	73279	30260	12247	4957	1889	671	224
20	74012	31817	13678	5821	2309	845	288
30	69722	31836	14391	6376	2660	1003	346
40	62494	30924	14998	7129	3096	1204	423
50	52246	28018	14875	7510	3395	1347	483
60	43069	25538	14547	7569	3526	1442	522
70	32919	20483	12024	6448	3065	1266	463
80	27370	16724	9622	5109	2380	963	349
90	25864	15806	9094	4780	2227	892	320
100	24596	15031	8648	4500	2075	823	289
110	23866	14585	8307	4279	1935	752	262
120	22173	13281	7414	3743	1642	632	220
130	19457	11422	6250	3062	1343	512	176
140	19520	11575	6333	3103	1320	493	168
150	18751	11007	5962	2863	1218	450	154
160	18940	11118	5962	2834	1170	428	145
170	18194	10680	5670	2695	1113	407	136
180	18194	10674	5610	2640	1079	391	131

Table 10 – Sound Level Contour Data for 100,000 lb Thrust Motor for Horizontal/Vertical Free Field Firing

Note: dB, RE: 0.00002 N/m^2