National Park Service
U.S. Department of the Interior

Palo Alto Battlefield National Historical Park
Texas

Integrated Vegetation Management Plan and Environmental Assessment

September 2013

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Palo Alto Battlefield National Historical Park
Integrated Vegetation Management Plan and Environmental Assessment

Executive Summary

Palo Alto Battlefield National Historical Park (PAAL) is charged with preserving and interpreting the sites of the two opening battles of the U.S.-Mexican War for the education, benefit, and inspiration of present and future generations. The battles of Palo Alto and Resaca de la Palma occurred on May 8, and May 9, 1846 respectively. Over the past century and a half, the physical environment at both battlefields has undergone dramatic changes due to twentieth century cultural activities. The majority of the Resaca de la Palma Battlefield site has been lost to urban development, while the remaining 34 acre tract that the park administers retains little of its historic character. In contrast, the site of Palo Alto Battlefield remains relatively undeveloped and largely unchanged since the time of the battle. However twentieth century activities have altered the physical environment and continue to degrade the historic character of Palo Alto. The principal concern is the continuing process of encroachment, and eventual domination, of native woody species on the historic gulf cordgrass prairies as a result of an altered hydrologic regime, past land management practices, and the lack of a proactive vegetation management program. Despite these changes, the park has distinct opportunities to restore or mitigate altered landscape situations on the core battlefield of Palo Alto through vegetation management practices. Consequently, PAAL could fulfill its legislative mandate of preserving the historic character of Palo Alto Battlefield by developing a comprehensive and integrated plan for managing the vegetation on the site with the goal of restoring and maintaining the cultural landscape of the core battlefield. The plan would also design vegetation management strategies for the areas of the park outside the core battlefield of Palo Alto with the intention of providing visitors with safe and enjoyable access to the park, while enhancing and nurturing the native biodiversity.

Three alternatives have been identified for consideration in the development of this comprehensive and integrated vegetation management plan for PAAL. These alternatives were developed with input from local agencies (U.S. Fish and Wildlife Service, Nature Conservancy, U.S. Department of Agriculture, and Texas Department of Parks and Wildlife) and various subject matter experts. All three alternatives focus primarily on exotic plant management and visitor access and safety in the areas outside the core battlefield of Palo Alto. In the core battlefield of Palo Alto each of the alternatives would provide some level of altered landscape restoration, however, the intensity of the restoration actions and the types of methods available for use would vary between the three alternatives as summarized below.

Alternative A: No Action - Under the no action alternative, current vegetation management practices would continue. These management activities would remain limited and focused on listed noxious weed species and exotic plant species, relying largely on the support of regional Exotic Plant Management personnel. Routine maintenance of vegetation for visitor safety and access in the developed areas of the park would continue. The current vegetation management program is not fully developed to include prevention and early detection methodologies for exotic species. Altered landscape restoration actions would remain limited and would not eliminate or improve visual intrusions on the cultural landscape of the core battlefield at Palo Alto.

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Alternative B: Proactive Vegetation Management – Under Alternative B, a comprehensive and integrated vegetation management program would be developed utilizing a full range of mechanical, cultural (including the use of prescribed fire), chemical, and biological treatments to restore and maintain the cultural landscape in the core battlefield area at Palo Alto. Specific multi-purpose and targeted vegetation monitoring protocols would be developed and implemented in coordination with the NPS personnel of the Gulf Coast Inventory and Monitoring Network, Gulf Coast Exotic Plant Management Team, and fire ecologists to: (1) define the effectiveness of specific vegetation management treatments, (2) provide early detection of newly invading species, (3) determine fire effects on native and non-native vegetation, and (4) determine cultural landscape restoration success in the core battlefield of Palo Alto. This would allow the park to adjust its management strategy so the best results can be achieved with the least amount of effort and impact to the environment. Alternative B serves as both the NPS and environmentally preferred alternative.

Alternative C: Improved Vegetation Management - Under Alternative C, vegetation management practices would be expanded to include mechanical, cultural (excluding the use of prescribed fire), chemical, and biological treatments. Efforts to restore and maintain the historic coastal prairie of the core battlefield at Palo Alto would include exotic plant management, invasive native tree and cactus removal, native seed augmentation, and native gulf cordgrass planting. Limited vegetation monitoring would be implemented to assess basic qualitative "change over time" analyses. The visual and ecological quality of the site would be improved above the no-action condition, but the park would have to sustain an intense level of effort for the foreseeable future in order to maintain the restored cultural landscape of the core battlefield.

PAAL developed the various vegetation management strategies put forth in Alternative B, the preferred alternative, through intensive and extensive collaboration with numerous subject matter experts concluding that this alternative provides the most effective, efficient, and environmentally sensitive long-term means for restoring and maintaining the historic character of the core battlefield area at Palo Alto for public enjoyment and understanding. Alternative B is designed for a relatively intensive effort of mechanical, chemical, and cultural treatments during the initial stages of implementation, but develops into a less intensive effort, relying largely on the cultural treatment of prescribed fire to maintain the desired condition in the core battlefield of Palo Alto. The key difference between Alternative B and Alternative C is the use of prescribed fire. Alternative C was developed to provide park managers with an alternative that does not use prescribed fire, since it appeared to be the one management strategy that was potentially controversial. However, the amount of effort and funds required to maintain a restored gulf cordgrass prairie without prescribed fire would be exponentially greater. In addition, the use of prescribe fire would reintroduce a natural process to the landscape that has been essentially eliminated by modern cultural practices. Therefore, Alternative B is determined to be the most efficient, effective, and environmentally sensitive alternative for meeting the overarching objectives of restoring and maintaining the core battlefield of Palo Alto to its 1846 appearance and enhancing the native biodiversity in the park. The analysis of the environmental impacts produced by implementing the preferred alternative have been determined to be beneficial, or negligible to minor adverse and of short duration. Preliminary public scoping solicited very

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limited response; however the response was positive toward the park's effort and in support of the NPS preferred alternative.

Public Comment

If you wish to comment on the EA, **you may post comments online at http://parkplanning.nps.gov/paal** or mail comments to: Superintendent; Palo Alto Battlefield National Historical Park, 1623 Central Blvd., Rm 213, Brownsville, Texas 78520. This environmental assesment will be on public review for 30 days. Before including your address, phone number, e-mail address, or other personal identifying information in your comment, you should be aware that your entire comment – including your personal identifying information – may be made publicly available at any time. Although you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

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SECTION 1: PURPOSE AND NEED

1.1 INTRODUCTION

Palo Alto Battlefield National Historic Site was effectively established in June, 1992 (PL 102-304) to preserve for the education, benefit, and inspiration of present and future generations the site of the first battle of the U.S.-Mexican War, and to provide for its interpretation in such manner as to portray the battle and the U.S.-Mexican War and its related political, diplomatic, military and social causes and consequences from the perspectives of both nations. The national historic site's enabling legislation specifically mandates that the park would be managed "to protect, manage, and administer the historic site for the purposes of preserving and interpreting the cultural and natural resources of the historic site and providing for public understanding and appreciation of the historic site in such manner as to perpetuate these qualities and values for future generations" (HR1642, 1992).

In 2009 legislation passed that added the site of Resaca de la Palma Battlefield National Historic Landmark as a second unit of the park, and changed the name of the park from National Historic Site to National Historical Park. The Resaca de la Palma Unit, a small 34 acre tract, is all that remains undeveloped of the site of the battle that took place the day after Palo Alto. Although this tract is currently undeveloped, it was significantly altered during the 20th century and the historic character and the archeological integrity of the site have been essentially lost. In August of 2011, the NPS purchased the property. The park has initially decided to maintain the current open urban park character of the site, due to the suburban setting and the lack of integrity. Accordingly, the current vegetation management strategy for the Resaca de la Palma Unit (REPA) is to maintain a safe environment for the public, limit the presence of exotic species, and encourage native biodiversity.

Palo Alto Battlefield National Historical Park (PAAL) is located in extreme south Texas (Figure 1). Both units of PAAL are located within the city limits of Brownsville, and are about six miles apart (Figure 2). The Palo Alto Battlefield Unit (PALO) is situated within the western terminus of the coastal prairie (Figure 3). The current boundary of the Palo Alto Battlefield Unit of PAAL occupies a land base of 3,426 acres, which includes approximately 275 acres of resaca ("RESACA" is a term used in northeastern Mexico and deep south Texas to identify former channels of the Rio Grande deltaic system), 1,358 acres of mixed grass prairie (higher quality), 1,375 acres of mixed brush grassland, and 418 acres of dense, old-growth brush thickets. This rudimentary vegetation classification was determined by the interpreted signatures of these communities in 2009 and 2010 aerial imagery. However, every year since the park has owned portions of the battlefield and is not actively involved in vegetation clearing as the previous land owners were, woody vegetation has been invading and overtaking the historic grassland prairie. The soils at Palo Alto are predominantly poorly drained clay soils high in salinity and are minimally productive for agriculture. Consequently, the area has not been intensively, or extensively, used for agriculture and the landscape of the Palo Alto Battlefield Unit possesses a relatively high degree of cultural and ecological integrity.

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Vegetation resources are especially important to the ecological and cultural significance of Palo Alto Battlefield Unit of PAAL. Cultural and natural resources at PALO are strongly interrelated, since the natural environment strongly influenced how the battle unfolded. Therefore, factors guiding management decisions and activities must also be strongly integrated in considering impacts to both cultural and natural resource values.

The Resaca de la Palma Battlefield Unit (REPA) is located within a former meander loop of the Rio Grande deltaic system (Figure 4). This 34 acre tract contains approximately 19 acres of mowed grasses and weeds, surrounded by approximately 10 acres of brush. The majority of the brush is comprised of diverse native brush communities, but there are dense concentrations of exotic Brazilian Pepper trees, especially on the eastern portion of the unit and along the resaca banks. The remaining 5 acres are aquatic, part of the resaca that surrounds the landform. The city maintains the resacas within its limits for storm drainage and transporting water. The soils at Resaca de la Palma are predominantly well drained silt loams to silty clays, and are better suited for agricultural purposes than the soils at Palo Alto. During the 1950's this tract sustained a productive citrus orchard. During the 1960's the property was converted into a polo field, which characterized the site for the remainder of the twentieth century. Currently the landscape at the Resaca de la Palma Battlefield Unit provides the park with a venue to interface with large groups of the public in a safe environment.

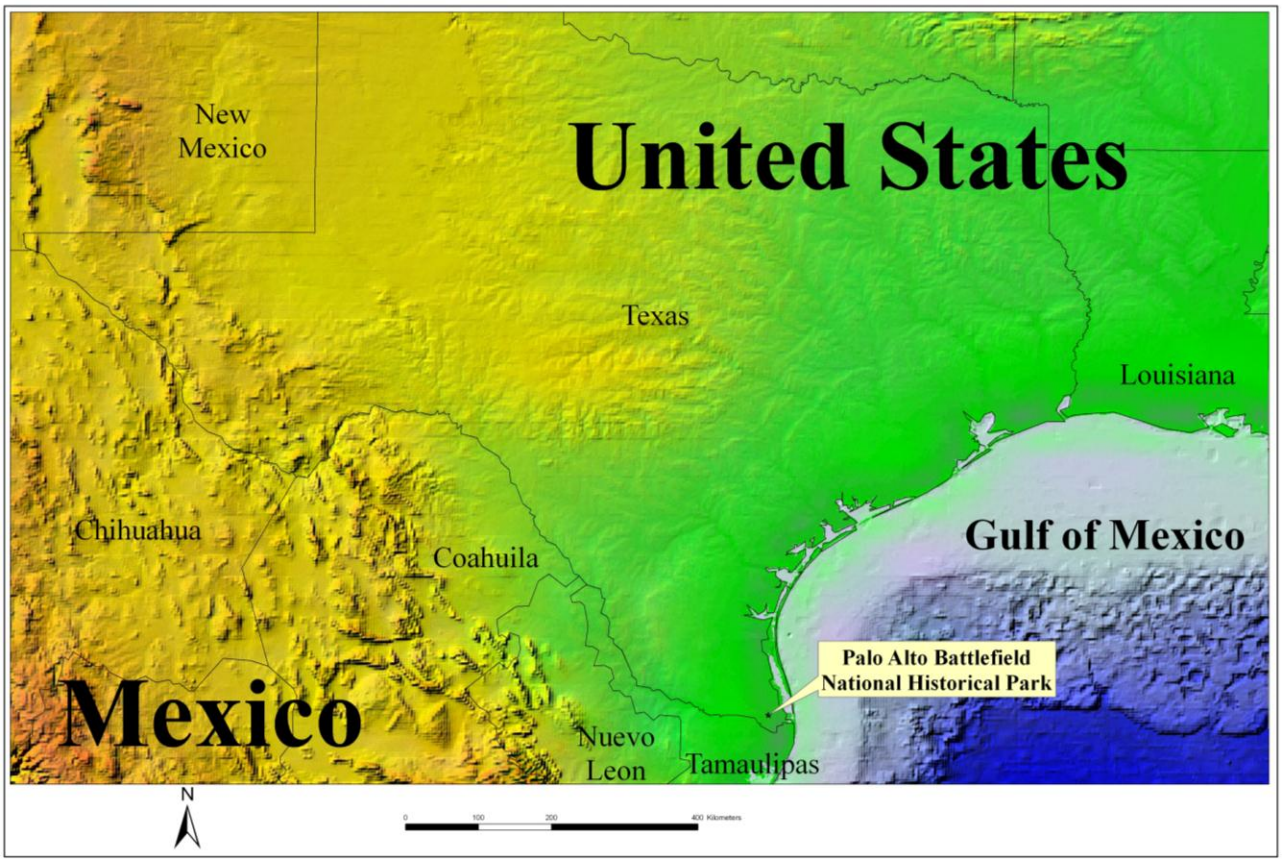

Figure 1. Palo Alto Battlefield National Historical Park – Regional Map.

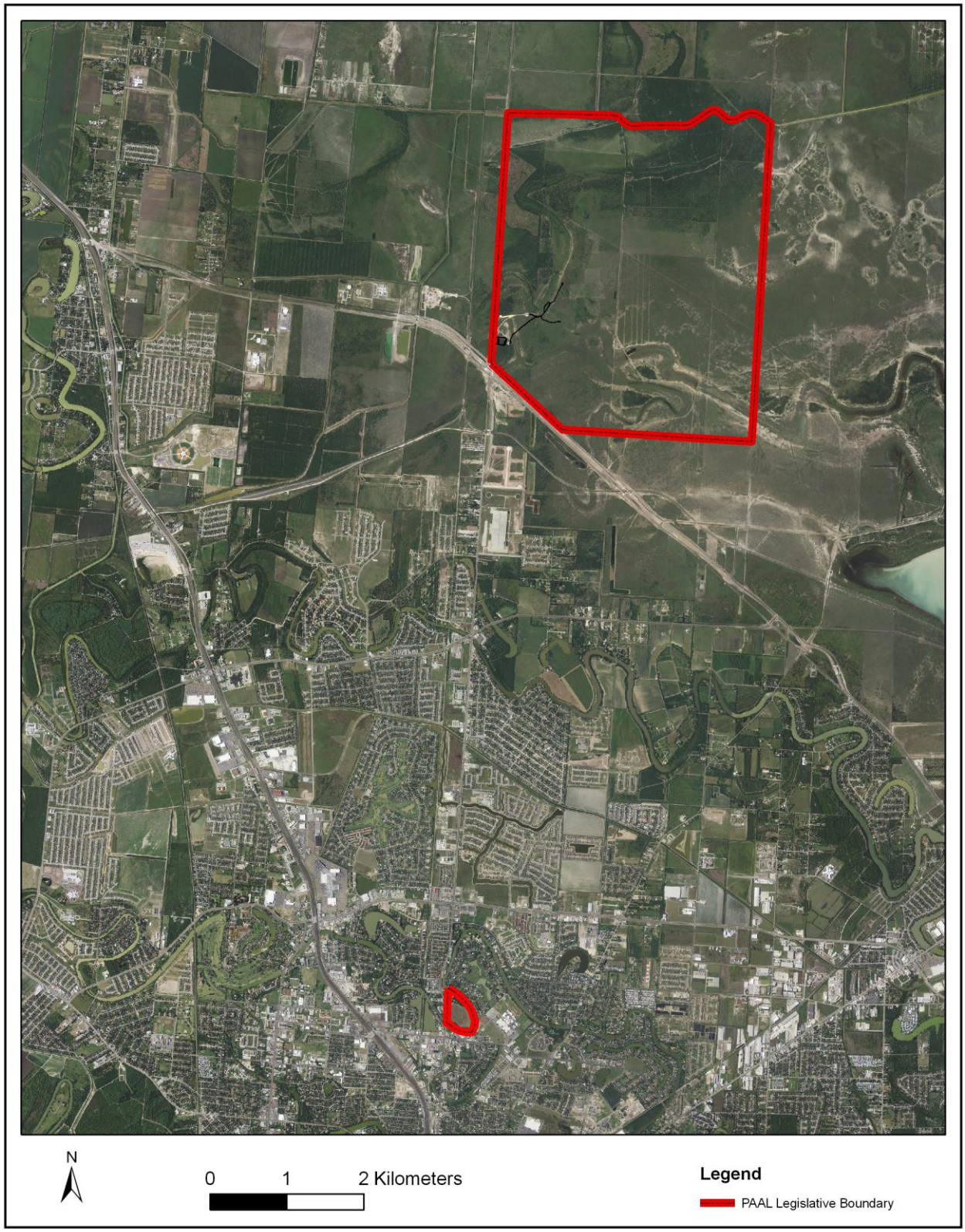

Figure 2. Palo Alto Battlefield National Historical Park Boundary, overlaid on 2010 NAIP imagery.

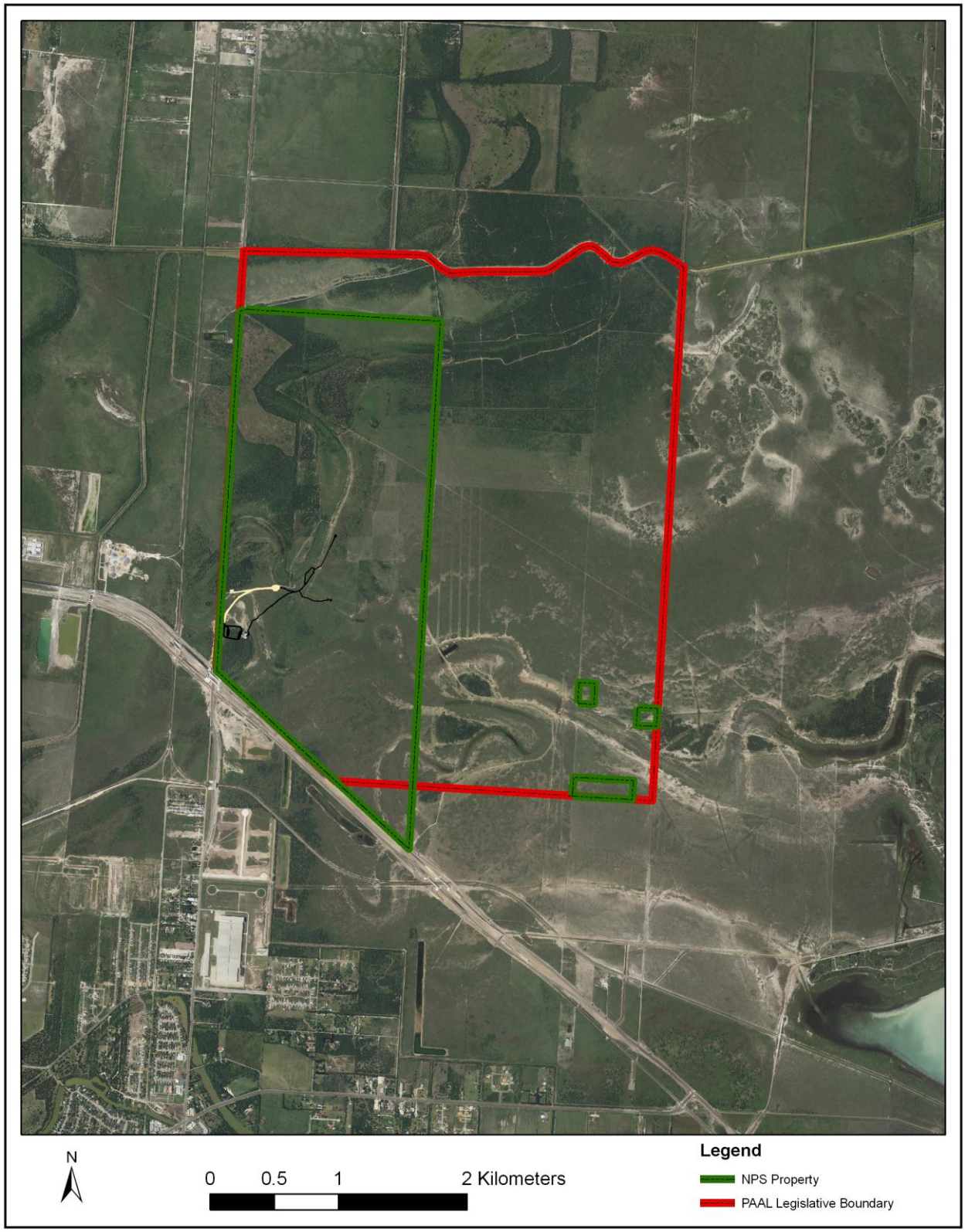

Figure 3. PAAL Palo Alto Battlefield Unit, overlaid on 2010 NAIP imagery.

Figure 4. PAAL Resaca de la Palma Battlefield Unit, overlaid on 2010 NAIP imagery.

1.2 PURPOSE OF THE VEGETATION MANAGEMENT PLAN

The purpose of this integrated Vegetation Management Plan is to provide a long-term framework for managing the vegetation within PAAL that enables the park to fulfill legislative and agency mandates in the most environmentally sensitive, effective, and efficient manner.

Under DO-12, "purpose" is defined as a statement of goals and objectives that the NPS intends to fulfill by taking action. Under this definition, the objectives of this integrated Vegetation Management Plan are to:

1. Restore and maintain the cultural landscape within the core battlefield area at the PALO unit.
2. Control, with the long-term goal of eliminating, the presence of exotic plants within the park.
3. Provide visitors with safe and enjoyable access to the resources the park is charged with preserving and interpreting.

1.3 NEED FOR A VEGETATION MANAGEMENT PLAN

Under DO-12, "need" is described as an existing condition that should be changed, problems that should be remedied, decisions that should be made, and policies or mandates that should be implemented. Under this definition, the following needs have been identified for this project:

Existing conditions that should be changed:

- A comprehensive integrated vegetation management plan is needed to stop the degradation, and begin the restoration and maintenance of cultural landscape within the core battlefield area of the PALO unit. Currently native woody and cacti vegetation are continuing to invade and overtake the historic wetland prairies at Palo Alto at an alarming rate.
- A comprehensive integrated vegetation management program is needed to reduce the threat of exotic plants to the natural and cultural resources at the park. Currently the park does not systematically manage for the control of exotic plant species.
- A comprehensive integrated vegetation management program is needed for the park to enhance its ability to provide visitors with safe and enjoyable access to the park's resources. Currently the park does not have an approved systematic plan for managing the vegetation within the development zones.

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Problems that should be remedied:

- An Integrated Vegetation Management Plan Environmental Assessment is needed to achieve compliance with environmental and cultural resource legislation for future vegetation management actions.

Decisions that should be made:

- A comprehensive evaluation of the potential impacts associated with vegetation management is needed to educate park management of the potential of effects of various vegetation management strategies. Resource managers would also need standardized best management practices (BMP) to mitigate the potential impacts associated with vegetation management.

Policies or Mandates that should be implemented:

- An Integrated Vegetation Management Plan Environmental Assessment is needed to ensure that relevant federal and agency polices and mandates are implemented.

In summary, the cultural landscape of the core battlefield at the PALO unit has been compromised due to twentieth century cultural activities and is continuing to degrade due to lack of active management. However, the historic site still retains a certain level of environmental integrity and if the appropriate vegetation management practices are implemented in the immediate future the park should be able to restore and maintain the mid-nineteenth environmental conditions of the site. PAAL also needs environmentally sensitive, efficient and effective vegetation management strategies for controlling exotic plant species in all areas of the park encouraging and maintaining native plant species diversity and a healthy natural ecosystem, as well as for providing visitors with safe and enjoyable access to the park's resources. The completion and implementation of an Integrated Vegetation Management Plan is urgently needed for the management of the resources at PAAL.

1.4 RELATIONSHIP TO OTHER PLANS AND POLICIES

Approved park plans, legal mandates, and NPS policies provide direction for what should and should not be considered in this plan. Several of the provisions of key legal mandates, related policies, and approved park plans are summarized below:

PALO ALTO BATLEFIELD NHS GENERAL MANAGEMENT PLAN (1998)

The General Management Plan for Palo Alto Battlefield NHS is the umbrella document guiding all resource management and visitor use activities within the park. This document (1) clearly states the parks legislatively mandated missions and (2) identifies the general management prescriptions needed for the various management zones of the park. These management prescriptions include the identification of desired resource conditions and visitor experiences, along with the definition of the kinds of management actions, visitor use and facilities development appropriate to each of the parks' identified management zones.

The GMP identified several statements regarding the integration of cultural and natural resource values that serve to guide vegetation management activities within the park:

- The native plant communities of the site provide a critical setting for interpreting the events of the battle; consequently, restoring the native vegetation would be an important objective for the park.
- The site should be restored to a state in keeping with the historic period.
- Features that interfere or do not contribute to an understanding of historical events should be removed.
- The resources should be managed to provide a visitor experience that would include a quiet and peaceful atmosphere ideal for contemplation and reflection.
- The park should strive to attain a sustainable historic landscape based on natural processes (such as fire) and with minimal need for intrusive methods.
- Restore the historic vegetation patterns while protecting archeological resources.

PALO ALTO BATTLEFIELD NHS RESOURCE MANAGEMENT PLAN (1994)

The resources management plan (RMP) describes the natural and cultural resources of the park, states and evaluates current resources conditions and threats, and prescribes an integrated action program based on legislative and executive mandates, NPS management policies, and other related planning documents. This document serves as a long-term strategic plan for the management of resources located at Palo Alto Battlefield National Historic Site and identifies specific short-term projects to assist in achieving longer-term management goals. Additionally, the park's RMP identifies the following key objective for natural resources management at the Palo Alto Battlefield Unit.

> *To reestablish and promote native plants and animals that contribute to and create the park's historic scene and the natural values of the area while controlling or extirpating exotics species introduced after 1846.*

PALO ALTO BATTLEFIELD NHS CULTURAL LANDSCAPE INVENTORY (2010)

A Cultural Landscape Inventory (CLI) was completed in August of 2010, updating the 1998 CLI. The CLI is an inventory and evaluation of all of the cultural landscapes within the Palo Alto Battlefield Unit's legislative boundary. The purpose is to identify the cultural landscapes within the park unit and to provide information on their location, historical development, character defining features, and management. The CLI is designed to assist managers in planning, programming, and management decisions.

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EXECUTIVE ORDER 13112 OF FEBRUARY 3, 1999 – INVASIVE SPECIES

This act establishes a national Invasive Species Council and identifies specific federal policy that requires the management of invasive, non-native plant and animals by most federal agencies. Invasive species are defined under this executive order as (1) non-native (or alien) to the ecosystem under consideration and (2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

NATIONAL PARK SERVICE MANAGEMENT POLICIES (NPS 2006)

This management policy document sets the framework and provides direction for all management decisions within the NPS. This document establishes the NPS policies for all natural and cultural resource management.

NATIONAL PARK SERVICE NATURAL RESOURCE MANAGEMENT REFERENCE MANUAL #77 (NPS 1991) AND NPS-28, CULTURAL RESOURCE MANAGEMENT GUIDELINES (NPS 1998a)

These service wide guidelines establish the basic principles and objectives for natural and cultural resource management by the NPS and define the steps for developing an ecologically sound and historically sustainable vegetation management program. These documents provide the general guidance for NPS actions proposed under this plan as well as program guidance for future action plans that may be needed to address site-specific vegetation management activities (e.g. detailed restoration/re-vegetation plans).

1.5 IMPACT TOPICS ANALYZED

Impact topics for this project have been identified on the basis of federal laws, regulations, and orders; National Park Service Management Policies (2006); and National Park Service knowledge of resources at Palo Alto Battlefield National Historical Park. Impact topics that are carried forward for further analysis in this environmental assessment are listed below along with the reasons why the topic is further analyzed. For each of these topics, the following text also describes the existing setting or base conditions (i.e. affected environment) within the project area. This information will be used to analyze impacts against the current conditions of the project area in the *Environmental Consequences* chapter.

1.5.1 Cultural Resources

1.5.1.1 Cultural Landscape

Cultural landscape refers to a geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity or person(s), or that exhibits other cultural or aesthetic values (NPS 1998b: 129). ‘Natural features such as landforms, soils, and vegetation are not only part of the cultural landscape, they provide the

framework within which it evolves" (NPS 1998a:Ch7 1). The NPS Management Policies (Section 5.3.5.2, 2006) state that the treatment of a cultural landscape will preserve significant physical attributes, biotic systems, and uses when those uses contribute to the historical significance. The Management Policies go on to state that the treatment decisions will be based on a cultural landscape's historical significance over time, existing conditions, and use. Treatment decisions will consider both the natural and man-made characteristics and features of a landscape, the dynamics inherent in natural processes and continued use, and the concerns of traditionally associated peoples.

The cultural landscape at the Palo Alto Battlefield Unit has been included as an impact topic because it is a primary resource that PAAL is trying to manipulate through the use of vegetation management practices. The cultural landscape of the core battlefield is strongly interrelated with the natural environment. The natural environment played an integral role in the battle, and plays a vital role in contemporary interpretation of the site. The management and restoration of native plant communities at Palo Alto Battlefield would restore the appearance of the site to one more historically representative of the 1846 time period. Consequently it is essential to analyze the impacts on the cultural landscape of the core battlefield from the implementation of the three identified alternatives.

1.5.2 Natural Resources

1.5.2.1 Air Quality

Through its Management Policies, (Section 4.7.1, 2006), the NPS is charged to protect air quality in all park units, and to meet the air quality standards delineated in the Clean Air Act. Since Palo Alto Battlefield is a Class II air quality area, and because prescribed fire has a potential to impact air quality, air quality will be discussed as an impact topic. The proper application of herbicides should mitigate any impacts to air quality from the spray drift or vaporization of herbicides.

1.5.2.2 Water Quality

The NPS is directed to protect surface water, ground water, and wildlife through both the NPS Management Policies (Section 4.6, 2006) and the Clean Water Act. There may be potential for minimal surface water and groundwater contamination due to runoff or drip in areas of herbicide application(s). Water quantity and availability to other plants and wildlife may also be beneficially altered as an effect of vegetation management actions. Therefore, water resources will be considered as an impact topic.

1.5.2.3 Wetlands and Floodplains

Executive Order 11990 *Protection of Wetlands* requires federal agencies to avoid, where possible, adversely impacting wetlands. National Park Service policies for wetlands as stated in 2006 *Management Policies* and Director's Order 77-1 *Wetlands Protection*, strive to prevent the loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. In accordance with DO 77-1 *Wetlands Protection*, proposed actions that have the potential to adversely impact wetlands must be addressed in a statement of findings for wetlands.

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Executive Order 11988 Floodplain Management requires all federal agencies to avoid construction within the 100-year floodplain unless no other practicable alternative exists. The NPS under 2006 Management Policies and Director's Order 77-2 Floodplain Management would strive to preserve floodplain values and minimize hazardous floodplain conditions. According to Director's Order 77-2 Floodplain Management, certain construction within a 100-year floodplain requires preparation of a Statement of Findings for floodplains.

An NPS Statement of Findings for impacts to wetlands or floodplains would not be necessary since neither of the action alternatives would have adverse impacts to wetlands or floodplains. A U.S. Army Corps of Engineers 404 permit will also not be required since none of the actions proposed in any of the management alternatives involve soil removal or the addition of fill material to wetlands.

In addition, NPS and Colorado State University hydrologists in a recently completed study (Cooper 2011) determined that the prairies of Palo Alto should be considered wetlands, despite the severely altered historic hydrologic regime of the Lower Rio Grande Valley. Even though it is beyond the park's ability to fully restore this ecosystem due to regional scale hydrologic alterations, efforts to restore the cultural landscape are essentially practices that are designed to restore the prairie closer to its historical wetland condition. Consequently, impacts to wetlands and floodplains will be considered in the impact analysis.

1.5.2.4 Soils

The NPS Management Policies (2006) state that the National Park Service will strive to understand and preserve the soil resources of park units and to prevent, to the extent possible, the unnatural erosion, physical removal, or contamination of the soil, or its contamination of other resources. The restoration activities put forth in the vegetation management plan have the potential to expose the soils to minor disturbance, and possibly undo compaction. In addition, the use of herbicides has the potential to contaminate soils. Therefore soil resources will be discussed as an impact topic.

1.5.2.5 Vegetation

Section 4.4 of the NPS Management Policies (2006) defines principles for managing plant communities in park units, including the preservation and restoration of natural populations and habitats, restoration of native plant populations and ecosystems, and minimization of human impacts on vegetation. The proposed level and intensity of vegetation management at the Palo Alto Battlefield Unit varies between the three alternatives and, thus, would influence the degree to which the park can to meet these principles and policies. Additionally, there may be short-term negative impacts to vegetation communities from the specific management actions taken to reduce weed densities and/or during removal of invading native woody species. Therefore, impacts to vegetation will be considered in this analysis.

1.5.2.6 Wildlife

Section 4.4 of the NPS Management Policies (2006) also addresses the management, preservation, and restoration of animal populations, habitats, and behaviors. Similar to the

impacts on vegetation at the Palo Alto Battlefield Unit, there may be some short-term impacts to native wildlife species depending on the vegetation management action. In the long term, the restoration of a more natural environment would allow for a more natural and diverse wildlife community. The effects of weed herbicide treatment on wildlife have been well-documented. In general, reported results do not indicate detrimental impacts on wildlife. Given that all alternatives include direct, application of herbicides to a targeted species it is likely that any potential for impacts to wildlife would be negligible. However, due to the potential for short-term minor adverse impacts on some wildlife species or individuals, primarily related to increased noise during non-native and invasive species management activities and restoration activities, wildlife will be considered as an impact topic in this analysis.

1.5.2.7 Natural Sound

Section 4.9 of the NPS Management Policies (2006) states that the NPS "would preserve, to the greatest extent possible, the natural soundscape…[that] is the aggregate of all the natural sounds that occur in parks, together with the physical capacity for transmitting natural sounds." Since restoration of altered landscapes at the Palo Alto Battlefield Unit may include sounds from the use of chainsaws, trucks, or heavy equipment during identified treatment/restoration periods, natural sound will be considered as an impact topic.

1.5.3 Visitor Use

1.5.3.1 Public Health and Safety

Section 8.2.5 of the NPS Management Policies (2006) states that, "the Service and its concessioners, contractors, and cooperators would seek to provide a safe and healthful environment for visitors and employees." Since the management of non-native and invasive species includes alternatives that rely on short-term chemical or mechanical treatment of vegetation, public health and safety will be considered as an impact topic.

1.5.3.2 Visitor Use and Experience

Section 8.2 and Section 7.1 of the NPS Management Policies (2006) define the Service's direction for and commitment to providing enjoyment of park resources for all visitors, and to provide education and interpretation of park resources and the values they represent. Restoration and weed management activities proposed under all alternatives may cause short-term, minor impacts on visitor use by limiting visitor access during restoration and other vegetation management actions. However, the restoration and maintenance of the cultural landscape at the PALO unit, would substantially enhance the visitor experience. Therefore, visitor use will be considered as an impact topic.

1.5.4 Topics Dismissed from Further Analysis

Some impact topics have been dismissed from further consideration, as listed below. The rationale for dismissing these specific topics is stated for each resource.

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1.5.4.1 Archeological Resources

Archaeological surveys have been completed on a 100% of the core battlefield on park owned land (report in production). The vegetation management practices proposed in all three of the alternatives do not involve ground disturbing activities, with the exception of planting gulf cordgrass plugs in the restoration efforts. However, the holes that will be excavated for the cordgrass plugs would be punched into the top 3-4" of soil using a ≤2" diameter soil punch at no less than 1m' intervals. This type of activity has proven to have no effect on the archeological record of a battlefield. Prescribed burning, as well as wildfires, has also proven to have negligible to no effect on battlefield artifacts or the archeological record. Therefore, the topic of Archeological Resources was dismissed from further discussion.

1.5.4.2 Historic Structures

The term "historic structures" refers to both historic and prehistoric structures, which are defined as constructions that shelter any form of human habitation or activity. The Palo Alto Battlefield Unit does not contain any historic structures that are eligible for the National Register of Historic Places. Therefore, the topic of historic structures was dismissed from further consideration.

1.5.4.3 Ethnographic Resources

Ethnographic resources are defined by the National Park Service as a "site, substance, object landscape, or natural resource feature assigned traditional legendary, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it (Director's Order – 28)." The park cannot verify whether or not there are any ethnographic resources, since all the Native American tribes contacted requesting their input into the plan did not respond. Regardless, there are no known ethnographic resources, nor any Native American sites documented within the park. Therefore, the topic of ethnographic resources was dismissed from further consideration.

1.5.4.4 Museum Collections

According to Director's Order 24 Museum Collections, the NPS requires the consideration of impacts on museum collections (historic artifacts, natural specimens, and archival and manuscript material), and provides further policy guidance, standards, and requirements for preserving, protecting, documenting, and providing access to, and use of, NPS museum collections. The proposed vegetation management actions do not affect the museum collections at Palo Alto Battlefield NHP. Therefore, the topic of museum collections was dismissed from further consideration.

1.5.4.5 Prime and Unique Farmlands

All Federal agencies are charged to protect prime and unique farmlands, as directed by the Council on Environmental Quality and the Farmland Protection Policy Act (7 U.S.C. 4201 et seq.). As directed by this Act, Federal programs that contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses would be minimized. According to maps and data from the Natural Resource Conservation Service, U.S. Department of Agriculture,

the neither unit of PAAL is not situated in a part of Texas that contains prime farmland. Furthermore, farmable areas at PAAL would only undergo exotic and invasive vegetation removal and native vegetation restoration under the proposed alternatives. So the proposed actions would not preclude the potential for future agricultural use. Therefore, prime and unique farmland was dismissed as an impact topic in this analysis.

1.5.4.6 Geologic Resources

The NPS Management Policies indicate the protection of geologic and topographic features, and geologic processes in park units. Since proposed restoration actions would have either no impact to geologic resources or beneficial impacts (e.g. restoring natural topography), impacts to the geological resources was dismissed as an impact topic in this analysis.

1.5.4.7 Lightscapes

The NPS Management Policies (2006) directs to service to strive to preserve natural ambient lightscapes, which are natural resources and values that exist in the absence of human-caused light. Vegetation management activities will have no impact on natural lightscapes because all work will occur during daylight hours. Therefore, lightscape, or night sky, was dismissed as an impact topic in this analysis.

1.5.4.8 Environmental Justice

Presidential Executive Order 12898, "General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requires all Federal agencies to incorporate environmental justice into their missions by identifying and addressing the disproportionately high and/or adverse human health of environmental effects of their programs and policies on minorities and low income populations and communities. None of the management alternatives would have disproportionate health or environmental effects on minorities or low-income populations and communities. Therefore, environmental justice was dismissed as an impact topic.

1.5.4.9 Climate Change

Although climatologists are unsure about the long-term results of global climate change, it is clear that the planet is experiencing a warming trend that affects ocean currents, sea levels, polar sea ice, and global weather patterns. Although these changes would likely affect regional precipitation patterns, it would be speculative to predict localized changes in temperature, precipitation, or other weather changes, in part because there are many variables that are not fully understood and there may be variables not currently defined. The management strategies put forth in this vegetation management plan adhere to NPS policies and regulations, and thus strive to have no adverse impact on the environment. Therefore, climate change was dismissed as an impact topic.

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1.5.4.10 Socioeconomics

The proposed action would neither change local and regional land use nor appreciably impact local businesses or other agencies. Implementation of the preferred alternative could provide a minor beneficial impact to the economies of Brownsville, TX as well as Cameron County due to some level of increased visitation at the park through an improvement of visitor use and experience. Because the impacts to the socioeconomic environment would be minor and beneficial, this topic was dismissed.

1.5.4.11 Indian Trust Resources

Secretarial Order 3175 requires that any anticipated impacts to Indian trust resources from a proposed project or action by the Department of Interior agencies be explicitly addressed in environmental documents. The federal Indian trust responsibility is a legally enforceable fiduciary obligation on the part of the United States to protect tribal lands, assets, resources, and treaty rights, and it represents a duty to carry out the mandates of federal law with respect to American Indian and Alaska Native tribes. There are no Indian trust resources at the Palo Alto Battlefield Unit. The lands comprising the Battlefield are not held in trust by the Secretary of the Interior for the benefit of Indians due to their status as Indians. Therefore, the project would have negligible effects on Indian trust resources, and this topic was dismissed as an impact topic.

1.5.4.12 Park Operations

This project would only have negligible effects on the overall park operations at Palo Alto Battlefield. Visitors would be restricted from accessing certain vegetation management units during and immediately following non-native and invasive species management treatments and/or possibly during use of motorized or heavy equipment during restoration activities. However the restoration of the cultural landscape of the core battlefield at Palo Alto will provide interpretive opportunities for the park. Park staff would not experience disruptions of their work except for light to moderate, sporadic noise from chainsaws, trucks, and other equipment during vegetation management activities. Therefore, this topic was dismissed as an impact topic for analysis.

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SECTION 2: MANAGEMENT ALTERNATIVES

2.1 PAAL MANAGEMENT ZONES

Palo Alto Battlefield National Historic Site General Management Plan (1998), which guides all resource management and visitor use activities in the park, delineated the need to implement restorative and maintenance actions to the vegetation resources in order to meet the legislative mandate for returning and maintaining the historic character of the 1846 battle site. In accordance with the 1998 NPS Management Policies; the GMP divided Palo Alto Battlefield NHS into three management zones: Core Battlefield Preservation Zone; Resource Protection Zone; and Development Zone (Figure 5). For the purposes of this vegetation management plan, the recently acquired Resaca de la Palma Battlefield Unit will be treated as the fourth management zone. The following is a brief description of PAAL's management zones:

Core Battlefield Preservation Zone: The Core Battlefield Preservation Zone contains the areas considered to contain significant cultural resources associated with the May 8, 1846 battle. This includes the areas believed to have contained troop movements, support activities, and actual combat, as well as corridors used to and from the battlefield. The management emphasis in this zone is to preserve the historic scene and associated archeological resources. The GMP mandates that the "vegetation and the landscape will be managed to this end, and any modern intrusions removed" (9).

Resource Protection Zone: The Resource Protection Zone contains the areas of the park that are unlikely to contain battle related resources, but possess natural habitat for plant and animal species. The management of the natural environment is the primary focus of this zone, which is intended to serve as a landscape backdrop or buffer for the Core Battlefield Preservation Zone. The management emphasis for this zone is to protect and enhance habitat, do nothing to compromise potential cultural resources, and to allow visitor use and enjoyment of these areas. The GMP directs the park to manage the vegetation to sustain natural communities with minimal requirements for mowing or intervention.

Development Zone: The Development Zone contains the areas of the park that have minimal natural resource value, are unlikely to contain significant cultural resources, and have the physical characteristics (i.e. soils and floodplains) to support development. The management emphasis for this zone is to provide for park development to serve the needs of visitors and park management. The GMP calls for the vegetation to be managed more intensively, and for greater natural resource impacts to be tolerated.

Resaca de la Palma Battlefield Unit: The Resaca de la Palma Battlefield Unit was added to PAAL in 2009 and is not covered by any approved management plan. This 34 acre unit represents only a small portion of the actual May 9, 1846 battlefield. However, it is the only portion that has not been totally lost to urban development. Nevertheless, the archeological and cultural landscape integrity is essentially gone. This area is managed to provide the park with a venue to interface with large groups of the public in a safe environment, while still providing a much needed green space in this urban setting.

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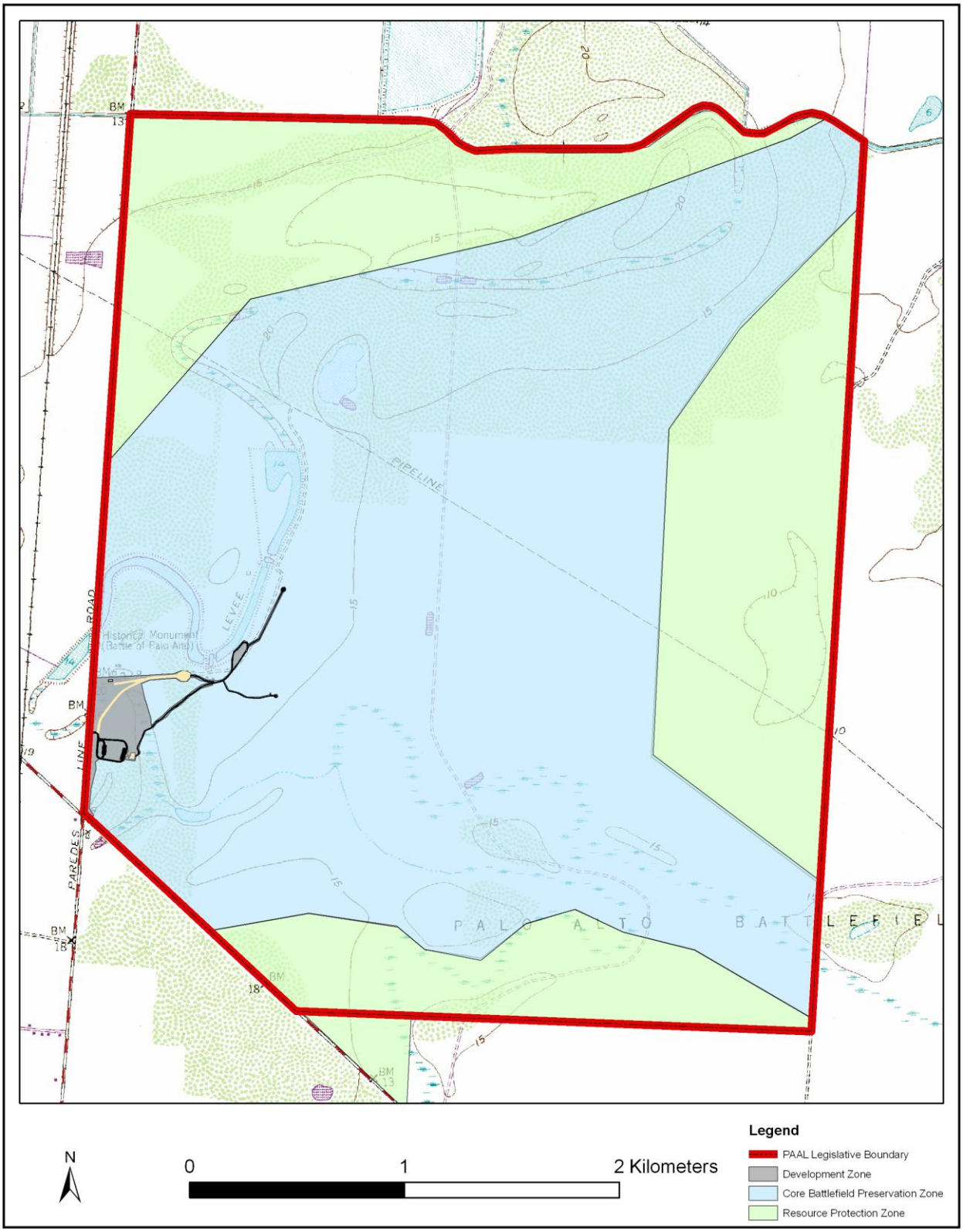

Figure 5. Management Zones at Palo Alto Battlefield Unit, overlaid on USGS 7.5 minute topographic map.

2.2 ALTERNATIVES FOR VEGETATION MANAGEMENT

Vegetation management issues identified to be addressed by the parks vegetation management program include (1) altered cultural landscape restoration and maintenance; (2) visitor access and safety; and (3) exotic plant management.

The scoping process for this Environmental Assessment identified three alternatives for vegetation management at the Palo Alto Battlefield National Historical Park. All three alternatives focus on exotic plant management, and visitor access and safety in all of PAAL's management zones. In the Core Battlefield Preservation Zone each of the alternatives provides some level of altered landscape restoration and maintenance, in addition to exotic plant management and visitor safety. However, the intensity of the restoration actions and the types of methods available for use would vary between the three alternatives, as summarized in Table 2.

PAAL developed the various vegetation management strategies put forth in Alternative B, the preferred alternative, through intensive and extensive collaboration with numerous subject matter experts concluding that this alternative provides the most effective, efficient, and environmentally sensitive long-term means for restoring and maintaining the historic character of Palo Alto for public enjoyment and understanding. Alternative B is designed for a relatively intensive effort of mechanical, chemical, and cultural treatments during the initial stages of implementation, but develops into a less intensive effort, relying largely on the cultural treatment of prescribed fire to maintain the desired condition in the core battlefield of Palo Alto. The key difference between Alternative B and Alternative C is the use of prescribed fire. Alternative C was primarily developed to provide park managers with an alternative that does not use prescribed fire, since it appeared to be the one management strategy that was potentially controversial. However, the amount of effort and funds required to restore and maintain a gulf cordgrass prairie without prescribed fire would be exponentially greater. Furthermore, the use of prescribed fire would reintroduce a natural process to the landscape that has been essentially eliminated by modern cultural activities.

2.2.1 Alternative A – No Action

Current vegetation management would continue without change under the no-action alternative. PAAL would continue to mow and manicure the vegetation immediately around structures, roadways and trails without a systematic plan in place to guide these actions. The park would continue to maintain a "Defensible Space" around structures to protect these assets from wildfire. Hazardous trees will be trimmed or removed when it is determined that they pose a threat to human health and safety. Exotic plant species would be removed/reduced both mechanically and chemically, in coordination with the Gulf Coast Exotic Plant Management Team and following DO 77-7 Integrated Pest Management Program. All other vegetative processes would be allowed to proceed undisturbed. An occasional small-scale restoration project may be implemented.

Under alternative A, the cultural landscape of the Core Battlefield Preservation Zone would remain compromised and continue to degrade, and the park would not meet the legislative mandate of restoring the historical scene of the 1846 battle.

2.2.1.1 Exotic Plant and Weed Management

Exotic plant management actions to date have included the use of mechanical removal techniques (primarily hand removal) and the use of herbicides, primarily related to the eradication or control of federal or state listed noxious weed species and exotic grasses. Herbicide use is currently limited to **Roundup®, Habitat**® and **Garlon 4®. Garlon 4®** is used at PAAL to control the federally listed noxious weed the Mother-of-Thousands. Triclopyr is the active ingredient in **Garlon 4®**. **Habitat**® is used to control exotic grasses. The active ingredient in **Habitat**® is imazapyr. The active ingredient in **Roundup®** is glyphosate, and this chemical is used to control common weeds along the park's roads, parking lots, trails and facilities.

Triclopyr is a selective, systemic herbicide used to control broad leaved plants; it does not affect grass and coniferous trees. It controls weeds by mimicking plant hormones. In soil triclopyr has a half life of 1-90 days, in water the half life is from 1-10 days, and triclopyr has a half life of 3-10 days in plants. To date, Tricopyr has been used exclusively for the treatment of the Mother-of-Thousands plant. The initial infestation of the Mother of Thousands began in the small median of the front parking lot of PAAL's Visitor Center. It soon spread along the margins of the visitor center's entrance/exit road. Park staff has been responsible for treating this highly invasive plant species under the direction and guidance of the Gulf Coast Exotic Plant Management Team Liason and the Regional Integrated Pest Management Coordinator. Currently there are no known live Mother-of-Thousands plants within the park. However the park is continuing to monitor the area that was infested as small clusters of these plants continue to appear from time to time.

Imazapyr is a broad-spectrum systemic herbicide used to control a broad range of plants including terrestrial and aquatic grasses. It prevents synthesis of amino acids to control plant growth. Sunlight rapidly degrades imazapyr: the half life of imazapyr in water is 2 days, and in soil is from 30-155 days. Imazapyr is used exclusively to treat exotic grasses on the core battlefield of Palo Alto when the Gulf Coast Exotic Plant Management Team staff is present at PAAL, which can occur less than once a year.

Glyphosate is a broad-spectrum systemic herbicide with a relatively low toxicity that is used to kill weeds, especially annual broadleaf weeds and grasses. It controls plant growth through the inhibition of enzyme production necessary for critical amino acid formation. Glyphosate bonds very strongly, thus very little leaves the site in runoff or enters groundwater. The half life of glyphosate in soil is 1-174 days. The half life of glyphosate in water is 12-70 days. Glyphosate is used almost exclusively by the park's maintenance staff to control weed and plant growth along the trails, roadways, parking lots, and structures. These treatments occur periodically throughout the year.

A list of weed species currently being managed at the Palo Alto Battlefield Unit, through use of mechanical and chemical treatments, is presented in Table 3. Most non-native plant management efforts have focused on King Ranch bluestem, Kleberg's bluestem, and Mother of Thousands.

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Table 3. Non-native weed species currently managed at the Palo Alto Battlefield Unit.

Bothriochloa ischaemum	King Ranch bluestem
Dichanthium annulatum	Kleberg's bluestem
Dichanthium aristatum	Angleton bluestem
Dichanthium sericeum	Camus silky bluestem
Kalanchoe daigremontiana	Mother of Thousands
Urochloa maxima	Guinea grass

Under Alternative A, management of federal and state listed noxious weeds and the above-listed non-native weed species would continue. Non-native weed management actions would remain limited to mechanical removal techniques or herbicide treatment. PAAL would continue to use the web-based NPS Pesticide Use Proposal System (PUPS), when documenting herbicide use. PUPS is explained in more detail in Section 2.2.2.1

2.2.1.2 Vegetation Monitoring

Currently, vegetation monitoring is limited to predominantly observational assessments with no true quantitative means of assessing and obtaining feedback information on the effects of visitor use and management actions on park vegetation resources. Under Alternative A, no additional vegetation monitoring actions are currently planned.

2.2.2 Elements Common To Both Action Alternatives

Alternative B and Alternative C propose similar vegetation management strategies for the treatment of vegetation in the Development Zone, the Resource Protection Zone, and the Resaca de la Palma Battlefield Unit, as well as the overall strategy for Exotic Plant Management. The primary difference between these two alternatives is the vegetation management tools available for restoring and maintaining the cultural landscape within the Core Battlefield Preservation Zone. This section describes the management actions common to both Alternative B and C, so that the subsequent descriptions of the alternatives can focus on the different management strategies proposed for the Core Battlefield Preservation Zone at PALO.

2.2.2.1 Exotic and Invasive Plant Management

The National Park Service (NPS) Management Policies (2006) define exotic (non-native) species as those occurring outside their native ranges in a given place as a result of actions by humans. This definition allows the National Park Service to distinguish between changes to park resources caused by natural processes, such as natural range expansions and contractions, and those changes caused by humans. This distinction is important because the Park Service, unless stated otherwise in specific park legislation, is required to keep the parks as unaltered by human activities as possible.

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All efforts at controlling exotic plant species would incorporate an Integrated Pest Management (IPM) approach. IPM is a decision making process that provides managers with a framework for controlling exotic or nuisance species of either plant or animals. The following is an example of steps that an IPM process could include for managing exotic plants and noxious weeds:

- Identify species
- Map populations
- Prioritize species by level of threat
- Determine control options for each targeted species
- Determine a treatment strategy and the feasibility of application based upon current research and impact on the human environment
- Implement treatments
- Monitor the effectiveness of the treatment
- Adjust strategy as necessary based on monitoring data and current research

There are four types of control methods that can be employed for managing exotic plant species, as well as managing vegetation resources in general. They are Administrative and Cultural Controls, Mechanical Controls, Chemical Controls, and Biological Controls. The following is a brief description of these control methods.

A. Administrative and Cultural Control Methods

Administrative controls are essentially the development and implementation of policies, procedures, or protocols designed to manage exotic plant species. In accordance with NPS Management Policies (2006) "… high priority would be given to the management of exotic (non-native) species that have a substantial impact on park resources and that can reasonably be expected to be successfully controlled".

Cultural Control: Cultural techniques for managing vegetation consist of actions that managers can take to directly or indirectly impact plant populations. Cultural techniques include livestock grazing, implementation of Best Management Practices, and restoration /re-vegetation. Timing of these controls can be extremely important in determining their effectiveness.

The park would implement "Best Management Practices" that would aid in the prevention and early detection of new weed introductions and that would assist in minimizing spread of existing weed populations.

B. Physical/Mechanical Control

Mowing – Mowing is generally conducted for aesthetic purposes in typically highly visible locations such as along roadways and lawns associated with the visitor–use facilities, or more minimally, in association with park trails and associated structures. In addition to aesthetic purposes, mowing in these areas also reduces fuel heights, thereby reducing the potential for wildfire impacts to structures. Shorter vegetation within these areas also increases visitor safety by increasing visibility of uneven ground surface

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features or dangerous wildlife, such as poisonous snakes. Mowing can be accomplished using all sorts of equipment ranging from a weed-eater to brush-hog.

Chainsaw Removals – Chainsaw use, especially when used in association with chemical treatment of cut stumps to prevent re-sprouting, is the most effective means of treating most non-native or invasive tree species.

Hand-Pulling/Cutting – Several smaller populations of herbaceous weed species within can be controlled through hand-pulling activities, though large infestations are likely to require additional spot-treatments with herbicides. Prickly Pear Cactus can be removed with pitch forks and shovels without disturbing the ground surface.

C. Chemical Control

Chemical control for exotic plant management consists of the use of herbicides to control a specific plant species. The National Park Service has very specific policies on the use of herbicides within National Park units. Use of herbicides is restricted within the NPS and can only be applied under the guidance of a licensed (certified) applicator (park staff or contractor). Parks are required to submit herbicide use requests to regional Integrated Pest Management Coordinators annually delineating all projects anticipated within a park that would require chemical treatment(s). These proposals are reviewed for appropriateness and if approved require park personnel to keep very specific pesticide use logs. When appropriately applied, herbicides are an important and often essential tool within the integrated exotic plant management toolbox.

D. Biological Control

Biological techniques for managing vegetation consist of the deliberate introduction or manipulation of a plant species natural enemy, such as insects or pathogens, in order to remove or reduce populations of that plant species from an area. Timing of these controls can be extremely important in determining the effectiveness.

Table 4 presents a list of known exotic plant species occurring at PAAL. Asterisks indicate federally-listed or state-listed noxious weeds.

Table 4. Known non-native and weed species occurring at PAAL.

Anagallis arvensis	Scarlet pimpernel
Bothriochloa ischaemum	King Ranch bluestem
Chloris canterai	Paraguayan windmill grass
Cynodon dactylon	Bermuda grass
Dichanthium annulatum	Kleberg's bluestem
Dichanthium aristatum	Angleton bluestem
Dichanthium sericeum	Camus silky bluestem

Kalanchoe daigremontiana	Mother of thousands
Kalanchoe delagoensis	Chandelier plant
Leucaena pulverulenta	Great lead tree
Melilotus albus	Yellow sweet clover
Pennisetum ciliare	Buffel grass
Phyla nodiflora	Turkey tangle fogfruit
Sisymbrium irio	London rocket
Sorghum halepense	Johnson grass
**Tamarix aphylla*	Athel tamarisk
Urochloa maxima	Guinea grass
**Urochloa panicoides*	Panic liverseed grass
Verbena brasiliensis	Brazilian vervain
**Schinus terebinthifolius*	Brazilian pepper-tree

PAAL would continue to use the web-based NPS Pesticide Use Proposal System (PUPS), when documenting herbicide use. PUPS is a historical database of a park's control actions, and includes information such as amount of products applied and area treated. Herbicide use in the field would be recorded using a park generated Herbicide Data Form. Information recorded on herbicide use form would include:

- Date and time of application
- Name, location, and estimated area of treatment site
- Brand name of the materials used, including formulation
- US EPA registration number of materials used
- Mix rate of material used
- Amount of material used
- Name and license number of herbicide applicator
- General weather conditions, including wind speed

Annual herbicide use proposals and herbicide use reports would be submitted electronically using PUPS.

2.2.2.2 Resource Protection Zone

For the Resource Protection Zone, the vegetation management strategies proposed in both action alternatives would focus primarily on exotic plant management. Exotic plants will be treated and monitored in coordination with the Gulf Coast Exotic Plant Management Team using an IPM approach. The current natural processes, which are allowing native woody plant species to invade and overtake historic grassland prairies, would be allowed to continue unobstructed. The idea is to let the native brush spread and grow dense in this zone to provide a visual and aural barrier for the Core Battlefield Preservation Zone. In addition, this strategy would provide more Tamaulipan Brush type habitat for native animal species that are experiencing the pressure of encroaching development. This would likely become more important in the years to come.

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2.2.2.3 Development Zone

For the Development Zone, the vegetation management strategies proposed in both action alternatives would focus on visitor safety and access, as well as exotic plant management. Exotic plants would be treated and monitored in coordination with the Gulf Coast Exotic Plant Management Team using an IPM approach. A general herbicide, such as **Roundup®**, would be periodically applied along roadways, trails, and parking lots to prevent the growth of vegetation that could cause structural damage. A three-foot buffer zone would be mowed along trails, roadways and parking lots for visitor safety. Brush would be trimmed back so it would not encroach upon this three-foot buffer zone. Hazardous trees, which could include trees that obstruct the view of traffic or trees and branches that have the potential to cause property damage or bodily injury, would be removed. A "Defensible Space" would be maintained around structures to prevent government asset damage or loss caused by wildfire. The Living History Demonstration Area would be mowed as necessary to allow the park to provide public events in a safe environment. Principally, stands of gulf cordgrass would not be mowed.

2.2.2.4 Resaca de la Palma Battlefield Unit

For the Resaca de la Palma Battlefield Unit, the vegetation management strategies proposed in both action alternatives would focus on visitor safety and access, as well as exotic plant management. Exotic plants would be treated and monitored in coordination with the Gulf Coast Exotic Plant Management Team using an IPM approach. The large open area would continue to be mowed on a regular basis. A general herbicide, such as **Roundup®**, would be periodically applied along roadways, trails, and parking lots to prevent the growth of weeds and grasses that can cause structural damage. Hazardous trees, which could include trees that obstruct the view of traffic or trees and branches that have the potential to cause property damage or bodily harm, would be removed. A "Defensible Space" would be maintained around structures to prevent government asset damage or loss caused by wildfire.

2.2.3 Alternative B – Proactive Vegetation Management

Alternative B would develop a comprehensive and integrated vegetation management program utilizing a full range of mechanical, cultural, chemical, and biological treatments to restore and maintain the cultural landscape in the Core Battlefield Preservation Zone. Alternative B also calls for the development of quantitative and qualitative vegetation monitoring protocols.

This alternative would provide the park with the widest range of tools for achieving stated vegetation management goals and objectives and would result in the greatest level of site restoration in meeting the mandate of the park's enabling legislation. Alternative B serves as the NPS preferred alternative.

2.2.3.1 Cultural Landscape Restoration and Maintenance in the Core Battlefield Preservation Zone

In the Core Battlefield Preservation Zone, PAAL would utilize a full range of vegetation management techniques for restoring and maintaining the cultural landscape. These would

include a combination of mechanical, cultural, chemical and biological controls. This would involve cutting invasive woody vegetation at ground level, immediate herbicide application on tree trunks to kill root balls and limit resprouting, mechanical or manual removal of prickly pear with no ground disturbance, re-introduction of gulf cordgrass, exotic plant management, and cyclical controlled burning to kill woody species and promote grass germination. Save for the re-introduction of gulf cordgrass, any ground disturbing activities would be prohibited due to the sensitive nature of the archeological record of the battlefield. The re-introduction of gulf cordgrass would involve the planting of nursery grown or harvested plugs, and possibly mechanical seeding if the method becomes reliable in the future, into small diameter holes that are punched into the upper 4-5" of soil. Currently there are no biological controls proposed, but PAAL would like to keep this management option available. Plant management efforts may be intensive at first, however, over time, could be reduced chiefly to cyclical burning, in conjunction with exotic plant management.

Prescribed Fire – The use of prescribed fire on native grassland habitats is critical to ensuring long-term stability and health of these areas. In the absence of historic natural fire regimes, prescribed burning is an extremely effective management tool that can help to control weeds and invasive woody species, reduce plant litter, recycle nutrients, and improve the overall health and vigor (e.g. resiliency) of native grassland communities.

The use of prescribed fire is essential to restoration and maintenance of the natural and cultural landscape within the Core Battlefield Preservation Zone at the Palo Alto Battlefield Unit of PAAL. The Vegetation Management Plan is intended to supplement information within the Fire Management Plan, especially issues related to fire effects on vegetation. The park would revise the Fire Management Plan to include prescribed fire, if prescribed fire is approved as a vegetation management tool as a result of this VMP EA. Regardless, the Fire Management Plan should be consulted for a more in-depth review of the NPS mandates and policy related to fire at the Palo Alto Battlefield Unit.

For each planned prescribed burn, a burn prescription plan and a smoke management plan would be developed and approved based on the specific management objectives for the unit(s) being burned. A properly timed prescribed burn can stress many undesirable weed species (e.g. bluestems) while promoting the growth of the desired native plants. However, it should also be noted that fire can also serve to promote certain weed species if not combined with other weed management tools. Fire combined with herbicide treatments is especially effective in controlling many annual weed species. Most weed species produce seed that can remain viable within the soil for many years. The release of nutrients after a fire stimulates the germination of seeds within the soil seed bank, which can then be effectively treated with a single application of herbicide (versus multiple applications without fire due to different seed germination rates). Burning at appropriate intervals can also assist in limiting excessive fuel buildup and reducing the potential for uncontrollable wildfire events.

The lomas, natural levees and other locations within the core battlefield that naturally or historically had woody vegetation would be managed primarily to control and eliminate exotic plant species.

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2.2.3.2 Vegetation Monitoring

Under Alternative B, both qualitative (e.g. photo-stations/repeat photography) and quantitative vegetation monitoring (e.g. nested frequency plots) would be established to provide the park continual feedback on all vegetation and restoration management activities. Specific multi-purpose and targeted vegetation monitoring protocols would be developed and implemented in coordination with the NPS personnel of the Gulf Coast Inventory and Monitoring Network, Gulf Coast Exotic Plant Management Team, and fire ecologists to: (1) define the effectiveness of specific vegetation management treatments, (2) provide early detection of newly invading species, (3) determine fire effects on native and non-native vegetation, and (4) determine cultural landscape restoration success in the core battlefield of Palo Alto.

2.2.4 Alternative C – Improved Vegetation Management

Alternative C would expand vegetation management activities to include mechanical, cultural (excluding the use of prescribed fire), chemical, and biological treatments. In comparison to Alternative A (no-action alternative), vegetation management efforts would be increased in the control of both non-native and invasive species. Efforts to restore the historic coastal prairie would be limited to native seed augmentations, re-introduction of gulf cordgrass, invasive tree and prickly pear cactus removal, and exotic plant management. Limited vegetation monitoring would be implemented to assess basic qualitative "change over time" analyses.

The visual and ecological quality of the site would be improved above the no-action alternative, but the park would struggle to maintain the cultural landscape of the Core Battlefield Preservation Zone at Palo Alto. In other words PAAL would have to expend a far greater effort to maintain the positive results of these vegetation management practices without the use of prescribed fire.

2.2.4.1 Cultural Landscape Restoration and Maintenance in the Core Battlefield Preservation Zone

In the Core Battlefield Preservation Zone, PAAL would utilize a restrictive range of vegetation management techniques for restoring and maintaining the cultural landscape. These would include a combination of administrative, mechanical and chemical controls. This would involve cutting invasive woody vegetation at ground level, immediate herbicide application on tree trunks to kill root balls and limit resprouting, mechanical or manual removal of prickly pear with no ground disturbance, re-introduction of gulf cordgrass, and exotic plant management. Save for the re-introduction of the gulf cordgrass, any ground disturbing activities would be prohibited due to the sensitive nature of the archeological record of the battlefield. The re-introduction of the gulf cordgrass would involve the planting of nursery grown or harvested plugs, and possibly mechanical seeding if the method becomes reliable in the future, into small diameter holes that are punched into the upper 4-5" of soil. Currently there are no biological controls proposed, but PAAL would like to keep this management option available. Plant management efforts would remain intensive over time in order to maintain the desired condition of the Core Battlefield Preservation Zone.

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2.2.4.2 Vegetation Monitoring

Vegetation monitoring would be implemented, but would remain limited to more basic qualitative "change over time" analyses (e.g. establishment of photo-stations and repeat photography). No quantitative monitoring would be established to address (1) the effectiveness of vegetation management treatments, (2) early detection of newly invading species, (3) determine cultural landscape restoration success in the core battlefield of Palo Alto.

2.3 Mitigation Measures Common to All Alternatives

Since all of the proposed alternatives include the use of chemical herbicides, clearing of brush, and other potentially hazardous operations; mitigation measures are necessary to ensure the health of staff, contractors, and visitors, as well as providing for the protection of cultural and natural resources in the park. PAAL has developed and will adhere to the following Best Management Practices in an effort to mitigate the risks, hazards, and potential negative environmental impacts associated with the implementation of the proposed alternatives.

2.3.1 Best Management Practices

General Best Management Practices include:

- Vehicles and equipment would use existing roads and trails to the maximum extent practical.
- The "Minimum Tool" required to get the task completed efficiently would be used.
- Follow Integrated Pest Management process in regard to "need" to use herbicide, "type" of herbicide, "amount" of herbicide to use, "when" to apply, and "how" to apply.
- Herbicides would be applied according to application rates specified on the product label.
- PAAL would not purchase more herbicide than it plans or could use in a year.
- Use of equipment in high visibility areas would be avoided to the extent feasible.
- PAAL would utilize highly experienced and environmentally sensitive personnel to carry out the prescribed burn events by partnering with the local U.S. Fish and Wildlife Fire Crews and Biologists.

2.3.1.1 Human Health and Safety

- Job Hazard Analysis (JHA) would be completed for all tasks.
- A Green/Amber/Red (GAR) risk assessment would be completed prior to the initiation of any tasks.
- These safety documents, as well as all Standard Operating Procedures (SOP) and an Accident Plan would be reviewed and revised if necessary by all staff, contractors, or volunteers at a project orientation meeting prior to any fieldwork.
- Regularly scheduled tail-gate safety meetings would be conducted.
- Safety protocols for storing, mixing, transporting, handling spills, and disposing of unused herbicides and containers would be developed and followed.

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- Herbicide applications would only be applied by personnel trained and supervised by a park approved person.
- All herbicide labels would be followed to ensure proper application is used in a safe manner.
- Park staff would keep all park visitors informed of daily work schedules and treatment locations.
- Visitors would not be allowed in treatment areas during the treatment process.
- Park trails will be closed during prescribed fire treatment events.
- Signs will be posted to inform visitors of chemically treated areas.
- All federal, state, and local regulations regarding herbicide use would be followed at all times.
- Prescribed fire events would only be carried out during periods of suitable meteorological conditions and with an approved smoke management plan.

2.3.1.2 Cultural Resources

- Management actions would take place on previously archeologically surveyed areas.
- Ground disturbing activities will be prohibited, except for the planting of gulf cordgrass.
- No work would be carried out when ground conditions are damp.
- After prescribed fire events, the site would be closely monitored to ensure that trespassers are not looting the site.
- All work performed would be coordinated with and monitored by the park's cultural resource staff.
- Equipment used for re-vegetation and restoration actions would be evaluated and chosen with regards the effectiveness for accomplishing the tasks, while causing the least amount of impacts to cultural resources.
- Tree felling, removals, and herbicide applications would be made by trained personnel only. Trees would be cut as close to the ground as possible and herbicide applied directly to the fresh cut stump.
- If new or unexpected cultural resources are identified within the treatment area, all work would be halted immediately until appropriate investigation and/or documentation can be made.

2.3.1.3 Water Resources

- No herbicide application would be made within 24 hours of an expected rain event to minimize any potential for herbicide "wash-off" into surface and/or ground water.
- All precautions would be taken to ensure that herbicide applications are direct to the targeted plants and with the minimization of any potential for herbicide overspray.
- Only herbicides that are registered for use in or near water will be used in those areas.
- Herbicides with high soil retention would be used in areas where there is potential to affect surface water or ground water resources.
- Highly water-soluble herbicides would not be used in areas where there is potential to affect surface water or ground water resources.

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- Herbicide pH and soil pH would be considered to select the herbicide with the lowest leaching potential, in areas where there is the potential to affect surface water or ground water resources.

2.3.1.4 Air Resources

- Herbicides would only be applied under conditions of little to no wind and under the appropriate air temperature regimes to minimize potential for air resource impacts as a result of undesired herbicide overspray and/or volatilization.
- Herbicides would be applied using coarse sprays to minimize the potential for drift. Avoid combinations of pressure and nozzle type that would result in fine particles (mist). Add thickeners if the product label permits.
- Prescribed fire events would only be carried out during periods of suitable meteorological conditions with an approved smoke management plan as required.

2.3.1.5 Soils

- No herbicide application would be made within 24 hours of an expected rain event to minimize any potential for herbicide "wash-off" onto the ground surface.
- Ground disturbing activities are prohibited with all proposed treatment activities, save for the planting of gulf cordgrass plugs.
- All precautions would be taken to ensure that herbicide applications are direct to the targeted plants and with the minimization of any potential for herbicide overspray.
- Herbicide applications would only be applied by personnel trained and supervised by a state licensed applicator.
- Damage to soils will be minimized by using existing access routes to the extent possible.
- Herbicides with longer persistence would be applied at lower concentrations and with less frequency to limit the potential for accumulation of herbicides in the soils.

2.3.1.6 Vegetation

- All herbicide applications would be applied by appropriately trained personnel and under appropriate environmental conditions as specified on the MSL.
- All herbicide application equipment (such as hand and backpack sprayers) would be checked daily to ensure proper functioning condition prior to use.
- The limits of weed management and restoration activities would be clearly defined to minimize any adverse effects to native vegetation.
- All re-vegetation/restoration projects at the park would use weed-free topsoil, seed, and mulch materials.
- All equipment used within the park will be cleaned to remove all remnants of exotic plant materials (this includes park mowers that are used to cut exotic grasses at REPA or along the highway at PALO) prior to being used within the park.
- All seed mixtures used for re-vegetation/restoration activities would be based on native genotypes from as local of source as is possible. All seed mixtures must be appropriately certified (tagged) and would be inspected (to ensure appropriate mixture and absence of weed seed) prior to planting by park resource management staff.

- All straw mulches and/or organic forms of erosion control used at the park would be certified weed-free.
- Annual follow-up monitoring for weed presences of all re-vegetated/restored areas would be conducted following completions of re-vegetation activities.
- Any new noxious weed species found on site would be controlled or eradicated immediately to prevent further spread.
- No non-native plant species with potential for spread would be introduced into park landscaping as per NPS Management Policies (2006).

2.3.1.7 Wildlife

- Treatment sites would be walked through prior to treatment initiation to assist in minimizing wildlife presence during treatment activities.
- All herbicide use would be limited to the minimal application needed to obtain management objectives and applied only under the appropriate environmental conditions.
- All efforts would be made to minimize implementation of treatment actions during sensitive wildlife breeding/nesting seasons.
- Noise levels associated with loud equipment use would be minimized to only the timeframe(s) necessary to accomplish identified vegetation management actions.

2.4 Other Action Alternatives/Actions Considered But Dismissed From Consideration

2.4.1 Allow Full-Time Grazing of Livestock on the Site

While it is recognized that short-term (7-10 day), managed grazing can serve as a beneficial management tool for weed and native prairie restoration (Menke, 1992), full-time grazing within the Palo Alto Battlefield Unit NHS would likely result in further degradation to park vegetation resources, especially within the riparian corridor. Additionally, full-time grazing would require the construction of permanent fencing to contain livestock and to ensure public safety. This would create further visual intrusions onto the cultural landscape of the park and significantly jeopardize the restoration of desired native plant biological diversity and community types. The existing park staff is small and would not adequately allow for the additional oversight responsibilities associated with managing, monitoring, and mitigating full-time grazing issues. Therefore, full-time grazing/livestock use has been dismissed as a potential action alternative.

2.4.2 Develop an Alternative That Considers All Treatments Except Chemical Treatments

Developing an management alternative that considers all treatments except chemical treatments was considered, but was eliminated from further analysis because of the efficiency and efficacy of chemicals for managing vegetation resources. Also, the use of chemical treatments may be restricted or avoided, as necessary, to protect resources under Alternatives B and C. NPS Management Policies (2006) states, “Exotic species will not be allowed to displace native species if displacement can be prevented.” In some

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instances, chemical treatment may be the only feasible method available for reducing the threat of exotic plants to environmental and cultural resources. According to NPS Management Policies, the use of herbicides is to be considered only when "all other available options are either not acceptable or not feasible." Because IPM applies a holistic approach to exotic plant management decision-making, it takes advantage of all appropriate exotic plant management tools, which may include, but is not limited to, herbicides (McCrea and DiSalvo 2001:394).

2.5 Alternative Summaries

Table 1 summarizes the major components of the three alternatives and compares the ability of these alternatives to meet the project objectives, as defined in Section 1.2 of this plan. As illustrated in the following table, Alternative B is the alternative that most fully and efficiently addresses the project objectives.

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Table 1. Alternatives Summary and Extent to Which Each Alternative Meets Project Objectives.

	Alternative A - No Action	Alternative B – Initiate Proactive Vegetation Management Program	Alternative C – Improved Vegetation Management
Summary of Proposed Actions	Under the no action alternative, current vegetation management practices would continue without a systematic plan in place to guide these actions. These management activities would remain limited and focused on listed noxious weed and exotic plant species, relying largely on the support of regional Exotic Plant Management personnel. Routine maintenance of vegetation for visitor safety and access in the developed areas would continue. The current vegetation management program is not fully developed to include prevention and early detection methodologies for exotic species. Altered landscape restoration actions would remain limited and would not eliminate or improve visual intrusions on the cultural landscape of the core battlefield at Palo Alto.	Under Alternative B, a comprehensive and integrated vegetation management program would be developed utilizing a full range of mechanical, cultural (including the use of prescribed fire), chemical, and biological treatments to restore and maintain the cultural landscape in the core battlefield area at Palo Alto. This alternative would also manage the vegetation in the other areas of the park in an effort to enhance and maintain visitor access and safety, as well as maximize native biodiversity. Specific multi-purpose and targeted vegetation monitoring protocols would be developed and implemented in coordination with the NPS personnel of the Gulf Coast Inventory and Monitoring Network, Gulf Coast Exotic Plant Management Team, and fire ecologists to: (1) define the effectiveness of specific vegetation management treatments, (2) provide early detection of newly invading species, (3) determine fire effects on native and non-native vegetation, and (4) measure cultural landscape restoration success in the core battlefield of Palo Alto.	Under Alternative C, vegetation management practices would be expanded to include mechanical, cultural (excluding the use of prescribed fire), chemical, and biological treatments. Efforts to restore and maintain the historic coastal prairie of the core battlefield at Palo Alto would be limited to native seed augmentation, native gulf cordgrass planting, and non-native and invading native plant removals. Limited vegetation monitoring would be implemented to assess basic qualitative "change over time" analyses. The visual and ecological quality of the site would be improved above the no-action condition, but the park would have to sustain an intense level of effort in order to maintain the restored cultural landscape at Palo Alto.
Does This Alternative Allow PAAL to Restore and Maintain	No. This alternative would not allow PAAL to meet the mandate of restoring and maintaining the cultural	Yes. This alternative provides PAAL with the widest range of tools for restoring and maintaining the cultural landscape on the core battlefield at Palo Alto. The use of	Yes, to a certain degree. This alternative provides PAAL with a range of tools for restoring the cultural landscape on the core

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the Cultural Landscape on the Core Battlefield at Palo Alto?	landscape on the core battlefield at Palo Alto. This alternative would eventually allow woody vegetation to overtake the historic coastal prairie, destroying the historic character of the core battlefield.	prescribed fire and the development of structured monitoring protocols would provide the park with the most efficient and environmentally sensitive means for maintaining the restored landscape of the core battlefield.	battlefield at Palo Alto. However the park would have to sustain an intense effort in perpetuity to maintain the restored landscape of the core battlefield.
Does the Alternative Allow PAAL to Control the Presence of Exotic Plants within the Park?	No. This alternative does not provide PAAL with a long-term, systematic approach for controlling, with the goal of eliminating, exotic plants within the park. This alternative does not provide any prevention or early detection methodologies for exotic plant species.	Yes. This alternative provides PAAL with best tools for controlling, with the goal of eliminating, exotic plants within the park. The development of structured monitoring protocols would provide the park with the best chances of preventing the spread and reducing the presence of exotic plants within the park.	Yes, to a certain degree. This alternative provides PAAL with tools for controlling, with the goal of eliminating, exotic plants within the park. However without the development of structured monitoring protocols, early detection and prevention of the spread of exotic plants would be limited.
Does the Alternative Allow PAAL to Provide Visitors with Safe and Enjoyable Access to the Resources the Park is Charged with Preserving and Interpreting?	Yes and No. This alternative allows PAAL to provide visitors with safe access to the resources the park is charged with preserving through the continued maintenance of the vegetation along the roadways, trails and facilities. However since the historic character of Palo Alto would be destroyed and exotic plants would not be controlled throughout the park, visitors would not be able to connect to the resources the park is charged with preserving. Therefore, the visitor experience would not be	Yes. This alternative provides PAAL with the best tools for providing visitors with safe and enjoyable access to the resources the park is charged with preserving and interpreting. The continued maintenance of the vegetation along roadways, trails and facilities would allow visitors safe access to these resources. While a maintained restored cultural landscape on the core battlefield at Palo Alto and the control of exotic plants throughout the park would provide the visitor with better opportunities to connect to these resources. Furthermore, since this alternative would require less intensive management actions to maintain the restored cultural landscape on the core	Yes, to a certain degree. This alternative provides PAAL with tools for providing visitors with safe and enjoyable access to the resources the park is charged with preserving and interpreting. The continued maintenance of the vegetation along roadways, trails and facilities would allow visitors safe access to these resources. While a maintained restored cultural landscape on the core battlefield at Palo Alto and a limited control of exotic plants throughout the park would provide the visitor with better opportunities

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	as enjoyable as intended by the park's establishing legislation.	battlefield of Palo Alto as time goes on, the visitor experience would be less interrupted and consequently more enjoyable.	to connect to these resources. However, since this alternative would require a continued intensive effort to maintain the restored landscape on the core battlefield of Palo Alto, the visitor experience would be more frequently interrupted and therefore less enjoyable.

Table 2 summarizes the anticipated environmental impacts for the three alternatives. Only those impact topics that have been carried forward for further analysis are included in this table. The *Effected Environment and the Environmental Consequences* chapter provides a more detailed explanation of these impacts.

Table 2. Environmental Impact Summary by Alternative.

Impact Topic	Alternative A - No Action	Alternative B – Initiate Proactive Vegetation Management Program	Alternative C – Improved Vegetation Management
Cultural Landscape	Alternative A would have the most long-term, moderate adverse impacts on the cultural landscape at Palo Alto of the three alternatives considered. With this No Action alternative, prickly pear cactus and woody vegetation would continue to invade and overtake the open grassland prairie. The cumulative effect of this alternative on the cultural	The impacts associated with the implementation of the vegetation management strategies proposed in Alternative B would have a direct, site-specific, long-term, moderate beneficial impact on the cultural landscape of the core battlefield at Palo Alto. The use of prescribed fire adds a principal advantage to Alternative B because it is the one management practice that can maintain and enhance the beneficial	The impacts associated with the implementation of the vegetation management strategies proposed in Alternative C would have a direct site-specific long-term moderate beneficial impact on the cultural landscape of the core battlefield at Palo Alto. However, Alternative C requires an increased and continual effort to maintain the improved condition of the core battlefield without the

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	landscape of the battlefield would be to move the condition of the cultural landscape further and further away from the desired condition.	results of the other management practices on the cultural landscape of the core battlefield with relatively minor effort. Consequently Alternative B is the only alternative that provides PAAL with the ability to efficiently and effectively restore and maintain the cultural landscape of the core battlefield to its desired condition.	use of prescribed fire. Since Alternative C does require a much more intense and continuing effort to maintain an improved cultural landscape it could be considered to be more of an intrusion on the landscape than Alternative B.
Air Quality	The impacts associated with the implementation of the vegetation management strategies proposed in Alternative A would have a direct, site-specific, short-term, negligible adverse impact. Overall it appears that any measurable long-term impacts to the air quality at the park will come from external sources that the park will have no control over. There is a possibility that the air quality at the PALO unit may degrade over time with the increase in industrial development and vehicular traffic.	The impacts associated with the implementation of the vegetation management strategies proposed in Alternative B would have a direct, site-specific, short-term, minor adverse impact on the air quality at PAAL. Even though Alternative B includes prescribed fire, these burn events would be brief, occur annually at first and then spread out to possibly once every five years. Nevertheless, it appears that any measurable long-term impacts to the air quality at the park will come from external sources that the park will have no control over.	The impacts associated with the implementation of the vegetation management strategies proposed in Alternative C would have a direct, site-specific, short-term, negligible adverse impact on air quality. It appears that any measurable long-term impacts to the air quality at the park will come from external sources that the park will have no control over.

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Water Quality	The potential impacts associated with the implementation of the vegetation management strategies proposed in Alternative A would have a direct, local, short-term, negligible adverse impact on the water quality of the water resources at the REPA unit. There is essentially no potential to impact the water quality of the water resources at the PALO unit by implementing the vegetation management strategies proposed in Alternative A.	The potential impacts associated with the implementation of the vegetation management strategies proposed in Alternative B would have a direct, local, short-term, negligible adverse impact on the water quality of the water resources at the REPA unit. There is essentially no potential to impact the water quality of the water resources at the PALO unit by implementing the vegetation management strategies proposed in Alternative B, even though chemical treatments would increase.	The potential impacts associated with the implementation of the vegetation management strategies proposed in Alternative C would have a direct, local, short-term, negligible adverse impact on the water quality of the water resources at the REPA unit. There is essentially no potential to impact the water quality of the water resources at the PALO unit by implementing the vegetation management strategies proposed in Alternative C, even though chemical treatments would increase.
Wetlands and Floodplains	Alternative A would have the most long-term, moderate adverse impacts on the historic coastal floodplain and wetlands at Palo Alto of the three alternatives considered. With this "No Action" alternative, prickly pear cactus and woody vegetation would continue to invade and overtake the open grassland prairie. The cumulative effect of this	The potential impacts to the floodplain and wetland prairie at Palo Alto associated with the implementation of the vegetation management strategies proposed in Alternative B would be direct, site-specific, short to long-term, moderate beneficial impacts. The management actions proposed in Alternative B move the floodplain and wetland prairie on the core battlefield at Palo Alto closer and closer towards their	The potential impacts associated with the implementation of the vegetation management strategies proposed in Alternative C would have a direct, site-specific, short to long-term, moderate beneficial impact on the floodplain and wetland prairie at Palo Alto. The management actions proposed in Alternative C move the floodplain and wetland prairie on the core battlefield at Palo Alto closer and

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	alternative on the floodplain and wetland resources of the battlefield would be to move the condition of these resources further and further away from their pre-disturbance functioning condition.	historic and functioning conditions. This environmentally preferred alternative carries this out with a more intensive effort upfront, and then with a reduced effort, relying largely on prescribed fire to maintain the desired condition.	closer towards their historic and functioning conditions. However, the management strategies proposed in Alternative C call for a continued intensive effort of mechanical and chemical treatments to control the presence of native woody and cactai species on the core battlefield since prescribed fire is not allowed. The inability to use prescribed fire may also serve to indirectly slow the process of the gulf cordgrass dominating the prairie.
Soils	The potential impacts associated with the implementation of the vegetation management strategies proposed in Alternative A would have a direct, site-specific, short-term, negligible adverse impact on the soils at both park units. Chemical contamination and inadvertent compaction are the greatest risks to these soils from the proposed management actions.	The potential impacts to the soils at PAAL associated with the implementation of the vegetation management strategies proposed in Alternative B would be the same as Alternative A for the areas of the park outside of the core battlefield at PALO. However, the management actions proposed in Alternative B are designed to restore and maintain the historic plant communities of the wetland prairie on the core battlefield of PALO. This would serve to move	The potential impacts associated with the implementation of the vegetation management strategies proposed in Alternative C would be the same as Alternative A and B for the areas of the park outside of the core battlefield at PALO. However, the management actions proposed in Alternative C would strive to restore and maintain the historic plant communities of the wetland prairie on the core battlefield of PALO. This would

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		the soil development process closer to its natural state. In addition, prescribed fires would deposit a layer of freshly burned organic material, thus increasing the nutrient availability in the soils. The use of prescribed fire would also decrease the amount of effort and intensity needed to maintain this condition.	serve to move the soil development process closer to its natural state. Although, without the use of prescribed fire, the process of reestablishing the natural state may take longer to achieve and the amount of effort to maintain this state would increase.
Vegetation	Selection of Alternative A would have long-term moderate adverse impact on the distribution of native vegetation communities at Palo Alto.	Selection of Alternative B would have long-term moderate beneficial impact on the preservation and distribution of native vegetation communities at Palo Alto.	Selection of Alternative C would have long-term negligible beneficial impact on the distribution of native vegetation communities at Palo Alto.
Wildlife	Selection of Alternative A would definitely have a negative impact on the preferred habit type for the one confirmed T&E animal species at Palo Alto, the northern Aplomado falcon. Alternative A might increase the amount of woody habitat for the other T&E animal species. However the density and biodiversity may never reach the level to be considered optimal habitat for these species. Furthermore, this emerging	Selection of Alternative B would gradually move the park towards the natural ecosystem and enhance the native biodiversity at Palo Alto. This would be a moderate benefit to the native wildlife species that inhabit the coastal prairie habitat and would definitely benefit the one confirmed T&E species at Palo Alto. The reintroduction of a fire regime to the ecosystem should not have any adverse impacts to the native wildlife of the park.	Selection of Alternative C would have a long-term minor adverse impact on native wildlife species, including the northern Aplomado falcon because of the increased and sustained amount of human presence and activity needed to maintain the restored landscape.

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	habitat would be overtaking native coastal grassland prairies and changing the natural ecosystem of the area and consequently negatively impacting the native biodiversity of the region. In conclusion, the overall impact of Alternative A on the native wildlife would be negative.		
Natural Sound	The potential impacts associated with the implementation of the vegetation management strategies proposed in Alternative A would have a direct, site-specific, short-term, minor adverse impact on the natural sound at both park units. The selection of Alternative A would not improve or degrade the natural sound at REPA, but would have occasional minor impacts. Conversely, this "No Action" alternative would allow woody vegetation to continue to invade and overtake the historic wetland prairies, ultimately changing the natural sound at	Alternative B is designed to restore the natural environment within the Core Battlefield Preservation Zone at PALO to its mid-nineteenth century conditions, which provides the best opportunity for replicating the natural sounds of Palo Alto prior to the modern aural intrusions. Vegetation management treatments proposed in Alternative B would have some direct adverse impacts to the natural sound at PALO, however, these would last only during the implementation of the treatments. The end result would be vegetation communities that more closely resemble the natural vegetation communities, thus improving the natural sound of the site	Alternative C is designed to restore the natural environment within the Core Battlefield Preservation Zone at PALO to its mid-nineteenth century conditions, which provides the opportunity for replicating the natural sounds of Palo Alto prior to the modern aural intrusions. Vegetation management treatments proposed in Alternative C would have some direct adverse impacts to the natural sound at PALO, however, these would last only during the implementation of the treatments. The end result would be vegetation communities that more closely resemble the

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	PALO.	within the core battlefield area. Furthermore, use of prescribed fire in Alternative B should allow PAAL maintain this restored natural environment with less effort than the Alternative C.	natural vegetation communities, thus improving the natural sound of the site within the core battlefield area. However, since prescribed fire is not allowed in Alternative C, PAAL would have to maintain a continual effort of mechanical treatments to keep invasive woody and cactus vegetation off the core battlefield, which would have continual short-term adverse impacts to the natural sound at PALO.
Human Health and Safety	The impacts to human health and safety by the implementation of the vegetation management strategies in Alternative A can be mitigated by strict adherence to the BMPs. Primarily, only the personnel carrying-out these treatments are at risks. Proper training, supervision, use of PPE, and a culture of safety should prevent accidents. If the BMPs are adhered to, the potential impacts to human health and safety should be	The impacts to human health and safety by the implementation of the vegetation management strategies in Alternative B can be mitigated by strict adherence to established BMPs. Primarily, only the personnel carrying-out these treatments are at risks. Proper training, supervision, use of PPE, and a culture of safety should prevent accidents. Although increased and intensive management activity will occur at first, the public will not be allowed in or around treatment areas.	The impacts to human health and safety by the implementation of the vegetation management strategies in Alternative C can be mitigated by strict adherence to established BMPs. Primarily, only the personnel carrying-out these treatments are at risks. Proper training, supervision, use of PPE, and a culture of safety should prevent accidents. Although increased and intensive management activity will be sustained, the public will not be allowed in or around treatment

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	reduce to inadvertent insect stings or minor scratches from vegetation.		areas.
Visitor Use and Experience	Alternative A would have most long-term, moderate adverse impacts on the cultural landscape at Palo Alto of the three alternatives considered. With this No Action alternative, prickly pear cactus and woody vegetation would continue to invade and overtake the open grassland prairie. The cumulative effect of this alternative on the cultural landscape of the core battlefield at PALO would be to move the condition of the cultural landscape further and further away from the desired condition.	The implementation of the vegetation management strategies prescribed in Alternative B would have temporary, negligible adverse impacts on the visitor use patterns at PAAL, while having a long-term, moderate beneficial impact on the visitor experience at the core battlefield of PALO. Alternative B provides PAAL with the most efficient and effective strategy for restoring and maintaining the historic character of the core battlefield of Palo Alto, which allows the park visitors the best opportunity to view the landscape of the core battlefield as looked in 1846, with the least amount of impacts to their experience and access, as well as to the environment.	The implementation of the vegetation management strategies prescribed in Alternative C would have temporary, negligible adverse impacts on the visitor use patterns at PAAL, while having a long-term, moderate beneficial impact on the visitor experience at the core battlefield of PALO. However, since this alternative does not allow for prescribed fire, it would require the park to sustain an increased effort to maintain the historic character of PALO, which would have increased direct, temporary adverse impacts to visitor use and access, as well as possibly have temporary adverse impacts to the visitor experience.

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2.6 Environmentally Preferable Alternative

According to the Council on Environmental Quality (CEQ) regulations implementing NEPA (43 CFR 46.30), the environmentally preferable alternative is the alternative "that causes the least damage to the biological and physical environment and best protects, preserves, and enhances cultural, and natural resources. The environmentally preferable alternative is identified upon consideration and weighing by the Responsible Official of long-term environmental impacts against short-term impacts in evaluating what is the best protection of these resources. In some situations, such as when different alternatives impact different resources to different degrees, there may be more than one environmentally preferable alternative."

The environmentally preferable alternative for vegetation management at the Palo Alto Battlefield National Historical Park is Alternative B. This alternative meets all of the above criteria for the environmentally preferred alternative, with the least amount of environmental effects on the natural and human environment at the Palo Alto Battlefield Unit. Although the types of herbicide used by the park would be expanded under this alternative, the targeted use of more species-specific herbicides would increase effectiveness of chemical weed management actions and reduce the numbers of herbicide applications needed to achieve non-native plant control. Restoration actions defined under alternative B would provide the park with the widest range of vegetation management tools and provide the greatest ability for the park to meet the legislated mandate of restoring the natural and cultural landscape associated with the 1846 battle. Alternative B is designed to utilize a full battery of vegetation management techniques to move the Core Battlefield Preservation Zone towards its desired condition at the beginning of the implementation process. As the desired condition is achieved, the amount of effort and the number of management techniques should be reduced significantly and the cultural landscape maintained primarily through cyclical prescribed fire and monitoring.

The no-action alternative, Alternative A, does not meet most of the above criteria for the environmentally preferred alternative. To begin with, Alternative A does not allow PAAL to adequately meet the objects of protecting, preserving and enhancing the natural and cultural resources. The no-action alternative would allow for continued non-native plant infestation and/or expansion, causing continued degradation of the natural resources and the cultural landscape at the park.

Alternative C, improved vegetation management, meets most of the above criteria for a possible environmentally preferred alternative. However, when compared to Alternative B, the effects of this alternative tend to be slightly less environmentally sound than Alternative B. This is primarily due to that fact that Alternative C would require a sustained amount of intensive effort to maintain the cultural landscape within the Core Battlefield Preservation Zone without the use of prescribed fire. This sustained intensive effort would continue to have impacts on the park resources. Therefore, Alternative C has not been selected as the environmentally preferred alternative.

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SECTION 3: AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter describes the affected environment (existing setting or baseline conditions) and analyzes the potential environmental consequences (impacts or effects) that would occur as a result of the implementation of the proposed vegetation management techniques put forth in each alternative. Direct, indirect, and cumulative effects are analyzed for each resource topic carried forward. Potential impacts are described in terms of type, context, duration, and intensity. General definitions are defined as follows, while more specific impact thresholds are given for each resource at the beginning of each resource section.

- **Type** describes the classification of the impact as either beneficial or adverse, direct or indirect:
  - *Beneficial*: A positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.
  - *Adverse*: A change that moves the resource away from a desired condition or detracts from its appearance or condition.
  - *Direct*: An effect that is caused by an action and occurs in the same time and place.
  - *Indirect*: An effect that is caused by an action but is later in time or farther removed in distance, but is still reasonably foreseeable.
- **Context** describes the area or location in which the impact would occur. Effects may be site-specific, local, regional, or even broader.
- **Duration** describes the length of time an effect would occur, either short-term or long-term:
  - *Short-term* impacts generally last only during the implementation of vegetation management activities, and the resources resume their prior conditions following the implementation of the management activity.
  - *Long-term* impacts last beyond the implementation of vegetation management activities, and the resources may not resume their prior conditions for a longer period of time following the implementation of the management activity.
- **Intensity** describes the degree, level, or strength of an impact. For this analysis, intensity has been categorized into negligible, minor, moderate, and major. Because definitions of intensity vary by resource topic, intensity definitions are provided separately for each impact topic analyzed in this EA.

Cumulative Impact Scenario

The CEQ regulations which implement NEPA require assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined 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" (40 CFR 1508.7). Cumulative impacts can

result from individually minor but collectively significant actions taking place over a period of time. Both additive and interactive cumulative impacts are assessed. Additive impacts accumulate by adding more of the same impact on a resource. For example, the establishment of a single non-surfaced back country access road may be of little significance, but the establishment of numerous such roads may cause significant impacts to a variety of resources. Interactive impacts accrue as a result of assorted similar and dissimilar actions being taken that tend to have similar impacts, relevant to the valued resource in question. Examples of interactive impacts could include mowing non-surfaced back country access roads with equipment that has not been decontaminated for exotic grass seeds, plus allowing adjacent land owners to pass their domesticated livestock, which feed on exotic grasses, through the park on these roads. These dissimilar actions would combine to increase the introduction and spread of exotic grasses in the park.

The geographic area of influence for cumulative impacts varies according to the resource. The geographic areas for the cumulative impact analysis were defined as follows:

- Soils, wetlands, and floodplains were defined as land inside the park unit boundaries and lands immediately adjacent to the park boundaries.
- Water resources are defined as the regional watershed.
- Air quality was defined as the regional air shed.
- Biological resources, including vegetation, wildlife and T&E species were limited to cumulative effects within the range of each species.
- Cultural landscapes are defined as landscapes inside the park unit boundaries.
- Human health and safety and visitor use and experience were defined as experience inside the park unit boundaries.
- Natural sound was defined as the sound inside the park unit boundaries.

The temporal scope is the same for all resources and was defined as impacts that have already taken place and would take place within the next 15 to 20 years.

Cumulative impacts were determined by combining the associated impacts resulting from the implementation of the different alternatives with other past, present, and reasonably foreseeable future projects or activities. Therefore, it was necessary to identify activities that took place prior to NPS ownership, in addition to the ongoing or reasonably foreseeable future projects or activities at Palo Alto Battlefield National Historical Park units and, if applicable, the surrounding region. Because the Vegetation Management Plan is designed to be a long-term management framework for addressing the vegetation management needs for PAAL, the scope of the cumulative analysis will consider the effects on the both units from recent or ongoing projects or activities that effect the natural environment throughout the foreseeable future. Accordingly, the following projects and activities were identified for the purpose of conducting the cumulative effects analysis:

- **Past activities at the Palo Alto Battlefield Unit:** During the first half of the nineteenth century the main road that connected the city of Matamoros to the fishing village of La Punta del Isabela and the natural deep water channel to the Gulf of Mexico, bisected the Palo Alto Battlefield Unit. 1850-1853 the Palo Alto Inn was established along this roadway, which enticed visitors to come see the battlefield and hunt for souvenirs. 1853 the historic road was relocated to the east, to what is now Old Port Isabel Road. 1912-

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1916 Paredes Line Rd (FM 1847) and the Cameron County Drainage District #1 Main Ditch #2 were constructed. 1930's to the present, cattle and other livestock have grazed on private property in what would become the legislative boundary. 1930's – 1960's the Valentin and the Martinez families maintained small homesteads within the legislative boundary. Late 1940's FM 511 was constructed and a natural gas pipeline was installed cutting through the park from the center of the eastern boundary to the northern quarter of the western boundary. 1960's – 1990's new ownership brought intensive mechanical land clearing and attempts at crop cultivation to selective portions of Palo Alto. In the 1970's 5 long, north-south running, linear features appear on aerial imagery in the central part of the core battlefield. Current research has not been able to identify how or why these features were created. These features are about 10 m wide and over 1,000 m long. Anecdotal explanations range from the clearing of roads for residential development to experimental grass planting plots for livestock grazing. These features were cut into broad dense stand of gulf cordgrass, which currently serves as the best example of how the Prairie of Palo Alto would have looked in 1846. Ground inspection reveals no topographic variance between these features and the adjacent prairie, possibly indicating limited soil removal or introduction. These features are currently populated with the typical native coastal ground cover, with limited clumps of gulf cordgrass gradually coming back in.

Palo Alto Battlefield became a National Historic Landmark in 1960, and in 1975 was placed on the National Register of Historic Places. In 1978 Palo Alto Battlefield National Historic Site was established by congress with a 50 acre boundary at the corner of FM 511 and FM 1847. This legislation directed the NPS to conduct historical research and archeological investigations to determine actual location and extent of the battlefield. In 1992 new legislation established a 3,400 boundary for the site and set forth a much more comprehensive mandate for preserving and interpreting the site of the first battle, as well as the war. This legislation also included a further research, including archeological investigations.

- **Past activities at the Resaca de la Palma Battlefield Unit:** 1930's Wells family move a house from Port Isabel to the northwest portion of the park unit. 1950's a productive citrus orchard was established and maintained. 1960's Yturria family purchased the property and developed it into a polo field. 1998 the City of Brownsville, and subsequently the Brownsville Community Foundation (BCF), acquired the property for the purpose of partnering with the NPS to preserve and develop the property as a historical site. 2005 PBS&J Environmental Consultants conducted a geoarcheological investigation to assess the integrity of the landform. 2005 PAAL hosted the 1st Annual Memorial Illumination, an interpretive event where 8,000 luminaries are lit to honor the soldiers from both countries who participated in the Campaign on the Rio Grande. 2006 PAAL & SEAC Archeologists conducted a systematic metal detector survey. 2007-2009 PAAL and BCF partner to install a pedestrian trail, wooden observation deck, gazebo shelter, and interpretive waysides. 2009 legislation passed that added the site as a second unit to the park. 2011 NPS purchased the property.

- **Development of the Palo Alto Battlefield Unit, Ongoing:** In 1998 the NPS purchased the first piece of property within the legislative boundary at Palo Alto. Since then, the

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NPS has added several more tracts of land, but the park still owns less than half of the 3, 400 acre legislative boundary. By 1999, PAAL had constructed a gravel parking lot, 300 meter gravel walking trail, and several interpretive waysides which allowed visitors to visit the site on their own. In 2004, PAAL completed construction and opened the park's Visitor Center and a half mile of walking trail which led to an overlook which sat about 20 feet above the surrounding prairie on constructed earth mound that was located in the center of the western portion of the core battlefield. The trail was 8 to 10' wide with an asphalt surface and a small section of boardwalk constructed with Trex material. Since then PAAL has added a "Resaca Loop Trail", a "Mexican Line Trail", a "U.S. Line Trail", a gravel auxiliary road and parking lot, an office trailer on the side of the Visitor Center, and a Maintenance Facility. There are currently no construction plans for future facilities, however as additional land is acquired additional trails may be considered.

- **Expansion of State Highways FM 511 and FM 1847:** When Palo Alto was initially established in 1978, it was situated northeast of the intersection of relatively low traffic Farm to Market State Highways. In fact throughout the 1980s, traffic was controlled by blinking traffic lights. Now both highways have been vastly expanded. FM 1847, which serves as the unit's western boundary, were recently expanded from a two-lane highway to a four-lane highway, with construction being completed in 2011. FM 511, which serves as a portion of the unit's southern boundary, is still undergoing expansion construction. The plans, as understood by park staff, calls for a four-lane divided highway with a four-lane commercial toll road (SH 550) in the middle, at least in the portion adjacent to Palo Alto. The plan is to turn this thoroughfare into a major artery that connects the Port of Brownsville to the proposed I-69, currently State Highway 77/83. Large overpasses with extremely tall lighting fixtures were recently installed in the immediate vicinity of the park.

- **Development of Fire Management Plan, 2005:** The Palo Alto Battlefield National Historic Site Fire Management Plan was completed in 2005. It calls for the suppression of wildfires and does not allow for prescribed burning. This management decision was highly influenced by the fact that PAAL had no full-time Resource Management staff.

- **Classification and Mapping Land Cover Changes Over Time, 2004:** A group of researchers from the U.S. Geological Services Wetland Research Center in Louisiana analyzed a sequence of aerial photos of the park to classify and map land cover changes over time. Using 138 ground truth sites within PAAL and a variety of spectral analysis and GIS techniques, they produced landcover classifications for 1934 (prior to tillage agriculture at PAAL) and 2000. Their 1934 land cover map indicates that the Resaca de Palo Alto was dominated by seaside oxeye daisy, as it is today, but the adjacent wetland prairie within the core battlefield was dominated by gulf cordgrass. It also illustrated that woody vegetation was limited to the natural low-lying topographical features within the park. The investigators concluded that the 1934 land cover map is representative of the 1846 land cover conditions.

- **Texas A&M University Resaca Restoration Project, 2006:** Researchers from Texas A&M University designed strategies for restoring a portion of the Resaca de Palo Alto in the core battlefield by removing twentieth century anthropogenic water control features

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(drainage ditches, stock ponds, and artificial levees), restoring the natural contours of the project area, and reestablishing gulf cordgrass on the adjacent prairies. They experimented with several methodologies for reestablishing the gulf cordgrass and determined that manually planting developed plugs of gulf cordgrass in the late fall season, without any soil preparation, is the efficient and productive method for reestablishing this historically and ecologically significant coastal prairie plant species.

- **Geoarcheological Investigations at Palo Alto Battlefield NHS, 2005:** McCulloch Archeological Services LLC conducted a geoarcheological investigation on the same portion of the Resaca de Palo Alto as the A&M study to enhance PAAL's understanding of the cultural and natural resources of the site. They excavated a step trench across the resaca and the adjacent prairie, documented the soil stratigraphy and performed soil and macro botanical analysis. The investigation revealed much about landscape evolution in the core battlefield area from pre-historical times through the time of the battle, and on to the present. Excavations into the man-made levees and ditches along the edges of the Resaca de Palo Alto provided important information about the pre-disturbance land elevations in those locations. The report described a very recognizable contact point between material that was excavated from the ditches and sidecast onto the adjacent rescaca edges to form artificially raised levees, and the underlying pre-disturbance ground surface. The results of the macro botanical analysis were in agreement with 2004 USGS conclusions.

- **Geoarcheological Investigations at Palo Alto Battlefield NHS, 2012:** Seramur and Associates conducted additional geoarcheological investigation on portions of the Resaca de Palo Alto that were contiguous to one examined in the previous geoarcheological investigation. PAAL initiated this project to expand upon the information gained from the previous investigations, in particular the precise physical impact of the twentieth century water control features excavated in the resaca. This was important because the park had a potential to acquire funds for wetland restoration, and was hoping to restore a portion of the Resaca de Palo Alto that was pivotal during the battle and is currently accessible to park visitors. Two more step trenches were excavated across the resaca at a wide enough interval to provide an accurate representation of the present surface and historic surface topography in the portion of the resaca that the park wishes to restore. The results of this investigation complemented the previous geoarcheological investigations results and greatly enhanced the park's ability to restore the natural resaca feature to its mid-nineteenth century topographical conditions.

- **Analysis and Restoration Design for Coastal Prairie and Resaca Environments at Palo Alto Battlefield NHP, 2012:** This project was conducted through a CESU Task Agreement between Colorado State University, NPS Water Resources Division and PAAL. This project was also initiated because the park had a potential to receive wetland restoration funds. The project conducted an intensive topographic and hydrologic investigation on the Resaca de Palo Alto and the adjacent wetland prairies. The project produced a detailed construction plan for removing the twentieth century cultural water control features (drainage ditches, stock ponds and artificial levees) and restoring the natural contours to the portion of the Resaca de Palo Alto that the previous investigations

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have studied. The project also produced a detailed plan for restoring gulf cordgrass to the adjacent prairies. Utilizing these plans PAAL submitted a project proposal to the NPS Natural Resource Program, which was funded, initiating in 2014. The same partnership will be utilized to carry out this project.

- **Palo Alto Battlefield National Historic Site Cultural Landscape Inventory, 2010:** A Cultural Landscape Inventory (CLI) was completed in August of 2010, updating the 1998 CLI. The CLI is an inventory and evaluation of all of the cultural landscapes within the Palo Alto Battlefield Unit's legislative boundary. The purpose is to identify the cultural landscapes within the park unit and to provide information on their location, historical development, character defining features, and management. The CLI is designed to assist managers with planning and programming needs.

- **Archeological Survey of the Core Battlefield at Palo Alto Battlefield NHP, Ongoing:** This project was initiated in Fiscal Year (FY) 2005 by PAAL cultural resource staff as an answer to pressures to continue to develop the core battlefield. The proposal was to systematically survey the core battlefield, rather than conduct a series of narrowly scoped trail construction driven surveys in order to comply with Section 106 of the National Historic Preservation Act (NHPA). This systematic metal detector survey of the core battlefield was designed to enhance the park's current understanding of the historic and archeological records by providing a more detailed and precise knowledge of how the battle unfolded based upon archeological evidence. PAAL partnered with NPS archeologists from the Southeast Archeological Center and Santa Fe Support Office, NPS GIS specialists from the Cultural Resources GIS Program in Washington, and a crew of volunteer metal detector operators to carry out this endeavor. Field seasons were conducted in FY 2005-FY2007 on a meager budget drawn from PAAL's base funds, and in FY2010-FY2012 using adequate funding from the NPS Cultural Resource Preservation Program. The entire NPS owned portion of the core battlefield at Palo Alto was systematically surveyed, as well as the 34 acre site of Resaca de la Palma. Report production is currently underway.

- **Exotic Plant Management, Ongoing:** Since 2008 the Gulf Coast Exotic Plant Management Team (EPMT) has assisted PAAL with managing the exotic plants at the Palo Alto Battlefield Unit. Baseline surveys were conducted in 2008 and treatments began in 2009. PAAL is in the process of becoming an official member of the Gulf Coast EPMT. Efforts are concentrated on controlling the exotic grasses in the Core Battlefield Preservation Zone and the federally listed noxious weed the Mother-of-Thousands found in the Development Zone. PAAL will require the technical and field support of the Gulf Coast EPMT for the foreseeable future.

- **Texas Tortoise Monitoring Program, Ongoing:** This long-term monitoring program was developed and is being carried out by the NPS Gulf Coast Inventory and Monitoring Network (GULN) and consultants from the University of Georgia Savannah River Ecology Laboratory. This monitoring program serves as a means for providing data and insights into the overall health of PAAL's ecosystem over time, by studying the health and viability of this one reptile species, which is a state listed "Threatened Species". The monitoring protocol utilizes a mark and recapture scheme. Field work began in 2008 and

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there are currently over 150 marked individuals. Preliminary data indicates a healthy population of Texas Tortoises within the Palo Alto Battlefield Unit and is providing information for a Habitat Utilization Model.

- **Cover Board Monitoring Program, Ongoing:** This long-term monitoring program was developed by the NPS Gulf Coast Inventory and Monitoring Network, as means for providing data and insights into the overall health of PAAL's ecosystem over time, by studying abundance and frequency of various amphibian and reptile species encountered at Palo Alto. Six arrays of ten cover boards are situated in various habitat types throughout the park. The field work is being carried out through a CESU Task Agreement with a Biologist from the University of Texas at Brownsville and PAAL staff. GULN is managing the data.

- **Bird Monitoring Program, Ongoing:** This long-term monitoring program was developed by the NPS Gulf Coast Inventory and Monitoring Network and a consultant from the U.S. Geological Services, as means for providing data and insights into the overall health of PAAL's ecosystem over time, by studying the abundance and migration patterns of the various avian species that are documented at PAAL. The monitoring protocol calls for winter and breeding season point bird counts. The field work is being carried out through a CESU Task Agreement with a Biologist from the University of Texas at Brownsville and PAAL staff. GULN is managing the data. GULN and PAAL have acquired an eBird Trail Tracker with the expectation of providing quality supplemental data. PAAL also participates in the Christmas Bird Count.

- **Natural Resource Condition Assessment, Ongoing:** This Natural Resource Condition Assessment (NRCA) is being completed through a CESU Task Agreement with GeoSpatial Services (GSS) of Saint Mary's University of Minnesota and the National Park Service. The NRCA will evaluate and report on current conditions, identify critical data and knowledge gaps, and describe resource threats and stressors of concern to PAAL resource managers. The assessment will rely on existing scientific data from multiple sources (no new data will be collected for this assessment), combined with best professional judgment from an interdisciplinary team of specialists (including park staff and outside experts) to evaluate the overall current condition and integrity of the Palo Alto Battlefield Unit of PAAL. Project scope is comprehensive in that a wide range of biotic, abiotic, landscape, and ecological resources and interactions will be considered, and that conditions will be evaluated for selected components identified as important or critical to PAAL natural resource management.

The following is a brief description of the current state of the vegetation resources in each of the park's management zones.

Core Battlefield Preservation Zone: The Core Battlefield Preservation Zone comprises approximately 2,192 acres of the PALO unit. In 1846 the majority of this zone consisted of a coastal grassland prairie dominated by gulf cordgrass (*Spartina spartinae*), encased to the north, west and east by abandoned channels of the Rio Grande deltaic system. Native woody vegetation, embedded in stands of gulf cordgrass, populated the natural low-lying levees associated with these abandoned channels. In the northwest portion of this zone there is a

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shallow pond feature, loosely nestled at the opening of a broad meander loop. There is also a scattering of slight rises, locally called lomas, which supported diverse Tamaulipan Brush communities. Currently, native woody plant species are invading and taking over the historic coastal prairie. However, there are still large expanses of gulf cordgrass, especially in the southern and eastern portions of this zone. The beds of the abandoned channels and the shallow pond are covered with high salt and water tolerant native ground cover species, dominated by sea oxeye daisy (*Borrichia frutescens)*, shore grass (*Monanthocloe littoralis)*, sea blite (*Suaeda linearis*), and glasswort (*Salicornia virginica*). These beds remain dry most of the year, except during periods of intense rain events, such as tropical storms and hurricanes. The lomas are still covered with diverse Tamaulipan Brush communities, with the exception of the loma in the northwest portion of this zone. This loma was extensively cleared in the latter part of the twentieth century and currently is covered predominantly with mesquite (*Prosopis* glandulosa) and prickly pear cactus (*Opuntia engelmannii*). Overall, the vegetation cover in this zone consists of native species. Even the areas that were subject to clearing and plowing for years are still chiefly covered with native plant species. Although the gulf cordgrass did not come back, other salt tolerant coastal grasses and ground cover, such as sea oxeye daisy, camphor daisy (*Machaerantera phyllocephala*), glasswort, tornillo (*Prosopis reptans*), and shore grass, did. However it is in these disturbed areas, particularly the areas which are slightly higher in elevation and possess slightly more permeable soils, where the European grasses, mainly King Ranch Bluestem (*Bothriochloa ischaemum*) and Kleberg Bluestem (*Dichanthium annulatum*), are present. It is estimated that there are approximately 200 acres infested with these exotic grasses within the Core Battlefield Preservation Zone.

Resource Protection Zone: The Resource Protection Zone comprises approximately 1,270 acres of the PALO unit. In 1846 the majority of this zone consisted of a coastal grassland prairie. In the northern section of this zone there are the Tule Chica shallow lake bed and a small portion of the Tule Grande shallow lake bed, as well as two small segments of resacas, protruding out from the Core Battlefield Preservation Zone. As in the Core Battlefield Preservation Zone, these lake and resaca beds are covered with high salt and water tolerant native ground cover species, dominated by sea oxeye daisy, glasswort, and shore grass. In the western portion of this zone there is an abandoned sorghum field, which is infested with the European bluestem grasses. However, native woody species are invading this field and are beginning to shade out these exotic grasses in the areas where the woody species are dense. The eastern section of this zone is essentially covered with native vegetation, with stands of gulf cordgrass, and native coastal ground cover particularly in the central portion of this section. Native woody species are present in the northern and southern portions of this section and are slowly spreading inward. The southern section of this zone is predominantly covered with a large expanse of gulf cordgrass. There is a very unpronounced segment of a resaca running through this area, with some associated pockets of the other native coastal ground cover. The western portion of this section contains a small portion of a large loma that extends to the south. The loma is covered with a diverse Tamaulipan Brush community. Adjacent to this loma, there are a few islands of native woody species within the gulf cordgrass, as well as a few isolated young trees coming up throughout this section.

Development Zone: The Development Zone is approximately 27 acres and is contained entirely within the Core Battlefield Preservation Zone. This zone includes the park's Visitor Center,

office trailer, maintenance yard, utility corridors, roads, parking lots, trails, battlefield overlook structure, picnic table pods, and living history demonstration area. The living history demonstration area is situated north of the Visitor Center in a large grassy area enclosed by a shallow resaca bed to the east and the gravel auxiliary parking lot road to the west. This area is covered mainly with low-lying native coastal grasses and ground cover, with a 10-15 m wide stand of gulf cordgrass running along the natural levees of the resaca. There are also some isolated stands of gulf cordgrass in the western portion of this area, along with the northern terminus of the large loma that occupies the southwest corner of the park. This portion of the loma that extends north of the visitor center exit road is called "Yucca Island" by park staff because of the abundance of tall Spanish dagger (*Yucca treculeana*) plants among the native brush community. The area in between the gravel auxiliary parking lot road, the maintenance road and the western boundary of the park, which contains the utility corridor for the maintenance facility, is dominated by gulf cordgrass, with some pockets of sea oxeye daisy, as well as some native huisache (*Acacia minuata)* and mesquite trees coming in along the fence line and auxiliary road. The area enclosed within the paved visitor center entrance/exit road and parking lots contains a well-developed diverse stand of Tamaulipan Brush community. The landscaping in front of the Visitor Center contains areas of mowed grass, a few native trees, and beds of native flowering shrubs. The park has been battling the listed noxious weed species, the Mother of Thousands (*Kalanchoe daigremontiana*), along the Visitor Center entrance/exit road and parking lots. Presently there are no known living Mother of Thousands plants, but the park is monitoring the area for their reappearance. Lastly, exotic grasses have been introduced along the roadways and a trail in the Development Zone due to the park's mowing operations. At this time the exotic grasses are mainly contained within the three foot buffer zone and up to two feet beyond in some locales. These grasses more than likely originated from mowing the highway easement at the entrance gate area.

Resaca de la Palma Battlefield Unit: The Resaca de la Palma Unit is a 34 acre tract of land situated within a former meander loop of the Rio Grande deltaic system. This unit contains approximately 19 acres of mowed grasses and weeds, surrounded by approximately 10 acres of brush. The majority of the brush is comprised of diverse native Tamaulipan Brush communities, but there are dense concentrations of exotic Brazilian Pepper (*Schinus terebinthifolius*) trees, especially on the eastern portion of the unit and along the resaca banks. The remaining 5 acres are aquatic, a portion of the resaca that surrounds the landform. The City of Brownsville has been actively managing the resacas for storm drainage, transporting water, and aesthetics.

3.1 Cultural Landscape

3.1.1 Affected Environment

The cultural landscape refers to the geographic area associated with culturally significant historic events. The NPS Management Policies (Section 5.3.5.2, 2006) state that the treatment of a cultural landscape will preserve will preserve significant physical attributes, biotic systems, and uses when those uses contribute to the historical significance. The Policies go on to state that the treatment decisions will be based on a cultural landscape's historical significance over time, existing conditions, and use. Treatment decisions will consider both the natural and man-made

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characteristics and features of a landscape, the dynamics inherent in natural processes and continued use, and the concerns of traditionally associated peoples.

Palo Alto Battlefield Unit encompasses the 3,400 acre historic Mexican War battle site 10 miles north of downtown Brownsville, Texas, in Cameron County. The site is bounded on the west and south by FM 1847 and FM 511 and to the north by Cameron County Drainage District No. 1, Main Ditch No. 2.

Early prehistoric use of the region consisted of hunter-gather cultures that relied on the region's flora and fauna for subsistence. The late prehistoric cultural tradition in the area, archeologically known as the Brownsville Complex, developed a sophisticated marine shell-working industry. In addition, there is evidence that the people of the Brownville Complex developed cemetery sites and traded with the cultures of Mesoamerica (Garza, 2005). However, there are no prehistoric nor historic Native American sites documented within the park boundaries.

Palo Alto Battlefield is significant because it is the location of the first major battle of the war between Mexico and the United States. Historic descriptions of the May 8, 1846 battle identified features such as topography, vegetation and water bodies as significant, natural points of reference for army maneuvers, staging areas, and battle formations. At the time of the battle, Palo Alto was a broad coastal prairie, dominated by gulf cordgrass. Abandoned channels of the Rio Grande deltaic system enveloped the core battlefield, although neither army noted any riverine-type features. Instead, they describe a pond at the north end of the battlefield where the U.S. army watered and secured their wagon train, and several marshy bottoms that were scattered across the battlefield. There was a large expanse of brush on the north end of the battlefield, associated with the low-lying natural levees of the more pronounced resaca feature and the slight general rise in elevation. To the west and to the south there were scattered pockets of brush associated with the resaca levees and lomas. The natural topography of the battlefield ranges from just below 10 feet above mean sea level (MSL) to just over 20 feet above MSL.

The only known cultural features present on the prairie of Palo Alto prior to the battle were historic roads. One was the main road that connected Matamoros to the small fishing village of La Punta de Isabella and the Gulf of Mexico. This road essentially bisected the prairie of Palo Alto, running from the southwest to the northeast. This is the route that the U.S. Army was using to return from the coast, supplied to relieve the besieged earthen fort opposite of Matamoros. There was also a road that led to Los Tanques de Ramireno, which exited out of the core battlefield area in a southeasterly direction. The initial battle line of the Mexican Army was anchored in between the road to Matamoros on the west and the road to los Tanques de Ramireno on the east, preventing the U.S. Army from continuing south. After the battle, the U.S. army did construct some minor earthen batteries to help secure the wagon train, but these appear to have been destroyed by late twentieth century land clearing activities.

The restoration of the cultural landscape the Palo Alto Battlefield Unit is necessary for the park to fulfill its legislative mandate of protecting and maintaining the battlefield's historic character.

The Resaca de la Palma Unit is a 34 acre tract of land situated within a former meander loop of the Rio Grande deltaic system. This unit contains approximately 19 acres of mowed grasses and

weeds, surrounded by approximately 10 acres of brush. This 34 acre tract is only a remnant of the actual battle site. Current research suggests that this tract would have been largely covered by dense Tamaulipan Brush type vegetation community. Essentially the Cultural Landscape associated with the Battle of Resaca de la Palma has been permanently lost to urban development. Although the historic setting is gone, the present landscape of this 34 acre tract provides PAAL with an ideal venue to interface with large groups of the public in a safe environment.

PAAL is currently in the planning process to develop a new management plan that would include the Resaca de la Palma Unit. Nevertheless, restoring or maintaining the cultural landscape of the REPA unit is not a legislative mandate, nor does it appear that it will become a primary objective for the park. All of the alternatives call for exotic plant management and maintaining a safe developed area at the Resaca de la Palma unit. These efforts might be able to remove plant species that were not present on the battlefield in 1846, but they would do little to improve or degrade the cultural landscape from its current state. Therefore impacts to the cultural landscape will not be analyzed.

Intensity Level Definitions

Negligible: The impact to features or elements within the cultural landscape and to the landscape as a whole is at the lowest level; barely measurable with hardly any perceptible consequences, either adverse or beneficial. For the purposes of Section 106 under NHPA, the determination of effect would be "no adverse effect".

Minor: The impact to features or elements within the cultural landscape and to the landscape as a whole is detectable and measurable. If adverse, the impact would not diminish the overall integrity or the significance of resource and the National Register eligibility of the resource would be unaffected. For the purposes of Section106 under NHPA, the determination of effect would be "no adverse effect".

Moderate: The impact to features or elements within the cultural landscape and to the landscape as a whole is readily apparent and considerably measurable. If adverse, the impact would result in the loss of some integrity or significance of the resource and/or the impact would change one or more of the character defining features of the resource, but would not affect the National Register eligibility of the resource. For the purposes of Section106 under NHPA, the determination of effect would be "adverse effect".

Major: The impact to features or elements within the cultural landscape and to the landscape as a whole is highly noticeable and substantial. If adverse, the impact would result in the loss of integrity or significance of the resource and/or would change one or more of the character defining features of the resource to the extent that it would no longer be eligible for listing in the National Register of Historic Places. For the purposes of Section 106 under NHPA, the determination of effect would be "adverse effect".

Duration: Short-term refers to a transitory effect, one that largely disappears over a period of days or months. The duration of long-term effects is essentially permanent.

3.1.2 Impact Analysis

3.1.2.1 Alternative A

While Alternative A utilizes the least intensive vegetation management strategies, this "no action" alternative would have the most deleterious impact on the cultural landscape of the core battlefield at Palo Alto. Continuing with the current exotic plant management program at the park should help to reduce the number of exotic plant species throughout the park. Nevertheless, the cultural landscape of the core battlefield of Palo Alto does not have a major issue with exotic plants. Therefore continuing the current exotic plant management program would have a site-specific direct long-term minor beneficial impact on the cultural landscape in the core battlefield area of Palo Alto. However, not implementing management actions to reduce and remove the invasive native woody species or reintroduce gulf cordgrass on the core battlefield at Palo Alto would let the historic character of the site continue to degrade. This would have a site-specific indirect long-term moderate adverse effect on the cultural landscape of the core battlefield at Palo Alto.

Cumulative Effects: Past land management activities at Palo Alto have removed stands of gulf cordgrass from the prairie and introduced exotic grasses. Since gulf cordgrass grows in clumps (does not have a rhizome root system), stands of cordgrass tend not to spread outward or invade other areas. Therefore, if the gulf cordgrass is removed from areas, especially large expanses it generally won't come back on its own. That said; if left unassisted gulf cordgrass might gradually reoccupy the area, but this process could take decades or even centuries depending on the extent of the area they were removed from, as well as numerous other natural and cultural influences. This is evident in the time the cordgrass has taken to come back into those long linear features on the core battlefield of Palo Alto. It has been almost 40 years since those features were created and the gulf cordgrass has reestablished itself in less than 10% of the area of those features. If no management actions are implemented to reintroduce gulf cordgrass to the areas of the core battlefield they will not come back on their own, at least not for the foreseeable future.

This situation is further exacerbated by twentieth century drainage activities and road construction, which have substantially altered the hydrologic regime by lowering the water table and truncating the historic floodplain. Essentially, these actions have caused the historic coastal wetland prairies of Palo Alto to become drier. Consequently, this is allowing low water tolerant native species, like the mesquite and the prickly pear cactus, to invade and dominate the former wetland prairies. If the current vegetation management activities are continued as is, the cultural landscape would continue to degrade until the once open prairie where the two armies met would no longer be recognizable.

The 2014 proposed project to remove twentieth century cultural water control features (drainage ditches, stock ponds, and artificial levees) from a portion of the Resaca de Palo Alto and restore the adjacent wetland prairies by planting gulf cordgrass on the newly exposed historic levee

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elevations and adjacent wetland prairies would have direct beneficial long term effects on the cultural landscape of the core battlefield area of Palo Alto. However, the entire project area is in the neighborhood of 60 acres. So without any other management actions to restore and maintain the cultural landscape, this project would have a minor impact and would do nothing to improve the degrading cultural landscape in the major portion of the core battlefield at Palo Alto.

Conclusions: Alternative A would have the most long-term, moderate adverse impacts on the cultural landscape at Palo Alto of the three alternatives considered. With this No Action alternative, prickly pear cactus and woody vegetation would continue to invade and overtake the open grassland prairie. The cumulative effect of this alternative on the cultural landscape of the battlefield would be to move the condition of the cultural landscape further and further away from the desired condition. The selection of Alternative A would have a direct minor beneficial effect by removing plant species that are not part of the 1846 landscape, but would have an indirect long-term moderate adverse impact on the cultural landscape of the core battlefield at Palo Alto by putting forth no management actions that would effectively restore and maintain the cultural landscape of the core battlefield area of Palo Alto.

3.1.2.2 Alternative B

The vegetation management strategies prescribed in Alternative B are designed to restore and maintain the cultural landscape of the core battlefield of Palo Alto utilizing a full battery of management techniques. Management actions proposed in Alternative B start with the mechanical reduction and removal of the woody vegetation that has invaded the historic grassland prairie. The tree tops would be strategically left in the field to serve as fuel for prescribed burning. Prickly pear cactus would be cut and removed from the site using shovels and pitch forks without disturbing the soil. Subsurface portions of the cactus would be left in place. This would have a direct site-specific short to long-term beneficial impact on the cultural landscape on the core battlefield of Palo Alto by opening up the viewshed. Although the tree tops may stick up some above the surrounding grasses, the overall appearance of the site would be open. Once the area has been burned, this issue should be significantly reduced, if not eliminated.

Alternative B also calls for the herbicide treatment of cut tree stumps to kill the root ball and prevent future growth. This would have indirect site-specific short to long-term moderate beneficial impact on the cultural landscape at Palo Alto by substantially reducing the amount of resprouts. Herbicide would also be used to control and eliminate exotic plants. This would have a direct site-specific long-term beneficial impact on the cultural landscape of core battlefield area at Palo Alto, since the core battlefield is only infested with about 200 acres of exotic grasses.

In addition, Alternative B calls for an active program of reestablishing gulf cordgrass on the historic coastal prairies of the core battlefield area of Palo Alto. This would have a direct site specific long-term moderate beneficial impact on the cultural landscape of the core battlefield area of Palo Alto. The reintroduction of gulf cordgrass in areas where it has been removed in the core battlefield area of Palo Alto would be beneficial to the cultural landscape, but it would take a few years before the plants mature and truly resemble the 1846 environment. The actual planting efforts might negatively impact the historic scene by having large crews and vehicles and/or equipment carrying out the effort. But these efforts would only last a few days at the

most. Therefore any adverse impacts to the cultural landscape from that planting process would be of short duration and of negligible intensity. Eventually these young plugs of gulf cordgrass will mature and dominate the area where they are planted, as illustrated in Texas A&M's test plots. Therefore the overall impact on the cultural landscape as a result of reestablishing the gulf cordgrass would be a direct site-specific long-term moderate beneficial impact.

Alternative B also calls for a cyclical prescribed fire program to promote the health and density of the gulf cordgrass, and reduce and stop the growth and spread of exotic grasses, prickly pear cactus, and woody vegetation. This management practice is the primary management action that separates Alternative B from the other alternatives. Eventually cyclical prescribed burning at longer intervals, mimicking the natural fire regime, would be able to maintain the restored cultural landscape with a reduced need for the other vegetation management practices. The prescribed fire events might have a negative impact on the historic scene by having modern fire engines and crews present. In addition, the immediate but temporary reduction of the vegetation on the prairie as result of fire might also be considered a negative impact on historic scene, even though portions of the prairie caught fire during the battle. Nonetheless, the prescribed fire events will only last a day or two, while the targeted gulf cordgrass would flourish as a result of this management practice, and the invasive native and exotic species would be reduced and controlled. Consequently, the implementation of a prescribed fire program to restore and maintain the cultural landscape of the core battlefield would be a direct site specific long-term moderate beneficial impact on the cultural landscape.

Lastly, Alternative B calls for both qualitative (e.g. photo-stations/repeat photography) and quantitative vegetation monitoring (e.g. nested frequency plots) to be established to provide the park continual feedback on all vegetation and restoration management activities. Specific multi-purpose and targeted vegetation monitoring protocols would be developed and implemented in coordination with the NPS personnel of the Gulf Coast Inventory and Monitoring Network, Gulf Coast Exotic Plant Management Team, and fire ecologists to: (1) define the effectiveness of specific vegetation management treatments, (2) provide early detection of newly invading species, (3) determine fire effects on native and non-native vegetation, and (4) determine cultural landscape restoration success in the core battlefield of Palo Alto. This would allow the park to adjust its efforts so the best results can be achieved with the least amount of effort and impact to the environment. Therefore, this management practice would have an indirect site-specific long-term moderate beneficial impact on the cultural landscape of the core battlefield.

Cumulative Effect: Past land management activities at Palo Alto have removed stands of gulf cordgrass from the prairie and introduced exotic grasses. Since gulf cordgrass grows in clumps (does not have a rhizome root system), stands of cordgrass tend not to spread outward or invade other areas. Therefore, if the gulf cordgrass is removed from areas, especially large expanses it generally won't come back on its own. That said; if left unassisted gulf cordgrass might gradually reoccupy the area, but this could take decades or even centuries depending on the extent of the area they were removed from, as well as numerous other natural and cultural influences. This is evident in the time the cordgrass has taken to come back into those long linear features on the core battlefield of Palo Alto. It has been almost 40 years since those features were created and the gulf cordgrass has reestablished itself in less than 10% of the area of those features. The reestablishment of gulf cordgrass in areas where it has been removed

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would resolve this issue, eventually allowing the gulf cordgrass to once again dominate the prairie of Palo Alto.

Twentieth century drainage activities and road construction have substantially altered the hydrologic regime by lowering the water table and truncating the historic floodplain. Essentially, these actions have caused the historic coastal wetland prairies of Palo Alto to become drier. Consequently, this is allowing low water tolerant native species, like the mesquite and the prickly pear cactus, to invade and dominate the former wetland prairies. The management practices proposed in Alternative B would work to help reverse this situation. The Colorado State University hydrological investigation (Cooper 2011) indicated that areas on the prairie of Palo Alto that are dominated by gulf cordgrass retain water on the surface and in the upper strata of the soil after rain events far longer than areas of the prairie covered with other vegetation. So even though PAAL will never be able to restore the mid-nineteenth century hydrologic regime, the vegetation management practices in Alternative B would serve to bring the conditions of the prairie closer to the mid-nineteenth century conditions.

The 2014 proposed project to remove twentieth century water control features from a portion of the Resaca de Palo Alto and restore the adjacent wetland prairies by planting gulf cordgrass on the newly exposed historic levee elevations and adjacent wetland prairies would have direct beneficial long term effects on the cultural landscape of the core battlefield area of Palo Alto. However, the entire project area is in the neighborhood of 60 acres. The implementation of the proposed management actions in Alternative B would serve to expand this area by restoring and maintaining the cultural landscape far beyond the scope of this project area.

Conclusions: The impacts associated with the implementation of the vegetation management strategies proposed in Alternative B would have a direct, site-specific, long-term, moderate beneficial impact on the cultural landscape of the core battlefield at Palo Alto. The use of prescribed fire adds a principal advantage to Alternative B because it is the one management practice that can maintain and enhance the beneficial results of the other management practices on the cultural landscape of the core battlefield with relatively minor effort. Consequently Alternative B is the only alternative that provides PAAL with the ability to efficiently and effectively restore and maintain the cultural landscape of the core battlefield to its desired condition. Since preserving and protecting the historic character of the site is one of PAAL's primary legislative mandates, the actions and impacts associated with Alternative B appear to be compatible with all of PAAL's other projects or activities. Therefore, when the implementation of Alternative B is considered with other past, present, and reasonably foreseeable future actions, it appears to have only long-term moderate beneficial cumulative effects on the cultural landscape of the core battlefield.

3.1.2.3 Alternative C

The vegetation management strategies prescribed in Alternative C would strive to restore and maintain the cultural landscape of the core battlefield of Palo Alto. Management actions proposed in Alternative C start with the mechanical reduction and removal of the woody vegetation that has invaded the historic grassland prairie. The trees would be cut as close to the ground as possible without disturbing the ground surface. The cut trees would have to be removed from the site, since the use of prescribed fire is not available in this alternative. Prickly

pear cactus would be cut and removed from the site using shovels and pitch forks without disturbing the soil. Subsurface portions of the cactus would be left in place. This mechanical reduction and removal of trees and cactus would have a direct site-specific short to long-term, moderate beneficial impact on the cultural landscape on the core battlefield of Palo Alto by opening up the viewshed. However the increased effort of removing the cut trees from the site would add to the amount of time and equipment needed to carry out these efforts, which would have a direct site-specific short-term negligible adverse impact on the cultural landscape.

In addition, Alternative C calls for the herbicide treatment of cut tree stumps to kill the root ball and prevent future growth. This would have indirect site-specific long-term moderate beneficial impact on the cultural landscape at Palo Alto by substantially reducing the amount of resprouts. Herbicide would also be used to control and eliminate exotic plants. This would have a direct site-specific short to long-term beneficial moderate impact on the cultural landscape of core battlefield area at Palo Alto, since the core battlefield is only infested with about 200 acres of exotic grasses.

Alternative C also calls for an active program of reestablishing gulf cordgrass on the historic coastal prairies of the core battlefield area of Palo Alto. This would have a direct site-specific moderate beneficial effect on the cultural landscape of the core battlefield area of Palo Alto. The reintroduction of gulf cordgrass in areas where it has been removed in the core battlefield area of Palo Alto would be beneficial to the cultural landscape, but it would take a few years before the plants mature and truly resemble the 1846 environment. The actual planting efforts might negatively impact the historic scene by having large crews and vehicles and/or equipment carrying out the effort. But these efforts would only last a few days. Therefore any adverse impacts to the cultural landscape from the planting process would be of short duration and of negligible intensity. Eventually these young plugs of gulf cordgrass will mature and dominate the area where they are planted, as illustrated in Texas A&M's test plots. Therefore the overall impact on the cultural landscape as a result of reestablishing the gulf cordgrass would be a direct long-term moderate beneficial impact.

Lastly, Alternative C calls for vegetation monitoring to be implemented, but would remain limited to more basic qualitative "change over time" analyses (e.g. establishment of photo-stations and repeat photography). No quantitative monitoring would be established to address (1) the effectiveness of vegetation management treatments, (2) early detection of newly invading species, (3) determine cultural landscape restoration success in the core battlefield of Palo Alto. This reduced vegetation monitoring would essentially limit PAAL's ability to efficiently and effectively restore and maintain cultural landscape of the core battlefield. Therefore, this management practice would have an indirect site-specific long-term minor beneficial impact on the cultural landscape of the core battlefield.

Cumulative Effect: Past land management activities at Palo Alto have removed stands of gulf cordgrass from the prairie and introduced exotic grasses. Since gulf cordgrass grows in clumps (does not have a rhizome root system), stands of cordgrass tend not to spread outward or invade other areas. Therefore, if the gulf cordgrass is removed from areas, especially large expanses it generally won't come back on its own. That said; if left unassisted gulf cordgrass might gradually reoccupy the area, but this could take decades or even centuries depending on the

extent of the area they were removed from, as well as numerous other natural and cultural influences. This is evident in the time the cordgrass has taken to come back into those long linear features on the core battlefield of Palo Alto. It has been almost 40 years since those features were created and the gulf cordgrass has reestablished itself in less than 10% of the area of those features. The reestablishment of gulf cordgrass in areas where it has been removed would help to resolve this issue, allowing the gulf cordgrass to once again dominate the prairie of Palo Alto.

Twentieth century drainage activities and road construction have substantially altered the hydrologic regime by lowering the water table and truncating the historic floodplain. Essentially, these actions have caused the historic coastal wetland prairies of Palo Alto to become drier. Consequently, this is allowing low water tolerant native species, like the mesquite and the prickly pear cactus, to invade and dominate the former wetland prairies. The management practices proposed in Alternative C would work to help reverse this situation. The Colorado State University hydrological investigation (Cooper 2011) indicated that areas on the prairie of Palo Alto that are dominated by gulf cordgrass retain water on the surface and in the upper strata of the soil after rain events, far longer than areas of the prairie covered with other vegetation. So even though PAAL will never be able to restore the mid-nineteenth century hydrologic regime, the vegetation management practices in Alternative C would serve to bring the conditions of the prairie closer to the mid-nineteenth century conditions.

The 2014 proposed project to remove twentieth century water control features from a portion of the Resaca de Palo Alto and restore the adjacent wetland prairies by planting gulf cordgrass on the newly exposed historic levee elevations and adjacent wetland prairies would have direct beneficial long term effects on the cultural landscape of the core battlefield area of Palo Alto. However, the entire project area is in the neighborhood of 60 acres. The implementation of the proposed management actions in Alternative C would serve to expand this area by restoring and maintaining the cultural landscape far beyond the scope of this project area.

Conclusions: The impacts associated with the implementation of the vegetation management strategies proposed in Alternative C would have a direct site-specific long-term moderate beneficial impact on the cultural landscape of the core battlefield at Palo Alto. However, Alternative C requires an increased and continual effort to maintain the improved condition of the core battlefield without the use of prescribed fire. Since preserving and protecting the historic character of the site is one of PAAL's primary legislative mandates, the actions and impacts associated with Alternative C appear to be compatible with all of PAAL's other projects or activities. Nonetheless, Alternative C does require a much more intense and continuing effort to maintain an improved cultural landscape that at times could be considered an intrusion on the landscape. Therefore, when the implementation of Alternative C is considered with other past, present, and reasonably foreseeable future actions, it appears to have direct, site-specific, long-term, moderate beneficial cumulative impact on the cultural landscape of the core battlefield at Palo Alto.

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3.2 Air Quality

3.2.1 Affected Environment

Air quality is a descriptive measure of the purity of air. Air quality is determined from measuring pollutants in the air which affect the health and safety of the population. The Clean Air Act of 1970 (CAA) provides the legislative framework to protect and enhance the quality of the Nation's air resources.

The Clean Air Act, which was last amended in 1990, requires the EPA to set National Ambient Air Quality Standards (NAAQS; 40 CFR Part 50) for pollutants considered harmful to public health and the environment. The CAA established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The CAA required US Environmental Protection Agency (EPA) to establish ambient ceilings for certain criteria pollutants. The fundamental method by which EPA tracks compliance with the NAAQS is the designation of a particular region as an "attainment" or "nonattainment" region.

PAAL is located in Cameron County within the EPA's Brownsville-Laredo Intrastate Air Quality Control Region (AQCR). This region is one of a nationwide system of AQCRs established by the USEPA for air quality planning purposes (40 CFR part 81) and is designated as AQCR No 213. The Brownsville-Laredo Intrastate AQCR includes the counties of Cameron, Hidalgo, Jim Hogg, Starr, Webb, Willacy, and Zapata. The entire AQCR 213 is designated by the EPA as being in attainment for all criteria pollutants, meeting all NAAQS standards. Palo Alto Battlefield is in an area that is in attainment of all National Ambient Air Quality Standards (NAAQS).

Intensity Level Definitions

Negligible: Any changes in air quality would be below or at the level of detection, and if detected, would have effects that would be considered slight and short-term.

Minor: Changes in air quality would be measurable although small, short-term, and site specific. No air quality mitigation measures would be necessary.

Moderate: Changes in air quality would be measurable and would have consequences, although the effect would be relatively local. Air quality mitigation measures would be necessary and likely successful.

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Major: Changes in air quality would be measurable, would have substantial consequences, and would be noticed regionally. Air quality mitigation measures would be necessary and their success could not be guaranteed.

Duration: Short-term refers to a transitory effect, one that largely disappears over a period of hours or days. The duration of long-term effects is months or years.

3.2.2 Impact Analysis

Air quality impacts were qualitatively assessed upon review of National Park Service best management practices to reduce air emissions, State of Texas Prescribed Burning Board Laws and Regulations, specifically 21 TexReg 8509, and the extent of proposed prescribed fire activities under the proposed alternatives.

3.2.2.1 Alternative A

Under Alternative A chemical treatments and mechanical treatments have the potential to impact the air quality. Chemical treatments, specifically herbicide applications associated with exotic plant management and weed control along roadways and trails, do have the potential for limited dispersion of the chemicals by wind. However, the resulting changes in air quality would probably not be detectable. Furthermore, the overall potential for herbicide drift would be negligible since herbicides would be applied in accordance with label specifications. Most herbicides used have a low volatility. Those herbicides with higher volatility are used at low concentrations. Therefore impacts from herbicide volatilization are expected to be negligible. Consequently it is determined that the overall impacts on air quality as a result of chemical treatments would be direct, site-specific, short-term, negligible adverse impact.

The potential impacts to air quality from mechanical treatments put forth in Alternative A stem mainly from temporary increases in fugitive dust and from increases in exhaust emissions from equipment. These mechanical treatments consist mainly of mowing, weed-eating, and trimming activities in the developed areas of the park. Keeping the equipment well maintained will help to reduce the amount of exhaust emissions. Nonetheless, the changes in air quality as a result of these activities would probably not be measurable. Therefore impacts on air quality as a result of mechanical treatments in Alternative A would be direct, site-specific, short-term, negligible adverse impacts.

Cumulative Effect: The primary potential impact to air quality appears to be from increased exhaust emissions associated with increased levels of vehicular traffic outside of both park units. The Resaca de la Palma Battlefield Unit is situated in an urban setting. The western boundary of this unit is Paredes Line Rd. (FM 1847) which is currently a four lane road divided by a center turning lane. Expansion of this road is unlikely in the immediate future. However, during the morning and afternoon commutes this roadway is congested. This roadway is on the west side of the REPA unit and the predominant winds in Cameron County are from the southeast. The western boundary of this unit is the only boundary that is not buffered by dense brush.

At the Palo Alto Battlefield Unit the recent and ongoing expansions of FM 1847 and FM 511 have been accompanied by an increase in vehicular traffic. The development of the commercial thoroughfare, SH 550 toll road, connecting the Port of Brownsville with the proposed I69 interstate should also be accompanied by an increase in large commercial diesel-fueled vehicles. The city has set plans to develop two industrial parks within two miles of the park as an offshoot of this commercial thoroughfare. These parks are designated for light industry. At the present, only the infrastructure has been developed at one site. There is talk about a spice factory coming to this park, but nothing has materialized.

There is a possibility that the park might become open to oil and gas exploration. These types of operations typically emit air pollutants. It is uncertain whether any type of energy development will take place at PAAL, but if it does it will likely impact the air quality.

The park occasionally has projects that require heavy equipment, such as roadwork, trail construction, geoarcheological investigation, or even the upcoming restoration of the resaca. However, these types of projects are infrequent and of relatively short duration. Therefore the impact to air quality as a result of carrying out such projects is negligible. The park is also trying to reduce its' carbon footprint by doing things such as purchasing electric utility vehicles.

Regardless, the strong prevailing southeasterly winds coming off of the Gulf of Mexico tend to keep the immediate air quality of the park units in good shape. However, the air pollutants released in and around the park are dispersed into the greater regional airshed. And if a major air pollutant crisis occurs down-wind of the park unit, these same winds that provide protection to the sites air quality, could also carry unforeseen contaminants.

Conclusions: The impacts associated with the implementation of the vegetation management strategies proposed in Alternative A would have a direct, site-specific, short-term, negligible adverse impact. Overall it appears that any measurable long-term impacts to the air quality at the park will come from external sources that the park will have no control over. There is a possibility that the air quality at the PALO unit may degrade over time with the increase in industrial development and vehicular traffic. Regardless, the adverse impacts to air quality caused by the implementation of Alternative A would be short-term and negligible, even when considered with past, present or future actions.

3.2.2.2 Alternative B

Under Alternative B chemical, mechanical, and cultural (prescribed fire) treatments have the potential to impact the air quality. Chemical treatments, specifically herbicide applications associated with exotic plant management, woody root system destruction, and weed control along roadways and trails, do have the potential for limited dispersion of the chemicals by wind. However, the resulting changes in air quality would probably not be detectable. Furthermore, the overall potential for herbicide drift would be negligible since herbicides would be applied in accordance with label specifications. Most herbicides used have a low volatility. Those herbicides with higher volatility are used at low concentrations. Therefore impacts from herbicide volatilization are expected to be negligible. Consequently it is determined that the

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overall impacts on air quality as a result of chemical treatments would be direct, site-specific, short-term, negligible adverse impact.

The potential impacts to air quality from mechanical treatments put forth in Alternative B stem mainly from temporary increases in fugitive dust and from increases in exhaust emissions from equipment. In Alternative B, the mechanical treatments are greatly expanded to include actions such as the cutting of woody vegetation and the removal of prickly pear cactus in an effort to restore the cultural landscape of core battlefield area at PALO, in addition to the mowing, weed-eating, and trimming activities in the developed areas of the park. Even though the amount of mechanical treatments will greatly increase to restore the cultural landscape of the battlefield at PALO, these treatments would be carried out through specific projects of relatively short duration. The need for mechanical treatments to restore the core battlefield should be greatly reduced after the first few years of implementing these activities. Nonetheless, the changes in air quality as a result of these activities would probably not be measurable. In addition, keeping the equipment well maintained will help to reduce the amount of exhaust emissions. Therefore impacts on air quality as a result of mechanical treatments in Alternative B would be direct, site-specific, short-term, negligible adverse impacts.

Prescribed burning is the one activity proposed in Alternative B that has the greatest potential to impact air quality. Smoke consists of dispersed airborne solids and liquid particles, called particulates, which could remain suspended in the atmosphere for a few days to several months. Particulates can reduce visibility and contribute to respiratory problems. Very small particulates can travel great distances and add to regional haze problems. Regional haze can sometimes result from multiple burn days and/or multiple owners burning within an airshed over too short a period of time to allow for dispersion. Prior to any prescribed fire, the park would be in compliance with rules and laws established by the Texas Prescribed Burning Board. For prescribed fires, there are three principle strategies to manage smoke dispersion and reduce air quality effects. They include:

1. Avoidance - This strategy relies on monitoring meteorological conditions when scheduling prescribed fires to prevent smoke from drifting into sensitive receptors, or suspending burning until favorable weather (wind) conditions;

2. Dilution – This strategy ensures proper smoke dispersion in smoke-sensitive areas by controlling the rate of smoke emissions or scheduling prescribed fires when weather systems are unstable, not under conditions when a stable high-pressure area is forming with an associated subsidence inversion. An inversion would trap smoke near the ground; and

3. Emission Reduction – This strategy utilizes techniques to minimize the smoke output per unit area treated. Smoke emission is affected by the number of acres burned at one time, pre-burn fuel loadings, fuel consumption, and the emission factor. Reducing the number of acres that are burned at one time would reduce the amount of emissions generated by that burn. Reducing the fuel beforehand, e.g. removing firewood, reduces the amount of fuel available. Conducting prescribed fires when fuel moistures are high

can reduce fuel consumption. Emission factors can be reduced by pile burning or by using certain firing techniques such as mass ignition.

In addition, burning areas that have been previously treated with an herbicide can be problematic. Chemicals released into the air through burning could be carried in air currents for some distance beyond the treated area, which could pose a health risk to employees conducting the burn and/or the public. The length of time that an herbicide would remain active and thereby available for re-release if a fire occurred depends on the herbicide used. Most chemicals should not be a concern three to four months after application. Burn areas may be treated with chemicals after the burn event has taken place. PAAL resource management staff will ensure that all prescribed fire treatments and chemical treatments are closely coordinated.

If there was a potential for violating air quality standards the park would implement a contingency plan, including the option for immediate suppression. The major fuel types (grasses, shrubs) to be burned on the park do not generate large quantities of smoke. Prescribed fires would not violate daily national or state emission standards and would cause very minor and temporary air quality impacts. The park would only conduct prescribed fires under environmental conditions that maximized smoke dispersion. Burning in PAAL would not alter the NAAQS attainment status of the air quality control region. Therefore impacts on air quality as a result of prescribed fire treatments in Alternative B would be direct, site-specific, short-term, negligible adverse impacts.

Cumulative Effect: The primary potential impact to air quality appears to be from increased exhaust emissions associated with increased levels of vehicular traffic outside of both park units. The Resaca de la Palma Battlefield Unit is situated in an urban setting. The western boundary of this unit is Paredes Line Rd. (FM 1847) which is currently a four lane road divided by a center turning lane. Expansion of this road is unlikely in the immediate future. However, during the morning and afternoon commutes this roadway is congested. This roadway is on the west side of the REPA unit and the predominant winds in Cameron County are from the southeast. The western boundary of this unit is the only boundary that is not buffered by dense brush.

At the Palo Alto Battlefield Unit the recent and ongoing expansions of FM 1847 and FM 511 have been accompanied by an increase in vehicular traffic. The development of the commercial thoroughfare, SH 550 toll road, connecting the Port of Brownsville with the proposed I69 interstate should also be accompanied by an increase in large commercial diesel-fueled vehicles. The city has set plans to develop two industrial parks within two miles of the park as an offshoot of this commercial thoroughfare. These parks are designated for light industry. At the present, only the infrastructure has been developed at one site. There is talk about a spice factory coming to this park, but nothing has materialized.

There is a possibility that the park might become open to oil and gas exploration. These types of operations typically emit air pollutants. It is uncertain whether any type of energy development will take place at PAAL, but if it does it will likely impact the air quality.

The park occasionally has projects that require heavy equipment, such as roadwork, trail construction, geoarcheological investigation, or even the upcoming restoration of the resaca.

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However, these types of projects are infrequent and of relatively short duration. Therefore the impact to air quality as a result of carrying out such projects is negligible. The park is also trying to reduce its' carbon footprint by doing things such as purchasing electric utility vehicles.

Regardless, the strong prevailing southeasterly winds coming off of the Gulf of Mexico tend to keep the immediate air quality of the park units in good shape. However, the air pollutants released in and around the park are dispersed into the greater regional airshed. And if a major air pollutant crisis occurs down-wind of the park unit, these same winds that provide protection to the sites air quality, could also carry unforeseen contaminants.

Conclusions: The impacts associated with the implementation of the vegetation management strategies proposed in Alternative B would have a direct, site-specific, short-term, negligible adverse impact on the air quality at PAAL. Even though Alternative B includes prescribed fire, these burn events would be brief, occur annually at first and then spread out to possibly once every five years. Nevertheless, it appears that any measurable long-term impacts to the air quality at the park will come from external sources that the park will have no control over. There is a possibility that the air quality at the PALO unit may degrade over time with the increase in industrial development and vehicular traffic. Regardless, the adverse impacts to air quality caused by the implementation of Alternative B would be short-term and negligible, even when considered with past, present or future actions.

3.2.2.3 Alternative C

Under Alternative C chemical and mechanical treatments have the potential to impact the air quality. Chemical treatments, specifically herbicide applications associated with exotic plant management, woody root system destruction, and weed control along roadways and trails, do have the potential for limited dispersion of the chemicals by wind. However, the resulting changes in air quality would probably not be detectable. Furthermore, the overall potential for herbicide drift would be negligible since herbicides would be applied in accordance with label specifications. Most herbicides used have a low volatility. Those herbicides with higher volatility are used at low concentrations. Therefore impacts from herbicide volatilization are expected to be negligible. Consequently it is determined that the overall impacts on air quality as a result of chemical treatments would be direct, site-specific, short-term, negligible adverse impact.

The potential impacts to air quality from mechanical treatments put forth in Alternative C stem mainly from temporary increases in fugitive dust and from increases in exhaust emissions from equipment. In Alternative C, the mechanical treatments are greatly expanded to include actions such as the cutting of woody vegetation and the removal of prickly pear cactus in an effort to restore the cultural landscape of core battlefield area at PALO, in addition to the mowing, weed-eating, and trimming activities in the developed areas of the park. Even though the amount of mechanical treatments will greatly increase to restore the cultural landscape of the battlefield at PALO, these treatments would be carried out through specific projects of relatively short duration. The need for mechanical treatments to restore the core battlefield should be reduced after the first few years of implementing these activities. However, since prescribed fire is treatment that is not available in Alternative C, mechanical treatments may be the primary tool used to address regrowth and maintain the restored cultural landscape of the core battlefield area

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of Palo Alto. Nonetheless, the changes in air quality as a result of these activities would probably not be measurable. In addition, keeping the equipment well maintained will help to reduce the amount of exhaust emissions. Therefore impacts on air quality as a result of mechanical treatments in Alternative C would be direct, site-specific, short-term, negligible adverse impacts.

Cumulative Effect: The primary potential impact to air quality appears to be from increased exhaust emissions associated with increased levels of vehicular traffic outside of both park units. The Resaca de la Palma Battlefield Unit is situated in an urban setting. The western boundary of this unit is Paredes Line Rd. (FM 1847) which is currently a four lane road divided by a center turning lane. Expansion of this road is unlikely in the immediate future. However, during the morning and afternoon commutes this roadway is congested. This roadway is on the west side of the REPA unit and the predominant winds in Cameron County are from the southeast. The western boundary of this unit is the only boundary that is not buffered by dense brush.

At the Palo Alto Battlefield Unit the recent and ongoing expansions of FM 1847 and FM 511 have been accompanied by an increase in vehicular traffic. The development of the commercial thoroughfare, SH 550 toll road, connecting the Port of Brownsville with the proposed I69 interstate should also be accompanied by an increase in large commercial diesel-fueled vehicles. The city has set plans to develop two industrial parks within two miles of the park as an offshoot of this commercial thoroughfare. These parks are designated for light industry. At the present, only the infrastructure has been developed at one site. There is talk about a spice factory coming to this park, but nothing has materialized.

There is a possibility that the park might become open to oil and gas exploration. These types of operations typically emit air pollutants. It is uncertain whether any type of energy development will take place at PAAL, but if it does it will likely impact the air quality.

The park occasionally has projects that require heavy equipment, such as roadwork, trail construction, geoarcheological investigation, or even the upcoming restoration of the resaca. However, these types of projects are infrequent and of relatively short duration. Therefore the impact to air quality as a result of carrying out such projects is negligible. The park is also trying to reduce its' carbon footprint by doing things such as purchasing electric utility vehicles.

Regardless, the strong prevailing southeasterly winds coming off of the Gulf of Mexico tend to keep the immediate air quality of the park units in good shape. However, the air pollutants released in and around the park are dispersed into the greater regional airshed. And if a major air pollutant crisis occurs down-wind of the park unit, these same winds that provide protection to the sites air quality, could also carry unforeseen contaminants.

Conclusions: The impacts associated with the implementation of the vegetation management strategies proposed in Alternative C would have a direct, site-specific, short-term, negligible adverse impact on air quality. It appears that any measurable long-term impacts to the air quality at the park will come from external sources that the park will have no control over. It is possible that the air quality at the PALO unit may degrade over time with the increase in industrial development and vehicular traffic. Regardless, the adverse impacts to air quality caused by the

implementation of Alternative B would be short-term and negligible, even when considered with past, present or future actions.

3.3 Water Quality

3.3.1 Affected Environment

Water quality is a description of the characteristics of water, referencing a set of standards. Compliance of water quality following management activities is based on a comparison between actual characteristics and these pre-established standards. Both the Clean Water Act (1972) and 2010 Texas Surface Water Quality Standards, Texas Administrative Code (TAC) Title 30, Chapter 307, define the standards against which impacts to water quality can be measured.

PAAL is located in the formerly active Rio Grande delta. Elevation change across the PALO unit is minimal and topographic features are limited to prairies, resacas (former river channels) and lomas, or small hills. Some of the resacas have been excavated in an effort to form year round water holding tanks for livestock. During the past two decades, there typically has been no surface water in the park throughout most of each year. Some years experienced no surface water lasting more than a week. Only two or three years during this period experience surface water lasting longer than three months. Surface water leaving the site is confined to storm runoff following ground saturation, occurring in extreme precipitation events.

The REPA unit, on the other hand, is a small landform enclosed within a former meander loop of the Rio Grande. The city maintains and manages this channel, as well as the numerous other abandoned channels within the city limits, for the transportation of irrigation water and for storm drainage. These water filled resacas also serve as an aesthetic resource for the city. The city's Public Utility Board (PUB) monitors and manages the water quality in these resacas. Elevation change at the REPA unit is minimal, only about10 to 15 foot change. Naturally this land form had a crown in the center and gradually sloped down to the banks of the resaca. However, the construction of the polo field has exaggerated this crown. Surface runoff during precipitation events flows directly into the surrounding resaca.

The Rio Grande is the 5th longest river in North America and the 20th longest in the world. The area of the watershed that feeds the Rio Grande is some 336,000 mi^2 (870,000 km^2). Because a large part of the river's basin is arid or semiarid, only about half of that area, approximately 176,000 mi^2 (455,000 km^2), contributes significantly to the flow of the river. The Rio Grande is the natural border between the United States and Mexico and has historically provided, and still provides, a source of water for the people, industry, and agriculture for both countries. (Manz et al., 2005)

Based on the most current data available, Draft 2010 Texas Water quality Inventory (Texas Commission on Environmental Quality, 2010), the Rio Grande Basin Tidal Zone, extending from the river mouth upstream 74.7 kilometers, water samples exceeded acceptable standards in samples for bacteria and elemental nutrients. For this inventory 9.1% of samples exceeded the acceptable threshold for fecal coliform bacteria. 5.6% of samples exceeded the acceptable

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threshold for ammonia, 36.8% of samples exceeded acceptable chlorophyll-a levels , 5.6% of samples exceeded acceptable nitrate levels , 5.9% of samples exceeded acceptable phosphorous levels. The bacteria and nutrients in excess of water quality standards are typical of water run-off from areas with a heavily developed agricultural sector.

Groundwater at PALO unit is approximately 20 feet below the surface, while it is about 12 feet below ground surface at the REPA unit. The quality of the groundwater is very poor and the groundwater is not considered to be a suitable source of drinking water or water for irrigation. The groundwater is classified as moderately to very saline (more than 3,000 mg/L) and concentrations of dissolved solids including sodium, chloride and sulfate range from 1,000 to 5,000 mg/L. High levels of nitrate are also present suggesting contamination from agricultural sources (Farmer, 1992).

In 2008, the Gulf Coast Inventory and Monitoring Network Hydrologist determined that the presence of the surface water at Palo Alto was so short-lived and sporadic that a water quality monitoring program would not produce meaningful data.

Intensity Level Definitions

Negligible: Water quality would be affected, or changes would be either non detectable below water quality standards and have effects that would be considered slight, site specific, and short-term.

Minor: Water quality would be measurable, although the changes would be below water quality standards, small, likely short-term, and effects would be site-specific or local. No water quality or hydrology mitigation would be necessary.

Moderate: Changes in water quality or hydrology would be measurable and long-term, may exceed water quality standards, but would be relatively local. Necessary water quality or hydrology mitigation measures would likely succeed.

Major: Changes in water quality or hydrology would be readily measurable, would have substantial consequences, and would be noticed on a regional scale. Mitigation measures would be necessary and their success would not be guaranteed.

Duration: Short-term refers to recovery in less than several days. Long-term refers to recovery requiring longer than several months.

3.3.2 Impact Analysis

3.3.2.1 Alternative A

Under Alternative A chemical treatment is the only activity that has the potential to impact the water quality. Chemical treatments, specifically herbicide applications associated with exotic plant management and weed control along roadways and trails, do have the potential for contaminating surface water through runoff or drip. Herbicide applications may also pose a risk of contaminating ground water by leaching through the soils. However, proper application of

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herbicides according to manufacturer's instructions would mitigate the potential impact to water resources.

It is highly unlikely that herbicide applications would contaminate water resources at the PALO unit. This is because most of the time there is no surface water and the ground water is protected by thick layers of highly impermeable clay soils. For the PALO unit the park will ensure that no herbicide applications take place in the vicinity of standing water, along with following the proper application procedures. Conversely, there is more potential for herbicide applications to contaminate water resources at the REPA unit. This is due to the fact the REPA unit is practically encased within a meander loop with flowing water and the exotic plant species of primary concern, the Brazilian pepper tree, is the densest along the water's edge. It is highly unlikely that herbicide applications would contaminate ground water at the REPA unit since they are protected by thick layers of silty clay soils. Currently the only chemical treatment at REPA is for weed control along the trails and roadsides, which are situated at some distance from the resaca. The park has not begun to address the Brazilian pepper tree infestation. However, the IPM process will be utilized to determine the most effective and environmentally sensitive strategy for reducing and controlling this exotic species. If it is decided that chemical treatments need to be a part of this strategy, then the appropriate herbicide would be selected and the proper applications procedures would be followed to reduce or eliminate the potential to adversely impact the water resources. Overall, following established Best Management Practices and the manufacturer's label would greatly reduce the potential to impact water resource as a result of herbicide applications. Therefore impacts on water quality as a result of chemical treatments in Alternative A would be direct, local, short-term, negligible adverse impacts.

Cumulative Effect: Early twentieth century anthropogenic activities, namely the construction of abutting roadways and the large drainage ditch on the park's northern boundary, have permanently altered the hydrologic regime at the PALO unit by lowering the ground water table and cutting off the wetland prairies and resacas from the surrounding floodplain and watershed. In addition, twentieth century land owners excavated stock tanks, mainly in natural water features, and series of small shallow ditches to transport water to these tanks. Shallow drainage ditches were also constructed along dirt ranch roads, especially when these roads run along old property lines.

In 2014 PAAL plans to initiate a project designed to mechanically remove the man-made water control features (drainage ditches, stock tanks, and artificial levees) in the portion of the Resaca de Palo Alto that is adjacent to trails that provide visitors access to the core battlefield. The purpose of this action is to restore this portion of the resaca to its natural topographic form, which coincides with the condition of the resaca at the time of the battle. This project also calls for the planting of gulf cordgrass along the adjacent prairie and on the newly exposed historic levee elevation where the spoil material from these twentieth century ditches will be removed. This project has very little potential to impact the water quality at PALO unit since the earthmoving activities will take place only when the project area is dry. Any incidental fuel or fluid leaks or spills from the heavy equipment will be properly cleaned up immediately. Overall this project benefits the water resources at the PALO unit by restoring this portion of the resaca to its natural state and reestablishing gulf cordgrass.

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The potential impacts to the water quality of the resaca at the REPA unit primarily originate from external sources that the park has no control over. As previously mentioned, the city uses the network of former river channels to transport agricultural and urban irrigation water, as well as for storm drainage. These bodies of water receive runoff from streets, residential and commercial properties and from agricultural fields, as well as from the system of storm drains. Managing the water quality of these resacas can be problematic. It is definitely difficult to control, yet alone know, what businesses and residents introduce into the resacas that are on their property. Currently PUB monitors and manages the water quality in these resacas. However it is possible that the park and the Gulf Coast Inventory and Monitoring Network would implement a water quality monitoring program at REPA.

PAAL occasionally has projects that require heavy equipment, such as roadwork, trail construction, or even geoarcheological investigation. However, these types of projects are infrequent and of relatively short duration, and can only be executed when the ground surface conditions are dry. Therefore the potential to impact water resources as a result of carrying out such projects is negligible.

Conclusions: The potential impacts associated with the implementation of the vegetation management strategies proposed in Alternative A would have a direct, local, short-term, negligible adverse impact on the water quality of the water resources at the REPA unit. There is essentially no potential to impact the water quality of the water resources at the PALO unit by implementing the vegetation management strategies proposed in Alternative A. It appears that any measurable long-term impacts to the water quality at the park will come from external sources that the park will have no control over. It is possible that the water quality of the resaca at the REPA unit can have elevated levels of various contaminants introduced beyond the boundaries of the park. Regardless, any adverse impacts to water quality caused by the implementation of Alternative A would be short-term and negligible, even when considered with past, present or future actions.

3.3.2.2 Alternative B

Under Alternative B chemical treatment is the only activity that has the potential to impact the water quality of the water resources at PAAL. Chemical treatments, specifically herbicide applications associated with exotic plant management, woody root system destruction, and weed control along roadways and trails, do have the potential for contaminating surface water through runoff or drip. Herbicide applications may also pose a risk of contaminating ground water by leaching through the soils. However, proper application of herbicides according to manufacturer's instructions would mitigate the potential impact to water resources.

It is highly unlikely that herbicide applications would contaminate water resources at the PALO unit. This is because most of the time there is no surface water and the ground water is protected by thick layers of highly impermeable clay soils. For the PALO unit the park will ensure that no herbicide applications take place in the vicinity of standing water, along with following the proper application procedures. Conversely, there is more potential for herbicide applications to contaminate water resources at the REPA unit. This is due to the fact the REPA unit is practically encased within a meander loop with flowing water and the exotic plant species of primary concern, the Brazilian pepper tree, is the densest along the water's edge. It is highly

unlikely that herbicide applications would contaminate ground water at the REPA unit since they are protected by thick layers of silty clay soils. Currently the only chemical treatment at REPA is for weed control along the trails and roadsides, which are situated at some distance from the resaca. The park has not begun to address the Brazilian pepper tree infestation. However, the IPM process will be utilized to determine the most effective and environmentally sensitive strategy for reducing and controlling this exotic species. If it is decided that chemical treatments need to be a part of this strategy, then the appropriate herbicide would be selected and the proper applications procedures would be followed to reduce or eliminate the potential to adversely impact the water resources. Overall, following established Best Management Practices and the manufacturer's label would greatly reduce the potential to impact water resource as a result of herbicide applications. Therefore impacts on water quality as a result of chemical treatments in Alternative A would be direct, local, short-term, negligible adverse impacts.

Cumulative Effect: Early twentieth century anthropogenic activities, namely the construction of abutting roadways and the large drainage ditch on the park's northern boundary, have permanently altered the hydrologic regime at the PALO unit by lowering the ground water table and cutting off the wetland prairies and resacas from the surrounding floodplain and watershed. In addition, twentieth century land owners excavated stock tanks, mainly in natural water features, and series of small shallow ditches to transport water to these tanks. Shallow drainage ditches were also constructed along dirt ranch roads, especially when these roads run along old property lines.

In 2014 PAAL plans to initiate a project designed to mechanically remove the man-made water control features (drainage ditches, stock tanks, and artificial levees) in the portion of the Resaca de Palo Alto that is adjacent to trails that provide visitors access to the core battlefield. The purpose of this action is to restore this portion of the resaca to its natural topographic form, which coincides with the condition of the resaca at the time of the battle. This project also calls for the planting of gulf cordgrass along the adjacent prairie and on the newly exposed historic levee elevation where the spoil material from these twentieth century ditches will be removed. This project has very little potential to impact the water quality at PALO unit since the earthmoving activities will take place only when the project area is dry. Any incidental fuel or fluid leaks or spills from the heavy equipment will be properly cleaned up immediately. Overall this project benefits the water resources at the PALO unit by restoring this portion of the resaca to its natural state and reestablishing gulf cordgrass.

The potential impacts to the water quality of the resaca at the REPA unit primarily originate from external sources that the park has no control over. As previously mentioned, the city uses the network of former river channels to transport agricultural and urban irrigation water, as well as for storm drainage. These bodies of water receive runoff from streets, residential and commercial properties and from agricultural fields, as well as from the system of storm drains. Managing the water quality of these resacas can be problematic. It is definitely difficult to control, yet alone know, what businesses and residents introduce into the resacas that are on their property. Currently PUB monitors and manages the water quality in these resacas. However it is possible that the park and the Gulf Coast Inventory and Monitoring Network would implement a water quality monitoring program at REPA.

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PAAL occasionally has projects that require heavy equipment, such as roadwork, trail construction, or even geoarcheological investigation. However, these types of projects are infrequent and of relatively short duration, and can only be executed when the ground surface conditions are dry. Therefore the potential to impact water resources as a result of carrying out such projects is negligible.

Conclusions: The potential impacts associated with the implementation of the vegetation management strategies proposed in Alternative B would have a direct, local, short-term, negligible adverse impact on the water quality of the water resources at the REPA unit. There is essentially no potential to impact the water quality of the water resources at the PALO unit by implementing the vegetation management strategies proposed in Alternative B, even though chemical treatments would increase. It appears that any measurable long-term impacts to the water quality at the park will come from external sources that the park will have no control over. It is possible that the water quality of the resaca at the REPA unit can have elevated levels of various contaminants introduced beyond the boundaries of the park. Regardless, any adverse impacts to water quality caused by the implementation of Alternative B would be short-term and negligible, even when considered with past, present or future actions.

3.3.2.3 Alternative C

Under Alternative C chemical treatment is the only activity that has the potential to impact the water quality of the water resources at PAAL. Chemical treatments, specifically herbicide applications associated with exotic plant management, woody root system destruction, and weed control along roadways and trails, do have the potential for contaminating surface water through runoff or drip. Herbicide applications may also pose a risk of contaminating ground water by leaching through the soils. However, proper application of herbicides according to manufacturer's instructions would mitigate the potential impact to water resources.

It is highly unlikely that herbicide applications would contaminate water resources at the PALO unit. This is because most of the time there is no surface water and the ground water is protected by thick layers of highly impermeable clay soils. For the PALO unit the park will ensure that no herbicide applications take place in the vicinity of standing water, along with following the proper application procedures. Conversely, there is more potential for herbicide applications to contaminate water resources at the REPA unit. This is due to the fact the REPA unit is practically encased within a meander loop with flowing water and the exotic plant species of primary concern, the Brazilian pepper tree, is the densest along the water's edge. It is highly unlikely that herbicide applications would contaminate ground water at the REPA unit since they are protected by thick layers of silty clay soils. Currently the only chemical treatment at REPA is for weed control along the trails and roadsides, which are situated at some distance from the resaca. The park has not begun to address the Brazilian pepper tree infestation. However, the IPM process will be utilized to determine the most effective and environmentally sensitive strategy for reducing and controlling this exotic species. If it is decided that chemical treatments need to be a part of this strategy, then the appropriate herbicide would be selected and the proper applications procedures would be followed to reduce or eliminate the potential to adversely impact the water resources. Overall, following established Best Management Practices and the manufacturer's label would greatly reduce the potential to impact water resource as a result of

herbicide applications. Therefore impacts on water quality as a result of chemical treatments in Alternative B would be direct, local, short-term, negligible adverse impacts.

Cumulative Effect: Early twentieth century anthropogenic activities, namely the construction of abutting roadways and the large drainage ditch on the park's northern boundary, have permanently altered the hydrologic regime at the PALO unit by lowering the ground water table and cutting off the wetland prairies and resacas from the surrounding floodplain and watershed. In addition, twentieth century land owners excavated stock tanks, mainly in natural water features, and series of small shallow ditches to transport water to these tanks. Shallow drainage ditches were also constructed along dirt ranch roads, especially when these roads run along old property lines.

In 2014 PAAL plans to initiate a project designed to mechanically remove the man-made water control features (drainage ditches, stock tanks, and artificial levees) in the portion of the Resaca de Palo Alto that is adjacent to trails that provide visitors access to the core battlefield. The purpose of this action is to restore this portion of the resaca to its natural topographic form, which coincides with the condition of the resaca at the time of the battle. This project also calls for the planting of gulf cordgrass along the adjacent prairie and on the newly exposed historic levee elevation where the spoil material from these twentieth century ditches will be removed. This project has very little potential to impact the water quality at PALO unit since the earthmoving activities will take place only when the project area is dry. Any incidental fuel or fluid leaks or spills from the heavy equipment will be properly cleaned up immediately. Overall this project benefits the water resources at the PALO unit by restoring this portion of the resaca to its natural state and reestablishing gulf cordgrass.

The potential impacts to the water quality of the resaca at the REPA unit primarily originate from external sources that the park has no control over. As previously mentioned, the city uses the network of former river channels to transport agricultural and urban irrigation water, as well as for storm drainage. These bodies of water receive runoff from streets, residential and commercial properties and from agricultural fields, as well as from the system of storm drains. Managing the water quality of these resacas can be problematic. It is definitely difficult to control, yet alone know, what businesses and residents introduce into the resacas that are on their property. Currently PUB monitors and manages the water quality in these resacas. However it is possible that the park and the Gulf Coast Inventory and Monitoring Network would implement a water quality monitoring program at REPA.

PAAL occasionally has projects that require heavy equipment, such as roadwork, trail construction, or even geoarcheological investigation. However, these types of projects are infrequent and of relatively short duration, and can only be executed when the ground surface conditions are dry. Therefore the potential to impact water resources as a result of carrying out such projects is negligible.

Conclusions: The potential impacts associated with the implementation of the vegetation management strategies proposed in Alternative C would have a direct, local, short-term, negligible adverse impact on the water quality of the water resources at the REPA unit. There is essentially no potential to impact the water quality of the water resources at the PALO unit by

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implementing the vegetation management strategies proposed in Alternative C, even though chemical treatments would increase. It appears that any measurable long-term impacts to the water quality at the park will come from external sources that the park will have no control over. It is possible that the water quality of the resaca at the REPA unit can have elevated levels of various contaminants introduced beyond the boundaries of the park. Regardless, any adverse impacts to water quality caused by the implementation of Alternative C would be short-term and negligible, even when considered with past, present or future actions.

3.4 Wetlands and Floodplains

3.4.1 Affected Environment

PAAL is located in the formerly active Rio Grande delta. The open prairie of PALO unit is a remnant of the historic coastal floodplain. Major hydrologic changes, largely due to human modifications of the immediate environment, have occurred since the 1846 battle. However, the soils and the vegetation communities retain much of the sites historic character. Moreover, an area of land with permanent or seasonal soil saturation where this saturation is the dominant factor determining the nature of soil development and plant communities present can be designated a wetland. The recent Colorado State University hydrological investigation determined that the prairie in core battlefield of Palo Alto should be considered a wetland despite the major hydrologic alterations (Cooper:2011). Therefore, any actions to be carried out on the prairies of Palo Alto will be considered for the impact analysis for floodplains and wetlands.

The REPA unit is essentially a small landform enclosed within a former meander loop of the Rio Grande system. Naturally, this abandoned river channel would only retain water seasonally and would continue to fill in with silt. However, the city manipulates this natural feature in order to transport irrigation water and to serve as drainage features during storm events. Since the resaca is full of water year round, it will be considered an aquatic feature and not a wetland feature. The terrestrial portion of the REPA unit has a pronounced crown. The soils, which are silty clays, and the plant communities are not indicative of a wetland. Consequently, the vegetation management actions that take place at the REPA unit will not be considered for the impact analysis for floodplains and wetlands.

A U.S. Army Corps of Engineers 404 permit will not be required since none of the actions proposed in any of the management alternatives involve soil removal or the addition of fill material to wetlands. In addition, an NPS Statement of Findings for impacts to wetlands or floodplains would not be necessary since both of the action alternatives are designed to restore wetlands and floodplains to their natural condition and therefore would have no adverse impacts to wetlands or floodplains.

Intensity Level Definitions

Negligible: Any effects to floodplains or wetlands would be below or at the lower levels of detection. Any detectable effects would be slight.

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Minor: Effects to floodplains or wetlands would be detectable, and relatively small and short-term to individual plants. No long-term effects to floodplains and wetlands would occur.

Moderate: The effects to floodplains or wetlands would be detectable and readily apparent, including a short-term effect on individual plants and short or long-term effect on the population of plants. The effect could be site-specific or local.

Major: Effects to floodplains or wetlands would be observable over a relatively large localized or regional area and would be long-term. The character of the wetland or floodplain would substantially change its function over the long-term.

Duration: Short-term refers to a period of less than 10 years. Long-term refers to a period longer than 10 years.

3.4.2 Impact Analysis

3.4.2.1 Alternative A

Under Alternative A chemical treatment is the only activity that has the potential to directly impact floodplains and wetlands. Chemical treatments, specifically herbicide applications associated with exotic plant management and weed control along roadways and trails, do have the potential to remove exotic grasses that are uncharacteristic of wetland plant communities. If the current exotic plant management program at the park is able to treat more acres and is successful at reducing the amount of exotic grasses present on the prairies of Palo Alto, then the vegetation communities on the prairie would be represented by native grass and ground cover species associated with wetland plant communities. Therefore, the impacts to floodplains and wetlands as a result of chemical treatments in Alternative A would be direct, site-specific, short to long-term, negligible to minor beneficial impacts. These beneficial impacts will only by minor to negligible because the majority of the prairie at Palo Alto is not infested with exotic grasses.

However, since Alternative A is the "No Action" alternative and does not include any actions that strive to restore and maintain the cultural landscape of the core battlefield, the selection of Alternative A would indirectly negatively impact floodplains and wetlands. This is because the alternative would allow the current trend of native woody species to continue to invade and overtake the historic grassland prairie. Eventually, the historic coastal grassland prairie would be dominated by plant species uncharacteristic of wetland plant communities, and the site would no longer be recognizable or function as a wetland or floodplain. Therefore, the overall impact to floodplains and wetlands as a result of selection of Alternative A would be indirect, local, long-term, moderate adverse impacts.

Cumulative Effect: Past land management activities at Palo Alto have removed stands of gulf cordgrass from the prairie and introduced exotic grasses. Since gulf cordgrass grows in clumps (does not have a rhizome root system), stands of cordgrass tend not to spread outward or invade other areas. Therefore, if the gulf cordgrass is removed from areas, especially large expanses it

generally won't come back on its own. That said; if left unassisted gulf cordgrass might gradually reoccupy the area, but this process could take decades or even centuries depending on the extent of the area the cordgrass was removed from, as well as numerous other natural and cultural influences. This is evident in the time the cordgrass has taken to come back into those long linear features on the core battlefield of Palo Alto. It has been almost 40 years since those features were created and the gulf cordgrass has reestablished itself in less than 10% of the area of those features. If no management actions are implemented to reintroduce gulf cordgrass to the areas of the core battlefield where it was removed, the species will not come back on their own, at least not for the immediate future.

This situation is further exacerbated by twentieth century drainage activities and road construction, which have substantially altered the hydrologic regime by lowering the water table and truncating the historic floodplain. Essentially, these actions have caused the historic coastal wetland prairies of Palo Alto to become drier. Consequently, this is allowing low water tolerant native species, like the mesquite and the prickly pear cactus, to invade and dominate the former wetland prairies. If the current vegetation management activities are continued as is, the appearance of the historic floodplain would continue to degrade and the composition of the plant communities on the prairie would no longer be representative of wetland plant communities. Eventually, the once open prairie where the two armies met would no longer be recognizable.

The 2014 proposed project to remove twentieth century cultural water control features from a portion of the Resaca de Palo Alto and restore the adjacent wetland prairies by planting gulf cordgrass on the newly exposed historic levee elevations and adjacent wetland prairie would have direct beneficial long-term effects on the floodplain and wetland resources within the core battlefield area of Palo Alto. However, the entire project area is in the neighborhood of 60 acres. So without any other management actions to restore and maintain the cultural landscape, this project would have a minor impact and would do nothing to improve the degrading cultural landscape in other areas of the core battlefield at Palo Alto.

Conclusions: Alternative A would have the most long-term, moderate adverse impacts on the historic coastal floodplain and wetlands at Palo Alto of the three alternatives considered. With this "No Action" alternative, prickly pear cactus and woody vegetation would continue to invade and overtake the open grassland prairie. The cumulative effect of this alternative on the floodplain and wetland resources of the battlefield would be to move the condition of these resources further and further away from their pre-disturbance functioning condition. The selection of Alternative A would have a direct, site-specific, short to long-term, minor beneficial impact on the historic floodplain and wetlands by removing plant species that are not characteristic of a wetland, but would have an indirect, local, long-term, moderate adverse impact on these resources when considered with other past, present or future actions.

3.4.2.2 Alternative B

The vegetation management strategies prescribed in Alternative B are designed to restore and maintain the cultural landscape of the core battlefield of Palo Alto utilizing a full battery of management techniques, which coincides with restoring and maintaining the character of the historic floodplain and wetlands. Management actions proposed in Alternative B start with the mechanical reduction and removal of the woody vegetation that has invaded the historic

grassland prairie. This process would take care not to disturb the ground surface, but cut the tree trunks as close to the ground as possible. The tree tops would be strategically left in the field to serve as fuel for prescribed burning. Prickly pear cactus would be cut and removed from the site using shovels and pitch forks without disturbing the soil. This would have a direct, site-specific, short to long-term, and moderate beneficial impact on the historic floodplain and wetlands of the core battlefield.

Alternative B also calls for the herbicide treatment of cut tree stumps to kill the root balls and prevent future growth. This would have indirect, site-specific, short to long-term, moderate beneficial impact on the historic floodplain and wetlands at Palo Alto by substantially reducing the amount of resprouts. This would preserve the historic character of the floodplain and keep the vegetation communities more characteristic of a wetland. Herbicide applications would also be used to control and eliminate exotic plants. This would have a direct, site-specific, short to long-term, minor beneficial impact on the historic floodplain and wetlands of the core battlefield area at Palo Alto. This impact is only minor since the core battlefield is only infested with about 200 acres of exotic grasses.

In addition, Alternative B calls for an active program of reestablishing gulf cordgrass on the historic coastal prairies of the core battlefield area of Palo Alto. This would have a direct, site specific, short to long-term moderate beneficial impact on the floodplain and wetland resources within the core battlefield area of Palo Alto. The reintroduction of gulf cordgrass in areas where it has been removed in the core battlefield would be beneficial to the historic floodplain and wetlands, but it would take a few years before the plants mature and truly resemble the unaltered environment. Eventually these young plugs of gulf cordgrass will mature and dominate the area where they are planted, as illustrated in Texas A&M's test plots. The end result would be plant communities much more characteristic of the historic floodplain and wetlands within the core battlefield. Furthermore, Cooper's (2012) research indicated that the areas of the prairie covered in dense stands of gulf cordgrass retain water longer on the ground surface and in the upper stratum of soils. This would recreate the functional character of the historic wetland. Therefore the overall impact on the historic floodplain and wetland resources as a result of reestablishing the gulf cordgrass in the core battlefield would be direct, site-specific, short to long-term, moderate beneficial impact.

Alternative B also calls for a cyclical prescribed fire program to promote the health and density of the gulf cordgrass, and reduce and stop the growth and spread of exotic grasses, prickly pear cactus, and woody vegetation. This management practice is the primary management action that separates Alternative B from the other alternatives. Eventually cyclical prescribed burning at longer intervals, mimicking the natural fire regime, would be able to maintain the restored cultural landscape with a reduced need for the other vegetation management practices. The gulf cordgrass prairie is a fire-reliant ecosystem and the reintroduction of a fire regime would help this plant community flourish at a more rapid pace. Reintroducing a fire regime would also serve to reduce the invasive native woody species, prickly pear cactus, and if strategically timed, exotic species. Consequently, the implementation of a prescribed fire program to restore and maintain the cultural landscape of the core battlefield would be a direct, site-specific, long-term, moderate beneficial impact on the historic floodplain and wetlands.

Lastly, Alternative B calls for both qualitative (e.g. photo-stations/repeat photography) and quantitative vegetation monitoring (e.g. nested frequency plots) to be established to provide the park continual feedback on all vegetation and restoration management activities. Specific multi-purpose and targeted vegetation monitoring protocols would be developed and implemented in coordination with the NPS personnel of the Gulf Coast Inventory and Monitoring Network, Gulf Coast Exotic Plant Management Team, and fire ecologists to: (1) define the effectiveness of specific vegetation management treatments, (2) provide early detection of newly invading species, (3) determine fire effects on native and non-native vegetation, and (4) determine cultural landscape restoration success in the core battlefield of Palo Alto. This would allow the park to adjust its efforts so the best results can be achieved with the least amount of effort and impact to the environment. Therefore, this management practice would have an indirect site-specific long-term moderate beneficial impact on the cultural landscape of the core battlefield.

Cumulative Effect: Past land management activities at Palo Alto have removed stands of gulf cordgrass from the prairie and introduced exotic grasses. Since gulf cordgrass grows in clumps (does not have a rhizome root system), stands of cordgrass tend not to spread outward or invade other areas. Therefore, if the gulf cordgrass is removed from areas, especially large expanses it generally would not come back on its own. That said; if left unassisted gulf cordgrass might gradually reoccupy the area, but this process could take decades or even centuries depending on the extent of the area the cordgrass was removed from, as well as numerous other natural and cultural influences. This is evident in the time the cordgrass has taken to come back into those long linear features on the core battlefield of Palo Alto. It has been almost 40 years since those features were created and the gulf cordgrass has reestablished itself in less than 10% of the area of those features. If no management actions are implemented to reintroduce gulf cordgrass to the areas of the core battlefield where it was removed, the species will not come back on their own, at least not for the immediate future.

This situation is further exacerbated by twentieth century drainage activities and road construction, which have substantially altered the hydrologic regime by lowering the water table and truncating the historic floodplain. This is allowing low water tolerant native species, like mesquite and prickly pear cactus to invade and dominate the former wetland prairies. The management actions proposed in Alternative B serve to restore and maintain the cultural landscape, by reducing and removing invasive native cactus, native woody species, exotic grass species; reestablishing gulf cordgrass communities; and utilizing prescribed fire to enhance these actions and efficiently maintain the results. Ultimately, the historic floodplain and once open wetland prairie where the two armies met would resemble their 1846 appearance. And although the hydrology of the site would not be restored to the mid-nineteenth century conditions, the natural function of the floodplain and wetland prairie of Palo Alto would be restored.

The 2014 proposed project to remove twentieth century water features from a portion of the Resaca de Palo Alto and restore the adjacent wetland prairies by planting gulf cordgrass on the newly exposed historic levee elevations would have direct beneficial long-term effects on the floodplain and wetland resources within the core battlefield area of Palo Alto. However, the entire project area is in the neighborhood of 60 acres. But with the management actions proposed in Alternative B, this project would as the pioneer effort of restoring the cultural landscape of the core battlefield.

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Conclusions: The potential impacts to the floodplain and wetland prairie at Palo Alto associated with the implementation of the vegetation management strategies proposed in Alternative B would be direct, site-specific, short to long-term, moderate beneficial impacts. The management actions proposed in Alternative B move the floodplain and wetland prairie on the core battlefield at Palo Alto closer and closer towards their historic and functioning conditions. This environmentally preferred alternative carries this out with a more intensive effort upfront, and then with a reduced effort, relying largely on prescribed fire to maintain the desired condition. Therefore, the selection of Alternative B would have direct, site-specific, short to long-term, moderate beneficial impact on the floodplain and wetland prairies at Palo Alto when considered with other past, present or future actions.

3.4.2.3 Alternative C

The vegetation management strategies prescribed in Alternative C are designed to restore and maintain the cultural landscape of the core battlefield of Palo Alto, which coincides with restoring and maintaining the character of the historic floodplain and wetlands. Management actions proposed in Alternative C start with the mechanical reduction and removal of the woody vegetation that has invaded the historic grassland prairie. This process would take care not to disturb the ground surface, but cut the tree trunks as close to the ground as possible. The tree tops would have to be removed off site since this alternative does not allow for prescribed fire. Prickly pear cactus would be cut and removed from the site using shovels and pitch forks without disturbing the soil. This would have a direct, site-specific, short to long-term, and moderate beneficial impact on the historic floodplain and wetlands of the core battlefield.

Alternative C also calls for the herbicide treatment of cut tree stumps to kill the root balls and prevent future growth. This would have indirect, site-specific, short to long-term, moderate beneficial impact on the historic floodplain and wetlands at Palo Alto by substantially reducing the amount of resprouts. This would preserve the historic character of the floodplain and keep the vegetation communities more characteristic of a wetland. Herbicide applications would also be used to control and eliminate exotic plants. This would have a direct, site-specific, short to long-term, minor beneficial impact on the historic floodplain and wetlands of the core battlefield area at Palo Alto. This impact is only minor since the core battlefield is only infested with about 200 acres of exotic grasses.

In addition, Alternative C calls for an active program of reestablishing gulf cordgrass on the historic coastal prairies of the core battlefield area of Palo Alto. This would have a direct, site specific, short to long-term moderate beneficial impact on the floodplain and wetland resources within the core battlefield area of Palo Alto. The reintroduction of gulf cordgrass in areas where it has been removed in the core battlefield would be beneficial to the historic floodplain and wetlands, but it would take a few years before the plants mature and truly resemble the unaltered environment. Eventually these young plugs of gulf cordgrass will mature and dominate the area where they are planted, as illustrated in Texas A&M's test plots. The end result would be plant communities much more characteristic of the historic floodplain and wetlands within the core battlefield. Furthermore, Cooper's (2012) research indicated that the areas of the prairie covered in dense stands of gulf cordgrass retain water longer on the ground surface and in the upper stratum of soils. This would recreate the functional character of the historic wetland. Therefore

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the overall impact on the historic floodplain and wetland resources as a result of reestablishing the gulf cordgrass in the core battlefield would be direct, site-specific, short to long-term, moderate beneficial impact.

Lastly, Alternative C calls for vegetation monitoring to be implemented, but would remain limited to more basic qualitative "change over time" analyses (e.g. establishment of photo-stations and repeat photography). No quantitative monitoring would be established to address (1) the effectiveness of vegetation management treatments, (2) early detection of newly invading species, (3) determine cultural landscape restoration success in the core battlefield of Palo Alto. This reduced vegetation monitoring would essentially limit PAAL's ability to efficiently and effectively restore and maintain cultural landscape of the core battlefield. Therefore, this management practice would have an indirect site-specific long-term minor beneficial impact on the cultural landscape of the core battlefield.

Cumulative Effect: Past land management activities at Palo Alto have removed stands of gulf cordgrass from the prairie and introduced exotic grasses. Since gulf cordgrass grows in clumps (does not have a rhizome root system), stands of cordgrass tend not to spread outward or invade other areas. Therefore, if the gulf cordgrass is removed from areas, especially large expanses it generally won't come back on its own. That said; if left unassisted gulf cordgrass might gradually reoccupy the area, but this could take decades or even centuries depending on the extent of the area they were removed from, as well as numerous other natural and cultural influences. This is evident in the time the cordgrass has taken to come back into those long linear features on the core battlefield of Palo Alto. It has been almost 40 years since those features were created and the gulf cordgrass has reestablished itself in less than 10% of the area of those features. The reestablishment of gulf cordgrass in areas where it has been removed would help to resolve this issue, allowing the gulf cordgrass to once again dominate the prairie of Palo Alto.

Twentieth century drainage activities and road construction have substantially altered the hydrologic regime by lowering the water table and truncating the historic floodplain. This is allowing low water tolerant native species, like the mesquite and the prickly pear cactus to invade and dominate the former wetland prairies. The management practices proposed in Alternative C would work to help reverse this situation. The Colorado State University hydrological investigation (Cooper 2011) indicated that areas on the prairie of Palo Alto that are dominated by gulf cordgrass retain water on the surface and in the upper strata of the soil after rain events, far longer than areas of the prairie covered with other vegetation. So even though PAAL will never be able to restore the mid-nineteenth century hydrologic regime, the vegetation management practices in Alternative C would serve to bring the conditions of the prairie closer to the mid-nineteenth century conditions.

The 2014 proposed project to remove twentieth century water features from a portion of the Resaca de Palo Alto and restore the adjacent wetland prairies by planting gulf cordgrass on the newly exposed historic levee elevations would have direct beneficial long term effects on the cultural landscape of the core battlefield area of Palo Alto. However, the entire project area is in the neighborhood of 60 acres. The implementation of the proposed management actions in

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Alternative C would serve to expand this area by attempting to restore and maintain the cultural landscape in the Core Battlefield Preservation Zone.

Conclusions: The potential impacts associated with the implementation of the vegetation management strategies proposed in Alternative C would have a direct, site-specific, short to long-term, moderate beneficial impact on the floodplain and wetland prairie at Palo Alto. The management actions proposed in Alternative C move the floodplain and wetland prairie on the core battlefield at Palo Alto closer and closer towards their historic and functioning conditions. However, the management strategies proposed in Alternative C call for a continued intensive effort of mechanical and chemical treatments to control the presence of native woody and cactai species on the core battlefield since prescribed fire is not allowed. The inability to use prescribed fire may also serve to indirectly slow the process of the gulf cordgrass dominating the prairie. Therefore, the selection of Alternative B would have direct, site-specific, short to long-term, moderate beneficial impact on the floodplain and wetland prairies at Palo Alto when considered with other past, present or future actions.

3.5 Soils

3.5.1 Affected Environment

PAAL is situated on Holocene/Modern age floodplain deposits, which span the southern and eastern portions of Cameron County. The sediments of this complex fluvial system are composed of deposits of mud, silt, and sand, and are derived from crevasse splays, meander-belt sands, abandoned mud-filled channels, overbank floodbasin muds, distributary sands and silts, interdistributary muds, and both active and inactive clay-sand dunes. The continuous migration of the Rio Grande across this Modern deltaic plain appears to have resulted in a labyrinthine arrangement of fluvial and deltaic deposits characterized by broad flood basins between numerous abandoned meanderbelts and distributary channels. (Mallouf et al. 1977:10; Farmer 1992:3)

The soils at the PALO unit of PAAL consists of the Lomalta series of soils within the Sejita-Lomalta-Barrada association, which is characterized by saline, loamy, and clayey soils at or near sea level. Lomalta series of soils have a surface layer of light-gray, calcareous clay, almost 14 centimeters (cm) thick. Below this upper layer, to a depth about 140 cm is light-gray clay. The underlying material is stratified silty clay loam and silt loam. The soils are poorly drained and very slowly permeable. (Williams et al. 1977:3)

The soils at the REPA unit of PAAL consists of the Laredo Urban Land Complex series of soils within the Laredo-Olmito association, which is characterized by higher, well-drained soils adjacent to resacas. The Laredo Urban Land Complex series of soils have a surface layer of dark-grayish brown, calcareous silty clay loam, about 45 cm thick. Below this upper layer, to a depth about 100 cm is light brownish-gray silt loam. The underlying material is stratified silt loam and silty clay loam. (Williams et al. 1977:7)

Overall, the soils at both park units are thick and sturdy, well-developed soils that were highly impacted during the twentieth century. The soils at PALO are very dynamic and shrink and

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swell based upon their moisture content. Analyses of the potential intensity of impacts to soils were derived from available soils information (USDA 1977) and PAAL staff's past observations of the effects on soils from visitor use, exotic plant management, archeological investigations, and other various projects. The thresholds of change for the intensity of an impact are defined as follows:

Intensity Level Definitions

Negligible: Any effects to soils would be below or at the lower levels of detection. Any effects to soils would be slight and short-term. Impacts would be site-specific, and no mitigation measures would be necessary.

Minor: The effects to soils would be detectable. Effects to soils would be small, as would the area affected. Impacts would be short-term. If mitigation were needed to offset adverse impacts, it would be simple to implement and likely successful.

Moderate: The effect on soils would be readily apparent and detectable, likely long-term, and would result in a change to the soil character over a relatively localized area. Mitigation measures would probably be necessary to offset adverse impacts and would likely succeed.

Major: The effect on soils would be readily apparent and detectable, long-term, and would substantially change the character of the soils over a large localized or regional area. Mitigation measures to offset adverse impacts would be needed, extensive, and their success could not be guaranteed.

Duration: Short-term refers to a period of less than 5 years. The duration of long-term effects is essentially permanent.

3.5.2 Impact Analysis

3.5.2.1 Alternative A

Under Alternative A chemical treatment is the only activity that has the potential to impact the soils at either park unit. Chemical treatments, specifically herbicide applications associated with exotic plant management and weed control along roadways and trails, do have the potential for contaminating soils through runoff or drip. However, proper application of herbicides according to manufacturer's label would mitigate the potential impact to soils from runoff or drip. Equipment or vehicles used to transport crews and equipment to carry-out these exotic plant management activities may inadvertently compact soils. However following the BMPs, in particular staying on established routes and using the minimal tool appropriate, would mitigate this impact. Therefore, the impacts to soils as a result of chemical treatments in Alternative A would be direct, site-specific, short-term, negligible adverse impacts.

Cumulative Effects: Past land management activities have highly impacted the soils on both park units. At the PALO unit, large areas of the core battlefield have been mechanically cleared

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and plowed for the purpose of crop cultivation. The area affected by this practice is primarily the land from the Battlefield Overlook to current eastern boundary of NPS property (excluding the small isolated tracts that the NPS owns along the eastern legislative boundary) northward to the gas pipeline. This area was evidently cleared and plowed annually during the 1970's and 1980's whether any crops were planted or not. Woody vegetation in the areas of the Core Battlefield Preservation Zone north of the gas pipeline was cleared using a bulldozer at least once or twice, during the same period. Also during the twentieth century, numerous dirt ranch roads were established along the perimeters of fields or pasture margins and were usually accompanied by shallow drainage ditches. During the latter part of the twentieth century portions of the core battlefield were used for recreational hunting or shooting and vehicles would drive across many areas of the battlefield. Currently, the ranch roads that the park abandoned have become overgrown with native vegetation.

The REPA unit saw equally high impacts to the soil during the latter half of the twentieth century. During the 1950's this tract was a productive citrus orchard with a subterranean irrigation system. In the 1960's the tract was then converted to a polo field. Fill was brought in and the surface was mechanically sculpted to make a level field. Since then, the large open area of this site has been periodically mowed with heavy mowing equipment. Currently this open area is covered with a dense matt of exotic grasses and weeds, which the park keeps manicured.

Conclusions: The potential impacts associated with the implementation of the vegetation management strategies proposed in Alternative A would have a direct, site-specific, short-term, negligible adverse impact on the soils at both park units. Chemical contamination and inadvertent compaction are the greatest risks to these soils from the proposed management actions. However, following the established BMPs should mitigate these potential impacts. In addition, when considering the sturdy nature and the previous impacts to these soils, inadvertent compaction does not appear to be a threat. Nevertheless, this "No Action" alternative would allow woody vegetation to continue to invade and overtake the historic wetland prairies, ultimately changing the soil development process and the nature of PALO wetland soils Therefore, the selection of Alternative A would have direct, site-specific, short to long-term, minor to moderate adverse impact on the soils at PAAL when considered with other past, present or future actions.

3.5.2.2 Alternative B

The vegetation management strategies prescribed in Alternative B are designed to restore and maintain the cultural landscape of the core battlefield of Palo Alto utilizing a full battery of management techniques. At some level, most of these management strategies have a potential to impact the soil resources of the park. The potential impacts to soils from chemical treatments would be the same as those describe in Alternative A. Therefore, the impacts to soils as a result of chemical treatments proposed in Alternative B would be direct, site-specific, short-term, negligible adverse impacts.

The remainder of the management actions proposed in Alternative B would be carried out on the Core Battlefield Preservation Zone at PALO. These management actions would start with the mechanical reduction and removal of the native woody vegetation that has invaded the historic grassland prairie. This process would take care not to disturb the ground surface, but cut the tree

trunks as close to the ground as possible. The tree tops would be strategically left in the field to serve as fuel for prescribed burning. Prickly pear cactus would be cut and removed from the site using shovels and pitch forks without disturbing the soil. There is a slight chance that during the mechanical removal of the vegetation, that a misguide shovel or saw might disturb the ground surface. However, this should be an incidental and sporadic occurrence that would only impact a pinpoint within the project area. There is also a potential to inadvertently or unduly compact the soils by the vehicles and equipment needed to carry-out these mechanical treatments, although the potential impact would be negligible when considering the sturdy nature of these soils. Therefore, the impacts to soils as a result of mechanical treatments proposed in Alternative B would be direct, site-specific, short-term, negligible adverse impacts.

Alternative B also calls for an active program of reestablishing gulf cordgrass on the historic coastal prairies of the core battlefield area of Palo Alto. This would have a direct, site specific, short-term negligible adverse impact and a long-term moderate beneficial impact on the soils within the core battlefield area of Palo Alto. The reintroduction of gulf cordgrass in areas where it has been removed in the core battlefield would eventually be beneficial to the historic wetland prairie soils. The immediate impact would be from equipment punching small diameter holes in the soil to plant the nursery grown or harvested grass plugs. This would have a short-term negligible adverse impact on the overall soils of the project area. The chance for inadvertent soils compaction during this process would also be negligible. However, eventually these young plugs of gulf cordgrass will mature and dominate the area where they are planted, as illustrated in Texas A&M's test plots. The end result would be plant communities much more characteristic of the historic wetland prairies within the core battlefield. Furthermore, Cooper's (2012) research indicated that the areas of the prairie covered in dense stands of gulf cordgrass retain water longer on the ground surface and in the upper stratum of soils. This would recreate the functional character of the historic wetland, and help to move the soil development process closer to its natural state. Therefore the overall impact on the soils as a result of reestablishing the gulf cordgrass on the core battlefield would be direct, site-specific, long-term, moderate to moderate beneficial impact.

Alternative B also calls for a cyclical prescribed fire program to promote the health and density of the gulf cordgrass, and reduce and stop the growth and spread of exotic grasses, prickly pear cactus, and woody vegetation. This management practice is the primary management action that separates Alternative B from the other action alternative. Eventually cyclical prescribed burning at longer intervals, mimicking the natural fire regime, would be able to maintain the restored wetland prairies with a reduced need for the other vegetation management practices. Prescribed fire treatments may increase the potential to inadvertently or unduly compact the soils since the extremely heavy back-county fire trucks would need to be on site. However, following the BMP of staying on established routes and not conducting treatment events when the ground surface is moist should mitigate this impact. The dynamic nature of the clay soils at PALO also serve to reduce and shorten any adverse impacts to the soil caused by inadvertent or undue compaction. Regardless, the gulf cordgrass prairie is a fire-reliant ecosystem and the reintroduction of a fire regime would help this plant community flourish at a more rapid pace. As mentioned above, dense stands of cordgrass would help to move the soil development process closer to its natural state. In addition, prescribed fires would deposit a layer of freshly burned organic material, thus increasing the nutrient availability in the soils. Consequently, the implementation of a prescribed

fire program to restore and maintain the cultural landscape of the core battlefield would be a direct and indirect, site-specific, short to long-term, moderate beneficial impact on the soils.

Lastly, Alternative B calls for both qualitative (e.g. photo-stations/repeat photography) and quantitative vegetation monitoring (e.g. nested frequency plots) to be established to provide the park continual feedback on all vegetation and restoration management activities. Specific multi-purpose and targeted vegetation monitoring protocols would be developed and implemented in coordination with the NPS personnel of the Gulf Coast Inventory and Monitoring Network, Gulf Coast Exotic Plant Management Team, and fire ecologists to: (1) define the effectiveness of specific vegetation management treatments, (2) provide early detection of newly invading species, (3) determine fire effects on native and non-native vegetation, and (4) determine cultural landscape restoration success in the core battlefield of Palo Alto. This would allow the park to adjust its efforts so the best results can be achieved with the least amount of effort and impact to the environment. Therefore, this management practice would have an indirect, site-specific, long-term moderate to moderate beneficial impact on the soils at PAAL.

Cumulative Effects: Past land management activities have highly impacted the soils on both park units. At the PALO unit, large areas of the core battlefield have been mechanically cleared and plowed for the purpose of crop cultivation. The area affected by this practice is primarily the land from the Battlefield Overlook to current eastern boundary of NPS property (excluding the small isolated tracts that the NPS owns along the eastern legislative boundary) northward to the gas pipeline. This area was evidently cleared and plowed annually during the 1970's and 1980's whether any crops were planted or not. This is the area that the effort to reestablish gulf cordgrass would focus on primarily, since it is where this plant species has been almost entirely removed.

Woody vegetation in the areas of the Core Battlefield Preservation Zone north of the gas pipeline was cleared using a bulldozer at least once or twice, during the same period. Also during the twentieth century, numerous dirt ranch roads were established along the perimeters of fields or pasture margins and were usually accompanied by shallow drainage ditches. During the latter part of the twentieth century portions of the core battlefield were used for recreational hunting or shooting and vehicles would drive across many areas of the battlefield. Currently, the ranch roads that the park abandoned have become overgrown with native vegetation. These actions have helped to move the soil conditions further from their natural state.

The REPA unit saw equally high impacts to the soil during the latter half of the twentieth century. During the 1950's this tract was a productive citrus orchard with a subterranean irrigation system. In the 1960's the tract was then converted to a polo field. Fill was brought in and the surface was mechanically sculpted to make a level field. Since then, the large open area of this site has been periodically mowed with heavy mowing equipment. Currently this open area is covered with a dense matt of exotic grasses and weeds, which the park keeps manicured.

Conclusions: The potential impacts to the soils at PAAL associated with the implementation of the vegetation management strategies proposed in Alternative B would be the same as Alternative A for the areas of the park outside of the core battlefield at PALO. However, the management actions proposed in Alternative B are designed to restore and maintain the historic

plant communities of the wetland prairie on the core battlefield of PALO. This would serve to move the soil development process closer to its natural state. In addition, prescribed fires would deposit a layer of freshly burned organic material, thus increasing the nutrient availability in the soils. The use of prescribed fire would also decrease the amount of effort and intensity needed to maintain this condition. Therefore, the selection of Alternative B would have direct and indirect, site-specific, short to long-term, moderate beneficial impacts on the soils at PAAL when considered with other past, present or future actions.

3.5.2.3 Alternative C

The vegetation management strategies prescribed in Alternative C are designed to restore and maintain the cultural landscape of the core battlefield of Palo Alto utilizing a restrictive battery of management techniques. At some level, most of these management strategies have a potential to impact the soil resources of the park. The potential impacts to soils from chemical treatments would be the same as those describe in Alternative A and B. Consequently, the impacts to soils as a result of chemical treatments proposed in Alternative C would be direct, site-specific, short-term, negligible adverse impacts.

The remainder of the management actions proposed in Alternative C would be carried out on the Core Battlefield Preservation Zone at PALO. These management actions would start with the mechanical reduction and removal of the native woody vegetation that has invaded the historic grassland prairie. This process would take care not to disturb the ground surface, but cut the tree trunks as close to the ground as possible. The tree tops would be removed from the field since prescribed fire is not a management option in Alternative C. Prickly pear cactus would be cut and removed from the site using shovels and pitch forks without disturbing the soil. There is a slight chance that during the mechanical removal of the vegetation, that a misguide shovel or saw might disturb the ground surface. However, this should be an incidental and sporadic occurrence that would only impact a pinpoint within the project area. There is also a potential to inadvertently or unduly compact the soils by the vehicles and equipment needed to carry-out these mechanical treatments, although the potential impact would be negligible when considering the sturdy nature of these soils. However, the increased need for vehicles, equipment, and effort would be increased due to the need to remove the tree tops from the site. Nonetheless, the impacts to soils as a result of mechanical treatments proposed in Alternative C would be direct, site-specific, short-term, negligible adverse impacts.

Alternative C also calls for an active program of reestablishing gulf cordgrass on the historic coastal prairies of the core battlefield area of Palo Alto. This would have a direct, site specific, short-term negligible adverse impact and a long-term moderate beneficial impact on the soils within the core battlefield area of Palo Alto. The reintroduction of gulf cordgrass in areas where it has been removed in the core battlefield would eventually be beneficial to the historic wetland prairie soils. The immediate impact would be from equipment punching small diameter holes in the soil to plant the nursery grown or harvested grass plugs. This would have a short-term negligible adverse impact on the overall soils of the project area. The chance for inadvertent soils compaction during this process would also be negligible. However, eventually these young plugs of gulf cordgrass will mature and dominate the area where they are planted, as illustrated in Texas A&M's test plots. The end result would be plant communities much more characteristic of the historic wetland prairies within the core battlefield. Furthermore, Cooper's

(2012) research indicated that the areas of the prairie covered in dense stands of gulf cordgrass retain water longer on the ground surface and in the upper stratum of soils. This would recreate the functional character of the historic wetland, and help to move the soil development process closer to its natural state. Therefore the overall impact on the soils as a result of reestablishing the gulf cordgrass on the core battlefield would be direct, site-specific, long-term, moderate beneficial impact.

Lastly, Alternative C calls for both qualitative (e.g. photo-stations/repeat photography) and quantitative vegetation monitoring (e.g. nested frequency plots) to be established to provide the park continual feedback on all vegetation and restoration management activities. Specific multi-purpose and targeted vegetation monitoring protocols would be developed and implemented in coordination with the NPS personnel of the Gulf Coast Inventory and Monitoring Network, Gulf Coast Exotic Plant Management Team, and fire ecologists to: (1) define the effectiveness of specific vegetation management treatments, (2) provide early detection of newly invading species, (3) determine fire effects on native and non-native vegetation, and (4) determine cultural landscape restoration success in the core battlefield of Palo Alto. This would allow the park to adjust its efforts so the best results can be achieved with the least amount of effort and impact to the environment. Therefore, this management practice would have an indirect, site-specific, long-term moderate beneficial impact on the soils at PAAL.

Cumulative Effects: Past land management activities have highly impacted the soils on both park units. At the PALO unit, large areas of the core battlefield have been mechanically cleared and plowed for the purpose of crop cultivation. The area affected by this practice is primarily the land from the Battlefield Overlook to current eastern boundary of NPS property (excluding the small isolated tracts that the NPS owns along the eastern legislative boundary) northward to the gas pipeline. This area was evidently cleared and plowed annually during the 1970's and 1980's whether any crops were planted or not. This is the area that the effort to reestablish gulf cordgrass would focus on primarily, since it is where this plant species has been almost entirely removed.

Woody vegetation in the areas of the Core Battlefield Preservation Zone north of the gas pipeline was cleared using a bulldozer at least once or twice, during the same period. Also during the twentieth century, numerous dirt ranch roads were established along the perimeters of fields or pasture margins and were usually accompanied by shallow drainage ditches. During the latter part of the twentieth century portions of the core battlefield were used for recreational hunting or shooting and vehicles would drive across many areas of the battlefield. Currently, the ranch roads that the park abandoned have become overgrown with native vegetation. These actions have helped to move the soil conditions further from their natural state.

The REPA unit saw equally high impacts to the soil during the latter half of the twentieth century. During the 1950's this tract was a productive citrus orchard with a subterranean irrigation system. In the 1960's the tract was then converted to a polo field. Fill was brought in and the surface was mechanically sculpted to make a level field. Since then, the large open area of this site has been periodically mowed with heavy mowing equipment. Currently this open area is covered with a dense matt of exotic grasses and weeds, which the park keeps manicured.

Conclusions: The potential impacts associated with the implementation of the vegetation management strategies proposed in Alternative C would be the same as Alternative A and B for the areas of the park outside of the core battlefield at PALO. However, the management actions proposed in Alternative C would strive to restore and maintain the historic plant communities of the wetland prairie on the core battlefield of PALO. This would serve to move the soil development process closer to its natural state. Although, without the use of prescribed fire, the process of reestablishing the natural state may take longer to achieve and the amount of effort to maintain this state would increase. Therefore, the selection of Alternative C would have direct and indirect, site-specific, short to long-term, moderate beneficial impacts on the soils at PAAL when considered with other past, present or future actions.

3.6 Vegetation

3.6.1 Affected Environment

PAAL is located in the Tamaulipan biotic province, a region of the Matamoran vegetation district. This vegetation is adapted to saline soils, low, variable precipitation and warm climate; and, the vegetation has characteristics of desert, tropical and coastal vegetative communities. Many of these species are endemic to south Texas and northeast Mexico (Farmer, 1992).

Based on the last complete survey of the flora at PAAL, surveyed and compiled between 2006 and 2009 (Palo Alto Battlefield Historic Park, 2009) there are 258 native plants in the park. Common vegetation assemblages and communities are defined as *Spartina spartinae* or gulf cordgrass prairie (sacahuistal plain), tamaulipan and mesquite forests (brush) and resacas, former river channels with ephemeral water and the resultant plant community (Ramsey III et al., 2001). The dominant vegetation zones are tamaulipan brush and the cordgrass prairie.

The tamaulipan brush community occurs on the higher elevation areas with less saline soils. Farmer (1992) found this type accounted for 23% of the total park area. Species common to this vegetation type are mesquite (*Prosopis glandulosa*), spiny hackberry (*Celtis pallida*), Texas ebony (*Pithecellobium flexicaule*), prickly pear (*Opuntia lindheimeri*), Spanish dagger (*Yucca treculeana*), and lotebush (*Zizyphus obtusifolia*)(Farmer, 1992; Richard and Richardson, 1993).

Cordgrass prairie accounted for the remaining 77% of the park area (Farmer, 1992). Continuing brush encroachment has decreased this area and threatens the persistence of this vegetative community in the park. This plant community occupies the lower soils, which are more saline than the upland soils occupied by the brush community. The cordgrass prairie is dominated by gulf cordgrass or sacahuista (*Spartina spartinae*) and sea ox eye or borrichia (*Borrichia frutescens*). Mesquite tumbleweed (*Salsoa kali*) and huisache (*Acacia farnesiana*) are also common in Palo Alto's salt prairies (Farmer, 1992; Richard and Richardson, 1993).

The Texas Parks and Wildlife Department (2009) lists 12 plants as rare, threatened, or endangered at the state or federal level in Cameron County Texas (Appendix A). Of these 12 plants, only one is found in the park, Bailey's ballmoss (*Tillandsia baileyi*). This plant is considered rare; it is not listed as threatened or endangered at either the State or Federal level.

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Bailey's ballmoss grows in clumps as an epiphyte. The leaves are gray and can grow up to 12 inches in length. It flowers in the spring and reproduces via seed. The plant is found in Cameron, Hidalgo and Willacy counties. Commonly found on Texas ebony trees, the ballmoss is threatened by fox squirrels, an introduced species, that destructively feed on the plants (Richardson and King, 2010). This plant has only been identified within the old growth brush on the two large lomas in the southwest quadrant of the Palo Alto Battlefield Unit. There are no federally listed threatened or endangered plant species present at PAAL. The soils and environment at the park are not appropriate for any of the three "Locally Endangered" federally listed plant species that occur in Cameron County.

Intensity Level Definitions

Negligible: No native vegetation populations would be affected but some individual native plants could be affected as a result of the alternative (site-specific). The effects would be short-term, and on a small scale.

Minor: The alternative would affect some individual native plants and a relatively minor portion of that species' population (site-specific). Impacts would be short-term. Mitigation to offset adverse impacts could be required and would be effective.

Moderate: The alternative would affect individual native plants and a sizeable segment of the species' population long-term and over a relatively large area (site-specific or local). Mitigation to offset adverse impacts could be extensive, but would likely be successful.

Major: The alternative would have a considerable long-term effect on native plant populations over a relatively large local or regional area. Mitigation measures to offset the adverse impacts would be required, extensive, and success would not be guaranteed.

Duration: Short-term refers to a period of less than 10 years. Long-term refers to a period of longer than 10 years.

3.6.2 Impact Analysis

3.6.2.1 Alternative A

Reduction in invasive species through mechanical and chemical techniques proposed in *Alternative A* does have the potential to impact native vegetation resources in the park. The targeted species under the "no action" alternative are all non-native species. Herbicide treatments are localized and plants specific; no broadcast spraying is proposed. All herbicide treatments would be effectively mitigated through strict adherence to all relevant chemical application protocols.

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However, the "no action" alternative would not stop continued brush encroachment and would result in the eventual loss of the sacahuistal plain, a critical habitat for the northern Aplomado falcon, and the vegetation with the most profound cultural significance in the park. The loss of this important vegetation type would constitute a negative impact to the vegetation resource.

The Bailey's ballmoss plant is commonly found in Texas ebony trees. Ebony trees are not impacted under the "no action" alternative.

Cumulative Effect: Actions associated with Alternative A would have moderate long-term adverse impact on the native vegetation communities of the park. This "No Action" alternative would allow the continuing encroachment and overtaking of the traditional coastal grassland prairies by woody vegetation. The results of the proposed 2014 "Resaca and Adjacent Wetland Prairie Restoration Project" would be negatively effected if this alternative is chosen. Efforts to control and reduce non-native plants would be beneficial to the native vegetation communities. However, this alternative would continue to allow Palo Alto's vegetation resources to move further and further away from the natural vegetation community distribution. The Natural Resource Condition Assessment will provide the park with some baseline data for qualitatively measuring the effects Alternative A would have on the native vegetation communities.

Conclusions: Selection of Alternative A would have long-term moderate adverse impact on the distribution of native vegetation communities at Palo Alto. Therefore the selection of Alternative A would not be environmentally preferable when considering its impacts on the native vegetation resources.

3.6.2.2 Alternative B

The proposed actions in Alternative B include manual and chemical reduction of brush density, and prescribed burning and planting to restore the sacahuistal plain in the core battlefield zone while promoting dense brush throughout the resource management zone. Herbicide treatments are localized and plants specific; no broadcast spraying is proposed. All herbicide treatments would be effectively mitigated through strict adherence to all relevant chemical application protocols.

The outcome of the "preferred alternative" is restoration of native plant communities and the cultural landscape. This restoration would improve overall ecosystem function in the park. The target vegetative communities resulting from the implementation of *Alternative B* are identified as necessary to fulfill the park's mandate to restore the cultural landscape. This goal is identified in both the park's establishing legislation and general management plan. This alternative would have long-term beneficial impacts to the native vegetation at PAAL.

The Bailey's ballmoss plant is most commonly found in Texas ebony trees. Ebony trees are not impacted under the "preferred" alternative.

Cumulative Effect: Actions associated with Alternative B would have long-term moderate beneficial impact on the native vegetation communities within the park. This environmentally preferred alternative would strive to move the native vegetation communities closer and closer to

their natural composition and distribution. The proposed 2014 "Resaca and Adjacent Wetland Prairie Restoration Project" will be a perfect compliment to the management practices put forth in this alternative for restoring and maintaining wetlands in the park. Ongoing exotic plant management work would be an integral part of this alternative. The monitoring protocols implemented through this alternative, combined with the information provided in the Natural Resource Condition Assessment would effectively provide qualitative and quantitative measurements of the effects these management practices on the native vegetation resources over time.

Conclusions: Selection of Alternative B would have long-term moderate beneficial impact on the preservation and distribution of native vegetation communities at Palo Alto. Therefore the selection of Alternatve B is the environmentally preferred alternative when considering its impacts on the native vegetation resources.

3.6.2.3 Alternative C

The proposed actions in *Alternative C* include manual and chemical reduction of brush density to stop continued brush encroachment of the sacahuistal plain in the core battlefield zone while promoting dense brush throughout the resource management zone. Herbicide treatments are localized and plants specific; no broadcast spraying is proposed. All herbicide treatments would be effectively mitigated through strict adherence to all relevant chemical application protocols.

This alternative would be more effective at controlling non-native and invasive species than *Alternative A.* However it would be ineffective at restoring the native historical plant communities as mandated by the park's establishing legislation. The overall outcome of this alternative would be an adverse impact to the vegetation resource with moderate intensity.

The Bailey's ballmoss plant is commonly found in Texas ebony trees. Ebony trees are not impacted under *Alternative C*.

Cumulative Effect: Actions associated with Alternative C would have a long-term moderate adverse impact on the native vegetation communities of the park. If executed properly, this alternative would essentially freeze the current distribution of the native plant communities. The management practices utilized in this alternative would not move the native vegetation communities closer to their natural composition and distribution. The results of the proposed 2014 "Resaca and Adjacent Wetland Prairie Restoration Project" may be negatively effected if this alternative is chosen. In this alternative, increase efforts to control and reduce exotic plants would have a cumulative beneficial effect on the native vegetation communities. Information from the Natural Resource Condition Assessment and qualitative monitoring techniques will provide the park with a means for qualitatively measuring the effects Alternative C would have on the native vegetation communities.

Conclusions: Overall, the selection of Alternative C would have long-term negligible beneficial impact on the distribution of native vegetation communities at Palo Alto. Therefore the selection of Alternative C would not be environmentally preferable when considering its impacts on the native vegetation resources.

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3.7 Wildlife

The lower Rio Grande Valley is a biologically diverse region with numerous habitat types. There is a variety of wildlife in the region and the predominance of neotropical species of vertebrate fauna makes this area unique (USACE, 1995). More than 700 vertebrates have been identified in the bioregion and over 500 of these are regular inhabitants. Richard and Richardson (1993) completed a faunal survey of the park. This survey documents the presence of ten fish species, 21 amphibians and reptiles, 11 mammals, and 84 bird species. However, there are four species of in the region that are listed as species of concern or threatened and endangered at either or both the state and federal level. These four species: the **Texas tortoise** (*Gopherus berlandieri*), **northern Aplomado falcon** (*Falco femoralis*), **ocelot** (*Leopardus pardalis*), and the **jaguarundi** (*Herpailurus yagouarundi cacomitli*), will be discussed individually to provide a complete analysis of impacts to the wildlife resources of the park. Consultation with the Fish and Wildlife service indicates that the Palo Alto unit does not possess "Critical Habitat" for these species and the differing methods or goals for the Core Battlefield Preservation Zone and Resource Protection Zones strive to enhance the varying habitat types for the local T&E animal species.

3.7.1 Affected Environment

The **Texas tortoise** is listed as a threatened species by the Texas Parks and Wildlife Code, Chapter 68. While populations of the tortoise are considered stable (Bury and Smith, 1986), habitat loss from human activity is the primary threat to the tortoise (Varela and Hogan, 1998). Its range extends from South-Central Texas in the United States southward into the Mexican states of Coahuila, Nuevo Leon, and Tamaulipas (Texas Parks and Wildlife Department, 2009). The tortoise's range contains a variety of habitat types. In coastal areas, including the Palo Alto Battlefield Historic Park, the tortoise occurs principally on lomas. These low hills and ridges provide thermal cover and food resources for the tortoise. Typically the lomas are surrounded by salt marsh or sacahuistal flats, as is the case at PAAL. The dense cordgrass of the sacahuistal flats are primarily uninhabitable for the tortoise and tortoises are rarely found in these areas (Bury and Smith, 1986). These sacahuistal flats preclude movement between lomas and individual lomas may represent discreet populations of tortoises in the Gulf Coast region (Judd and Rose, 1983).

The **northern Aplomado falcon** is listed as endangered in the state of Texas and was placed on the Federal Endangered Species List in 1986. The falcon has been sighted in the park. These sightings were transitory; there are no northern Aplomado falcons nesting in the park. However, there is a pair nesting just to the east of the park boundary. The natural range for the falcon stretches from the southern tip of South America to the South Texas and Trans-Pecos regions, their northern limit. Northern Aplomado falcons do not construct nests of their own; rather they utilize stick nests of other birds. Habitat requirements for the falcon are open grasslands or savannah landscapes with scattered trees or brush. They subsist on a diet comprised predominantly of insects and birds. Habitat loss from grazing induced brush encroachment on native grasslands is frequently cited as the cause for the falcons decline. Breeding and release of falcons raised in captivity has been undertaken since 1997; this program has established at least 37 nesting pairs (Texas Parks and Wildlife Department, 2009).

Study of released falcons at the Laguna Atascosa National Wildlife Refuge (LANWR) indicated that falcons were utilizing habitat with lower densities of perch trees than previously observed. Gulf cordgrass was the most prevalent plant in all roosting sites (Perez et al., 1996).

The **ocelot** is listed as endangered in the state of Texas and was placed on the Federal Endangered Species list in 1972. There are no confirmed sightings of this species in the park. Habitat loss and fragmentation have contributed significantly to the population decline of this cat. The native range of the cat includes South Texas Brush Country and the Lower Rio Grande Valley, and extends south through Central America and South America. The cat requires areas of dense brush for denning and hunts rabbits, birds, and small rodents. Ocelots demonstrated a strong selective preference (use greater than availability) for areas with canopy cover of 95% or greater. Ocelots avoided (use was less than availability) areas with canopy cover density lower than 75% (Harveson et al., 2004). The animal hunts primarily nocturnally. There is a confirmed small population of ocelots in and around LANWR (Texas Parks and Wildlife Department, 2009).

The **jaguarundi** is listed as endangered in the state of Texas and was placed on the federal Endangered Species list in 1976. There are no confirmed sightings of this species in the park. The species occurs throughout Mexico and Central America. The lower Rio Grande Valley in Texas is the extreme northern extent of its historical range. Documented accounts of jaguarundi occurrence are restricted to Cameron, Webb and Wouldacy counties (Tewes and Everett, 1982). More recent work documenting sightings of the jaguarundi were restricted to one confirmed sighting in extreme southern Cameron County (Grigione et al., 2009).The jaguarondi is active early morning and evening, hunting, birds, rabbits, and other small rodents. Jaguarundi rely on dense brush for cover; their decline is believed to be a result of the loss of this habitat type (Texas Parks and Wildlife Department, 2009).

Intensity Level Definitions

Negligible: Any effects to wildlife would be at or below the level of detection, short-term, site-specific, and so slight that they would not be of any measurable or perceptible consequence to the terrestrial wildlife species' population.

Minor: Effects to wildlife would be detectable, although short-term, site-specific, small, and of little consequence to the species' population. Mitigation measures, if needed to offset adverse impacts, would be simple and successful.

Moderate: Effects to wildlife would be readily detectable, short- or long-term, and site-specific, with consequences at the population level. Mitigation measures, if needed to offset adverse impacts, would be extensive and likely successful.

Major: Effects to wildlife would be obvious, long-term, local or regional, and would have substantial consequences to wildlife populations in the region. Extensive mitigation measures would be needed to offset any adverse impacts and their success would not be guaranteed.

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Duration: Short-term refers to a period of less than 10 years. Long-term refers to a period of longer than 10 years.

3.7.2 Impact Analysis

3.7.2.1 Alternative A

Reduction in invasive species through mechanical and chemical techniques does not have the potential to significantly affect wildlife resources in the park. The targeted non-native species are not traditional food sources of any indigenous wildlife populations. All herbicide treatments would be effectively mitigated through strict adherence to all relevant chemical application protocols.

Potential **Northern Aplomado falcon** habitat would be negatively impacted by woody brush encroachment in the core battlefield and other open areas. The falcon's preference for open grasslands and savannah landscapes are not coincident with the vegetation structure developing from implementation of the "no action" alternative.

Any potential habitat of the **Texas tortoise** would not be a candidate for management activities under the "no action" alternative, save for the occasional exotic plant or noxious weed removal. There would be negligible, if any, impact to the tortoise under this alternative.

There has never been a confirmed sighting of the **jaguarundi** at the park. The proliferation of brush vegetation communities resulting from implementing the "no action" alternative would increase the area of potential jaguarundi habitat. Occurrence of this species is extremely rare in the Lower Rio Grande Valley of the United States and any impact to the population from the "no action" alternative would be negligible. This equates to a determination of "no effect" under the Endangered Species Act.

There has never been a confirmed sighting of the **ocelot** at the park. The proliferation of brush vegetation communities resulting from implementing the "no action" alternative would increase the area of potential ocelot habitat. Occurrence of this species is extremely rare in the Lower Rio Grande Valley of the United States and any impact to the population from the "no action" alternative would be negligible. This equates to a determination of "no effect" under the Endangered Species Act.

Cumulative Effect: Actions associated with Alternative A would have a cumulative negative impact on the habitat type preferred by the northern Aplomado falcon. These negative impacts to the Aplomado's preferred habitat type could become moderate to moderate adverse impacts if the management practices for Alternative A are employed for the foreseeable future. This gradual and progressive spread of woody vegetation on the traditional sacahuistal flats may provide new moderately suitable habitat for the other species of concern over time. However, the density, canopy cover, and biodiversity probably would not be suitable permanent habitat for the two feline species of concern, even after several decades of growth. Furthermore, this emerging habitat may become similar to the Texas Tortoises preferred loma habitat over time, but could lead to perilous situation if the tortoises are occupying the low-lying sacahuista flatlands during an extreme flood event, such as those associated with hurricanes and tropical

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storms. The ongoing Texas Tortoise Monitoring Program should provide information on the direct and indirect effects of these management practices on this species. The various monitoring programs implemented by the Gulf Coast Inventory and Monitoring Network and the completion of the Natural Resource Condition Assessment should provide data to assist with measuring these effects on wildlife in the Palo Alto Battlefield Unit of PAAL.

Conclusions: Selection of Alternative A would definitely have a negative impact on the preferred habit type for the one confirmed T&E animal species at Palo Alto, the northern Aplomado falcon. Alternative A might increase the amount of woody habitat for the other T&E animal species. However the density and biodiversity may never reach the level to be considered optimal habitat for these species. Furthermore, this emerging habitat would be overtaking native coastal grassland prairies and changing the natural ecosystem of the area and consequently negatively impacting the native biodiversity of the region. In conclusion, the overall impact of Alternative A on the native wildlife would be negative.

3.7.2.2 Alternative B

The proposed actions in the "preferred alternative" include manual and chemical reduction of brush density, and prescribed burning and planting to restore the sacahuistal plain in the Core Battlefield Preservation Zone while promoting dense brush throughout the Resource Protection Zone. This would serve the parks wildlife resources by providing a diverse array of suitable habitats for a wide variety of species and promoting the native biodiversity of the area. Any proposed reduction in mesquite brush would not be detrimental to potential use by the brush dwelling species of concern (turtle, jaguarundi and ocelot). The density target for these areas is consistent with historical brush densities, which has been used as habitat by these species prior to their precipitous population decline.

Alternative B would effectively improve northern Aplomado falcon habitat in the park. Perez et al. (1996) found gulf cordgrass communities with a low density of perch trees the most favorable vegetation for roosting sites. This is the target structure for the restoration of the core battlefield zone. The "preferred alternative" would have beneficial impact for the falcon and constitute a "may effect, not likely to adversely affect" under the parameters of the Endangered Species Act.

Prescribed burning has the potential to impact the Texas tortoise. The tortoise may not be able to escape fire on the coastal plain of the core battlefield. However, while present in the park the majority of tortoise activity is expected to be confined to the lomas, with very little occurrence of tortoises in the cordgrass prairie (Judd and Rose, 1983). Also, Bury and Smith (1986), identified lomas with open scrub more likely to be optimum habitat than dense brush since tortoise mobility is increased in the more open brush community and basking opportunities are enhanced. Impacts to the tortoise may be mitigated if burning is not done during the hottest and driest periods of the year. Furthermore, the use of cyclical prescribed fire is designed to replicate the natural grassland fire regime, which the tortoise and other native wildlife flourished in for centuries.

The park's vegetation management strategy, proposed as *Alternative B*, may impact potential ocelot habitat. While brush cover in the Core Battlefield Preservation Zone would be reduced, the target condition for the Resource Protection Zone is an increase in area with brush cover.

This would result in a net increase of potential habitat for this species in the park, a beneficial impact. The "preferred alternative" would have beneficial impact for the ocelot and constitute a "may effect, not likely to adversely affect" under the parameters of the Endangered Species Act.

The park's vegetation management strategy, proposed as *Alternative B*, may impact potential jaguarundi habitat. While brush cover in the Core Battlefield Preservation Zone would be reduced, the target condition for the Resource Protection Zone is an increase in area with brush cover. This would result in a net increase of potential habitat for this species in the park, a beneficial impact. The "preferred alternative" would have beneficial impact for the jaguarundi and constitute a "may effect, not likely to adversely affect" under the parameters of the Endangered Species Act.

Cumulative Effect: The cumulative effects produced from the implementation of the management practices of Alternative B would definitely have a beneficial for the one confirmed T&E species in the park, while potentially having a beneficial effect for the other T&E species of concern. The overall cumulative effect of Alternative B would be to move the Palo Alto Battlefield Unit closer to natural ecosystem and thus enhances the native biodiversity of the area. This is determined to be a moderate to moderate beneficial impact over time to all native wildlife species, in particular the northern Aplomado falcon. This will be especially true as the inevitable development associated with the continuing growth of the community will destroy the natural habitat in the surrounding area. The replication of the natural fire regime has a potential to directly adversely impact the Texas Tortoise. However, the gradual and progressive movement of the vegetation community closer to the natural ecosystem should reinforce the traditional habitat utilization patterns of the tortoise. The ongoing Texas Tortoise Monitoring Program should provide information on the direct and indirect effects of these management practices on this species. The various monitoring programs implemented by the Gulf Coast Inventory and Monitoring Network and the completion of the Natural Resource Condition Assessment should provide data to assist with the qualitative and quantitative measuring of the effects on wildlife in the Palo Alto Battlefield Unit of PAAL.

Conclusions: Selection of Alternative B would gradually move the park towards the natural ecosystem and enhance the native biodiversity at Palo Alto. This would be a moderate benefit to the native wildlife species that inhabit the coastal prairie habitat and would definitely benefit the one confirmed T&E species at Palo Alto. Consequently Alternative B would be the environmentally preferred alternative for managing native wildlife species within the park.

3.7.2.3 Alternative C

The proposed actions in *Alternative C* include manual and chemical reduction of brush density to limit continued brush encroachment of the sacahuistal plain in the Core Battlefield Preservation Zone while promoting dense brush throughout the Resource Protection Zone. Any proposed reduction in mesquite brush would not be detrimental to potential use by the brush dwelling species of concern (turtle, jaguarundi and ocelot). The density target for these areas is consistent with historical brush densities, which has been used as habitat by these species prior to their precipitous population decline.

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Alternative C would not change the current quality of habitat available to the northern Aplomado falcon in the park. The limited effectiveness of this treatment would preclude total restoration of the battlefield. It would arrest further mesquite encroachment into the park; but, it is not expected to reduce mesquite density and increase cordgrass cover enough to resemble the Falcons preferred habitat.

Any potential habitat of the Texas tortoise would not be a candidate for management activities under Alternative C. There would be no impact to the tortoise under this alternative.

The park's vegetation management strategy, proposed as *Alternative C*, may impact potential ocelot habitat. While brush cover in the core battlefield zone would not increase, the brush cover the resource protection zone would increase. This would result in a net increase of potential habitat for this species in the park, a beneficial impact. Alternative C would have beneficial impact for the ocelot and constitute a "may effect, not likely to adversely affect" under the parameters of the Endangered Species Act.

The park's vegetation management strategy, proposed as *Alternative C*, may impact potential jaguarundi habitat. While brush cover in the core battlefield zone would not increase, the brush cover the resource protection zone would increase. This would result in a net increase of potential habitat for this species in the park, a beneficial impact. Alternative C would have beneficial impact for the jaguarundi and constitute a "may effect, not likely to adversely affect" under the parameters of the Endangered Species Act.

Cumulative Effect: Actions associated with Alternative C should have a cumulative beneficial impact on the habitat type preferred by the northern Aplomado falcon. However this would not encourage increase usage and possible nesting within the park by this one confirmed T&E species, because of the increased activity to maintain this habitat. Alternative C may stop or slow down the gradual and progressive spread of woody vegetation on the traditional sacahuistal flats, but it would take a considerable amount of intense effort to maintain this condition which would negatively impact the wildlife in the park. The cumulative effects of this, when considered with the inevitable development associated with the continuing growth of the community will destroy the natural habitat in the surrounding area, would not be beneficial to native wildlife, especially the Aplomado. The various monitoring programs implemented by the Gulf Coast Inventory and Monitoring Network and the completion of the Natural Resource Condition Assessment should provide data to assist with measuring these effects on wildlife in the Palo Alto Battlefield Unit of PAAL.

Conclusions: Selection of Alternative C would have a long-term minor adverse impact on native wildlife species, including the northern Aplomado falcon because of the increased and sustained amount of human presence and activity needed to maintain the restored landscape. Therefore the selection of Alternatve C would not be environmentally preferable when considering its impacts on the native wildlife populations.

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3.8 Natural Sound

3.8.1 Affected Environment

PAAL is located very close to the urban centers of Brownsville, Texas and Matamoros, Mexico. At the PALO unit, personal and commercial traffic can be heard from the highways that abut the southern and western boundaries. Railroad noises can be heard from trains passing near the park's southern and western boundaries. Air traffic noise is present from the flights into local airports, distant over-flights and agricultural applications. Weather conditions, wind speed and direction, and season all affect the noise levels within the park. Noise level decreases in the park interior and towards the northern and eastern park boundaries, where the park is bounded by agricultural land. The PALO's interior, particularly the northern and eastern portions, is the area where natural sounds are more dominant than the urban sounds present in the western and southern portions of the park. The historic natural sound, that is the sound prior to all the modern intrusions, would have been dominated by the strong prevailing southeasterly winds whipping through the cordgrass in the wide open prairies accompanied by the various sounds of wildlife.

The REPA unit is located within the urban area of Brownsville. A major thoroughfare serves as the units' western boundary. A large public high school is just to the east of the unit. A wide variety of urban sounds intrude upon the natural sound at REPA. These modern intrusions are present in all areas of the unit. However the dense brush that encases the large open area of the unit does serve to muffle some of the sound. Regardless, weather conditions, wind speed and direction, and season all affect the noise levels within REPA. The historic natural sound would have been dominated by the strong prevailing southeasterly winds bristling through the dense canopy of brush that once covered the site accompanied by the various sounds of wildlife.

Intensity Level Definitions

Negligible: Noise may be generated by plant management activities during daylight hours. Noise is rarely audible at 100 feet or more from the source. When noise is present, it is at very low levels and occurs only for short durations in most of the area.

Minor: Noise generated by plant management activities may predominate during daylight hours, but for the majority of the time the noise is at low levels. When noise is at medium or high levels, it occurs only for a short duration in site-specific areas. Human-caused noise is rarely audible at 500 feet or more from the source.

Moderate: Noise generated by plant management activities predominates during daylight hours, but it is at medium or lower levels for a majority of the time. Localized areas may experience noise at medium to high levels during half of the daylight hours.

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Major: Noise generated by plant management activities predominates during daylight hours, and is at greater than medium levels a majority of the time that noise is present. Large areas may experience noise at medium to high levels during a majority of the daylight hours.

Duration: Short-term refers to a transitory effect, one that largely disappears over a period of minutes or hours. The duration of long-term effects is days or weeks.

3.8.2 Impact Analysis

Analyses of the potential intensity of impacts to natural sound considered noise context, amplitude, and time factors, including duration, frequency of occurrence, and sensitive time periods. The qualitative method used to assess noise impacts from vegetation management activities in this document is in accordance with *Management Policies* 2006 and *Director's Order #47: Soundscape Preservation and Noise* M*anagement.*

3.8.2.1 Alternative A

Under Alternative A, mechanical treatments have the highest potential to impact the natural sound at PAAL. Mechanical treatments, specifically mowing, trimming, and cutting associated with routine maintenance of vegetation within the Development Zone at PALO and at REPA, do have the potential for impacting the natural sound. Mowing and weed-eating activities would be the primary source for these impacts. Currently, PAAL routinely mows and weed-eats the manicured landscape of the visitor center, along trails and roadways, the living history demonstration area, and the large open area at REPA. This activity typically occurs once or twice or month, depending on amount of precipitation. It generally takes a few hours to mow the front lawn of the Visitor Center. It also takes less than half a day to weed-eat around the buildings and plant beds at the Visitor Center. Gas powered riding mowers, hand-pushed mowers, and weed-eaters are used to carry-out this task. It may take a day or two to mow and weed-eat along the roadways and trails of the Development Zone at PALO. Gas powered riding mowers and weed-eaters are used to carry-out this task. A tractor with a mower attachment is used to mow the large open area at REPA, and gas powered weed-eaters are used to maintain the grass and weeds along the trails edge. Generally, the noise from this equipment is at low levels at 100 feet away from its operation. It is very rare that PAAL uses chainsaws to maintain vegetation at the park. Within the past five years, chainsaws have been used to remove hazardous trees from the front entrance area. This operation took less than half a day to complete and the project was carried-out by a small fire crew from FWS. Chainsaws were also used to remove hazardous trees shortly after the park acquired the REPA unit. This took place over a span of a month, but the use of chainsaws was sporadic and many days could go by without one being employed. Consequently it is determined that the overall impacts on natural sound as a result of mechanical treatments prescribed in Alternative A would be direct, site-specific, short-term, minor to minor adverse impact.

Chemical treatments prescribed in Alternative A, for the purpose of exotic plant management and the control of weeds along roadways and trails, have a slight potential to indirectly adversely impact the natural sound at PAAL. Typically, this task is performed on foot, using back pack sprayers. The primary direct impact to the natural sound would be from the vehicles used to

transport the crews and equipment to the project area. This impact is further reduced at PALO since the staff generally uses electric utility vehicles to get around the park. On a rare occasion, generally only when the liason from the Gulf Coast Exotic Plant Management Team is on site, the park will utilize a larger sprayer mounted on the back of a UTV that has a small electric pump motor. The sound of this motor would have a direct adverse impact on the natural sound, however, the sound of the motor can hardly be heard from more than 30 feet away. Therefore, the impacts to natural sound as a result of chemical treatments proposed in Alternative A would be direct, site-specific, short-term, minor adverse impacts.

Cumulative Effect: Past land management activities and twentieth century development have altered the natural sound at both units of PAAL. The REPA unit is totally engulfed by urban development. The dense brush that once covered the majority of this tract has been removed, leaving a large open field. Although native wildlife sounds can be heard, specifically bird species, the continuous sound of urban activity dominates the current soundscape at REPA. The sound intrusions associated with mechanical treatments at REPA would contribute to the degradation of the natural sound. However these adverse impacts would only occur during mechanical treatments that generally occur only a few days out of the month.

Urban development is rapidly approaching the PALO unit. The recent expansion of FM 1847, the ongoing expansion of FM 511, and the development of SH 550 commercial corridor have served to increase the volume and intensity of private and commercial vehicular traffic along the southern and western boundaries of PALO. Currently the sound associated with this increased traffic is the primary source of modern intrusions to the natural sound. The degradation to the natural sound at PALO caused by the increase in vehicular traffic is compounded by the trains that run daily just to the south and west of the unit, as well as by the fact the unit is within the commercial flight path for the Brownsville South Padre Island International Airport. The sound intrusions associated with mechanical treatments at PALO would contribute to the degradation of the natural sound. However these adverse impacts would only occur in the immediate vicinity of the mechanical treatments and would be relatively of short duration and occur only a few times of month.

Past land management activities at PALO and the surrounding area have led to native woody species overtaking the historic grassland prairies. The spread of these woody species may help to dampen the sound of these modern intrusions, however this effect does serve to move the soundscape further and further away from its' historic natural condition.

Conclusions: The potential impacts associated with the implementation of the vegetation management strategies proposed in Alternative A would have a direct, site-specific, short-term, minor adverse impact on the natural sound at both park units. The selection of Alternative A would not improve or degrade the natural sound at REPA, but would have occasional minor impacts. Conversely, this "No Action" alternative would allow woody vegetation to continue to invade and overtake the historic wetland prairies, ultimately changing the natural sound at PALO. Therefore, the selection of Alternative A would have direct, site-specific, short to long-term, minor to moderate adverse impact on the natural sound at PAAL when considered with other past, present or future actions.

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3.8.2.2 Alternative B

The vegetation management strategies prescribed in Alternative B are designed to restore and maintain the cultural landscape of the core battlefield of Palo Alto utilizing a full battery of management techniques. At some level, most of these management strategies have a potential to impact the natural sound, at very least during their implementation. The potential impacts to natural sound from the mechanical treatments associated with routine maintenance of the vegetation in the development areas of the park would be the same as those describe in Alternative A. However, Alternative B calls for additional mechanical treatments in the core battlefield area of PALO to restore the cultural landscape. These management actions would start with the mechanical reduction and removal of the native woody vegetation that has invaded the historic grassland prairie. This would involve the use of chainsaws to cut the tree trunks as close to the ground surface as possible. The tree tops would be strategically left in the field to serve as fuel for prescribed burning. This activity would have a direct, moderate to minor adverse impact on the natural sound at PALO. Although these projects would involve 8 to 10 hour workdays, the projects would only be carried out for a week or two during the year. In addition, prickly pear cactus would be cut and removed from the site using shovels and pitch forks without disturbing the soil. The potential impact to the natural sound from this treatment would be from the vehicles used to transport the crews, as well as the vegetation that is to be carried off site. Alternative B calls for more intensive use of mechanical treatments on the core battlefield during the initial stages of implementation. Overall, these mechanical treatments would restore the open prairies of the park, and in part restore the natural sound of the site. Eventually the need for mechanical treatments would be reduced because prescribed fire should be able to maintain this open prairie with less effort. Therefore, the impacts to natural sound as a result of mechanical treatments proposed in Alternative B would be direct, site-specific, short-term, minor to moderate adverse impacts, as well as having an indirect, site-specific, long-term, moderate beneficial impact on the natural sound.

Alternative B also calls for an active program of reestablishing gulf cordgrass on the historic coastal prairies of the core battlefield area of Palo Alto. This would have a direct, site specific, short-term, negligible adverse impact and a long-term moderate beneficial impact on the natural sound at Palo Alto. The immediate impact on the natural sound would be from the vehicles and equipment used during the preparation and planting process of nursery grown or harvested grass plugs and from the sound of the numerous volunteers needed to carry-out these endeavors. The planting events would last for less than one week per year. Therefore, this would have a direct, short-term, negligible adverse impact on the natural sound at PALO. However, eventually these young plugs of gulf cordgrass will mature and dominate the area where they are planted, as illustrated in Texas A&M's test plots. The end result would be the restoration of the historic, spartina-dominated, wetland prairies within the core battlefield, which should bring the current soundscape closer to the natural state. Therefore the overall impact on the natural sound as a result of reestablishing the gulf cordgrass on the core battlefield would be direct, site-specific, long-term, moderate beneficial impact.

Alternative B also calls for a cyclical prescribe fire program to promote the health and density of the gulf cordgrass, and reduce and stop the growth and spread of exotic grasses, prickly pear cactus, and woody vegetation. Eventually cyclical prescribed burning at longer intervals, mimicking the natural fire regime, would be able to maintain the restored wetland prairies with a

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reduced need for the other vegetation management practices. The gulf cordgrass prairie is a fire-reliant ecosystem and the reintroduction of a fire regime would help this plant community flourish at a more rapid pace. As mentioned above, dense stands of cordgrass would help to move the natural sound closer to its natural state. There may be some direct, negligible adverse impacts to the natural sound at PALO due the equipment and crews carrying out this operation, but these would be of short duration. Overall, the implementation of a prescribed fire program to restore and maintain the cultural landscape of the core battlefield would be a direct and indirect, site-specific, short to long-term, moderate beneficial impact on the natural sound at Palo Alto.

Lastly, Alternative B calls for both qualitative (e.g. photo-stations/repeat photography) and quantitative vegetation monitoring (e.g. nested frequency plots) to be established to provide the park continual feedback on all vegetation and restoration management activities. Specific multi-purpose and targeted vegetation monitoring protocols would be developed and implemented in coordination with the NPS personnel of the Gulf Coast Inventory and Monitoring Network, Gulf Coast Exotic Plant Management Team, and fire ecologists to: (1) define the effectiveness of specific vegetation management treatments, (2) provide early detection of newly invading species, (3) determine fire effects on native and non-native vegetation, and (4) determine cultural landscape restoration success in the core battlefield of Palo Alto. This would allow the park to adjust its efforts so the best results can be achieved with the least amount of effort and impact to the environment. Therefore, this management practice would have an indirect, site-specific, long-term moderate beneficial impact on the natural sound at PALO.

Cumulative Effect: Past land management activities and twentieth century development have altered the natural sound at both units of PAAL. The REPA unit is totally engulfed by urban development. The dense brush that once covered the majority of this tract has been removed, leaving a large open field. Although native wildlife sounds can be heard, specifically bird species, the continuous sound of urban activity dominates the current soundscape at REPA. The sound intrusions associated with mechanical treatments at REPA would contribute to the degradation of the natural sound. However these adverse impacts would only occur during mechanical treatments that generally occur only a few days out of the month.

Urban development is rapidly approaching the PALO unit. The recent expansion of FM 1847, the ongoing expansion of FM 511, and the development of SH 550 commercial corridor have served to increase the volume and intensity of private and commercial vehicular traffic along the boundaries of PALO. The sounds associated with this increased traffic currently serves to be the primary source of modern intrusions to the natural sound. The degradation to the natural sound at PALO caused by the increase in vehicular traffic is compounded by the trains that run daily just to the south and west of the unit, as well as by the fact the unit is within the commercial flight path for the Brownsville South Padre Island International Airport. The sound intrusions associated with vegetation management treatments at PALO proposed in Alternative B would contribute to the degradation of the natural sound. However these adverse impacts would only occur in the immediate vicinity of the mechanical treatments and would be relatively short-lived.

Past land management activities at PALO and the surrounding area have led to native woody species overtaking the historic grassland prairies. The spread of these woody species may help

to dampen the sound of these modern intrusions, however this effect does serve to move the soundscape further and further away from its' historic natural condition.

Conclusions: Alternative B is designed to restore the natural environment within the Core Battlefield Preservation Zone at PALO to its mid-nineteenth century conditions, which provides the best opportunity for replicating the natural sounds of Palo Alto prior to the modern aural intrusions. Vegetation management treatments proposed in Alternative B would have some direct adverse impacts to the natural sound at PALO, however, these would last only during the implementation of the treatments. The end result would be vegetation communities that more closely resemble the natural vegetation communities, thus improving the natural sound of the site within the core battlefield area. Furthermore, use of prescribed fire in Alternative B should allow PAAL maintain this restored natural environment with less effort than the Alternative C. Therefore, the selection of Alternative B would have direct, site-specific, short-term, minor adverse impact on the natural sound at PALO, but when considered with other past, present or future actions, Alternative B would have a direct and indirect, site-specific, long-term, moderate to moderate beneficial impact on the natural sound.

3.8.2.3 Alternative C

The vegetation management strategies prescribed in Alternative C are designed to restore and maintain the cultural landscape of the core battlefield of Palo Alto utilizing a restrictive battery of management techniques. At some level, most of these management strategies have a potential to impact the natural sound, at very least during their implementation. The potential impacts to natural sound from the mechanical treatments associated with routine maintenance of the vegetation in the development areas of the park would be the same as those describe in Alternative A. However, Alternative C calls for additional mechanical treatments in the core battlefield area of PALO to restore the cultural landscape. These management actions would start with the mechanical reduction and removal of the native woody vegetation that has invaded the historic grassland prairie. This would involve the use of chainsaws to cut the tree trunks as close to the ground surface as possible. The tree tops would be strategically left in the field to serve as fuel for prescribed burning. This activity would have a direct, moderate to minor adverse impact on the natural sound at PALO. Although these projects would involve 8 to 10 hour workdays, the projects would only be carried out for a week or two during the year. In addition, prickly pear cactus would be cut and removed from the site using shovels and pitch forks without disturbing the soil. The potential impact to the natural sound from this treatment would be from the vehicles used to transport the crews, as well as the vegetation that is to be carried off site. Alternative C calls for more intensive use of mechanical treatments on the core battlefield during the initial stages of implementation. Overall, these mechanical treatments would restore the open prairies of the park, and in part restore the natural sound of the site. However, a continued effort of mechanical treatments would be necessary over the foreseeable future since prescribed fire is not allowed in this alternative. Therefore, the impacts to natural sound as a result of mechanical treatments proposed in Alternative C would be direct, site-specific, short to long-term, minor to moderate adverse impacts, as well as having an indirect, site-specific, long-term, minor to moderate beneficial impact on the natural sound.

Alternative C also calls for an active program of reestablishing gulf cordgrass on the historic coastal prairies of the core battlefield area of Palo Alto. This would have a direct, site specific,

short-term negligible adverse impact and a long-term moderate beneficial impact on the natural sound at Palo Alto. The immediate impact on the natural sound would be from the vehicles and equipment used during the preparation and planting process of nursery grown or harvested grass plugs and from the sound of the numerous volunteers needed to carry-out these endeavors. The planting events would last for less than one week per year. Therefore, this would have a direct, short-term, negligible adverse impact on the natural sound at PALO. However, eventually these young plugs of gulf cordgrass will mature and dominate the area where they are planted, as illustrated in Texas A&M's test plots. The end result would be the restoration of the historic, spartina-dominated, wetland prairies within the core battlefield, which should bring the current soundscape closer to the natural state. Therefore the overall impact on the natural sound as a result of reestablishing the gulf cordgrass on the core battlefield would be direct, site-specific, long-term, moderate beneficial impact.

Cumulative Effect: Past land management activities and twentieth century development have altered the natural sound at both units of PAAL. The REPA unit is totally engulfed by urban development. The dense brush that once covered the majority of this tract has been removed, leaving a large open field. Although native wildlife sounds can be heard, specifically bird species, the continuous sound of urban activity dominates the current soundscape at REPA. The sound intrusions associated with mechanical treatments at REPA would contribute to the degradation of the natural sound. However these adverse impacts would only occur during mechanical treatments that generally occur only a few days out of the month.

Urban development is rapidly approaching the PALO unit. The recent expansion of FM 1847, the ongoing expansion of FM 511, and the development of SH 550 commercial corridor have served to increase the volume and intensity of private and commercial vehicular traffic along the boundaries of PALO. The sounds associated with this increased traffic currently serves to be the primary source of modern intrusions to the natural sound. The degradation to the natural sound at PALO caused by the increase in vehicular traffic is compounded by the trains that run daily just to the south and west of the unit, as well as by the fact the unit is within the commercial flight path for the Brownsville South Padre Island International Airport. The sound intrusions associated with mechanical treatments at PALO would contribute to the degradation of the natural sound. However these adverse impacts would only occur in the immediate vicinity of the mechanical treatments and would be relatively short-lived.

Past land management activities at PALO and the surrounding area have led to native woody species overtaking the historic grassland prairies. The spread of these woody species may help to dampen the sound of these modern intrusions, however this effect does serve to move the soundscape further and further away from its' historic natural condition.

Conclusions: Alternative C is designed to restore the natural environment within the Core Battlefield Preservation Zone at PALO to its mid-nineteenth century conditions, which provides the opportunity for replicating the natural sounds of Palo Alto prior to the modern aural intrusions. Vegetation management treatments proposed in Alternative C would have some direct adverse impacts to the natural sound at PALO, however, these would last only during the implementation of the treatments. The end result would be vegetation communities that more closely resemble the natural vegetation communities, thus improving the natural sound of the site

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within the core battlefield area. However, since prescribed fire is not allowed in Alternative C, PAAL would have to maintain a continual effort of mechanical treatments to keep invasive woody and cactus vegetation off the core battlefield, which would have continual short-term adverse impacts to the natural sound at PALO. Therefore, the selection of Alternative C would have direct, site-specific, short-term, minor to moderate adverse impact on the natural sound at PALO, but when considered with other past, present or future actions, Alternative C would have a direct and indirect, site-specific, long-term, moderate beneficial impact on the natural sound.

3.9 Human Health and Safety

3.9.1 Affected Environment

Visitors to PALO have access to the Visitor Center, which provides an interpretive video, museum exhibits, and a souvenir and bookstore. There is also a picnic table area and a living history demonstration area to the north of the Visitor Center, as well as a pedestrian trail system that provides visitor access onto the core battlefield. The REPA unit, which is currently open to the public only during scheduled tours and special events, has a half-mile loop trail, with a few small spur trails. There is also a large gazebo with picnic benches at REPA.

Visitors, park staff, contractors, partners and volunteers, as well as the general public in the surrounding community, have a reasonable expectation that the park facilities or park management activities will not expose them to unknown and unnecessary health and safety hazards.

Intensity Level Definitions

Negligible: The impact to human health would be so small that it would not be of any measurable or perceptible consequence and/or will affect few visitors or staff.

Minor: The impact to human health is slight but would be small and localized and of little consequence, and/or will affect some visitors or staff.

Moderate: The impact to human health is readily apparent, would be measurable and consequential, but more localized and/or will affect many visitors and staff.

Major: The impact to human health is severely adverse. The change would be measurable and possibly permanent, and/or will affect the majority of visitors or staff.

Duration: Short-term effects last only during the proposed treatment period (i.e. treatment of a particular site at a particular point in time). Long term effects refer to lasting longer than the treatment period.

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3.9.2 Impact Analysis

3.9.2.1 Alternative A

Under Alternative A, mechanical and chemical treatments have the potential to impact human health and safety at PAAL. Mechanical treatments, specifically mowing, trimming, and cutting associated with routine maintenance of vegetation within the Development Zone at PALO and at REPA, do have the potential for impacting human health and safety. The personnel implementing these treatments, whether they be park staff, contractors, partners, or volunteers, are at the greatest risk, while visitors at the park have a slight risk, and the general public in the surrounding community are at no risk. The threats to human health and safety for the personnel carrying-out these treatments could be from circumstances such as debris flying up from a mower or weed-eater, thorny vegetation striking the face, dehydration, heat exhaustion, or venomous wildlife. While the threats to human health and safety for the visitor at the park is mainly from debris flying up from a mower or weed-eater. Following the BMPs outlined in Section 2, which include practices such as producing JHAs and GARs, conducting routine tailgate safety sessions, proper training, using the minimum tool necessary, using the appropriate PPE, and carrying-out these activities when visitors are not present would mitigate these risks. Therefore, the impacts to human health and safety as a result of mechanical treatments prescribed in Alternative A would be direct, site-specific, short-term, negligible adverse impacts for the personnel carrying-out these treatments, while there would be no impact to human health and safety for the visitor at the park or the general public in the surrounding community.

Chemical treatments, specifically herbicide treatments for exotic plant management throughout the park, as well as herbicide treatments for weed control along trails and roadways, do have the potential for impacting human health and safety. Again, the risk is greater for personnel carrying-out the treatments than it would be for the visitor at the park, while there would be no risk for the general public in the surrounding community. These risks can also be mitigated by following the BMPs outlined in Section 2, which include such practices as the ones mentioned above, as well as practices such as adhering to the manufacturer's label and closing off treatment areas to the visitor.

Cumulative Effects: Current and increased traffic congestion may increase the risk to human health and safety for park visitors, staff, contractors and volunteers entering and leaving either park unit. The park has minimal control over this, but can mitigate some of the risk by maintaining safe entrances and exits. In addition, some projects, such as the proposed 2014 resaca and adjacent wetland prairie project or unforeseen construction projects, may contribute to increase the risk to human health and safety, by increased activity. However, the increase in risk would only be during the implementation of the project and would be primarily for the personnel carrying-out the work.

Conclusion: The impacts to human health and safety by the implementation of the vegetation management strategies in Alternative A can be mitigated by strict adherence to the BMPs. Primarily, only the personnel carrying-out these treatments are at risks. Proper training, supervision, use of PPE, and a culture of safety should prevent accidents. If the BMPs are adhered to, the potential impacts to human health and safety should be reduce to inadvertent insect stings or minor scratches from vegetation. Furthermore, there does not appear to be any

true cumulative effects on human health and safety by implementing the vegetation management strategies proposed in Alternative A when considered with any past, present or future projects or activities. Therefore the impacts to human health and safety by implementing Alternative A would be direct, site-specific, short-term, negligible adverse impacts.

3.9.2.2 Alternative B

Under Alternative B, the potential impacts to human health and safety from mechanical and chemical treatments would be the same as those described for Alternative A. Even though Alternative B calls for a substantial increase in mechanical and chemical treatments in the Core Battlefield Preservation Zone, the associated impacts to human health and safety can be mitigated by strict adherence to the BMPs. Moreover, the need for mechanical and chemical treatments in the core battlefield area of PALO should be reduced over time in Alternative B, since this alternative allows the cultural treatment of prescribed fire. Therefore, the impacts to human health and safety as a result of mechanical or chemical treatments prescribed in Alternative B would be direct, site-specific, short-term, negligible adverse impacts for the personnel carrying-out these treatments, while there would be no impact to human health and safety for the visitor at the park.

Alternative B also calls for an active program of reestablishing gulf cordgrass on the historic coastal prairies of the core battlefield area of Palo Alto. This has the potential to impact human health and safety by an increase in activity. As with the chemical and mechanical treatments, the risks are primarily to the personnel carrying-out these treatments and not to the visitor at the park, or the general public in the surrounding community. There is a slight increase of chance for accidents, dehydration, or heat related illnesses since these planting efforts would call for large number of volunteers. However, the primary activity that the volunteers would be doing during these events would be placing nursery grown or harvested grass plugs in existing holes and then patting the dirt around them. Regardless, these risks can be mitigated by following the BMPs outlined in Section 2, which include proper training and safety orientation, proper supervision, and the use of appropriate PPE. Therefore, the impacts to human health and safety as a result of the re-vegetation program prescribed in Alternative B would be direct, site-specific, short-term, negligible adverse impacts for the personnel carrying-out this activity, while there would be no impact to human health and safety for the visitor at the park or the general public in the surrounding community.

The cultural treatment of prescribe fire is the one management strategy that has a potential to adversely impact the human health and safety, not only of the personnel carrying-out the task, but for the visitor at the park, and the general public in the surrounding community. However, the risk to the visitor and the public is minimal compared those carrying-out the activity. The primary risk to human health and safety is from smoke inhalation. To mitigate these risks, the park would adhere to established BMPs, which would include such practices as the following. Area closures would be in effect for the entire time the prescribed fire is present. Prior to the ignition of any prescribed fire in the park, all the burn parameters of the existing and approved fire prescription plan must be met to ensure a safe and effective prescribed fire. In addition, staff would inform the public and adjacent landowners of the time and extent of the proposed prescribed fire. All mandatory protective measures and procedures detailed in National Park Service fire management protocols would be strictly followed. Strict adherence to guidelines

concerning firefighter accreditation, and equipment and procedure safety guidelines would minimize accidents. Prescribed fire events would only be carried out during periods of suitable meteorological conditions. Therefore, the impacts to human health and safety as a result of prescribed fire treatments called for in Alternative B would be direct, site-specific, short-term, negligible adverse impacts for the personnel carrying-out these treatments, while there would be no impact to human health and safety for the visitor at the park or the general public in the surrounding community.

Cumulative Effects: Current and increased traffic congestion may increase the risk to human health and safety for park visitors, staff, contractors and volunteers entering and leaving either park unit. The park has minimal control over this, but can mitigate some of the risk by maintaining safe entrances and exits. In addition, some projects, such as the proposed 2014 resaca and adjacent wetland prairie project or unforeseen construction projects, may contribute to increase the risk to human health and safety, by increased activity. However, the increase in risk would only be during the implementation of the project and would be primarily for the personnel carrying-out the work.

Conclusions: The impacts to human health and safety by the implementation of the vegetation management strategies in Alternative B can be mitigated by strict adherence to established BMPs. Primarily, only the personnel carrying-out these treatments are at risks. Proper training, supervision, use of PPE, and a culture of safety should prevent accidents. Furthermore, there does not appear to be any true cumulative effects on human health and safety by implementing the vegetation management strategies proposed in Alternative B when considered with any past, present or future projects or activities. Therefore the impacts to human health and safety by implementing Alternative B would be direct, site-specific, short-term, negligible adverse impacts.

3.9.2.3 Alternative C

Under Alternative C, the potential impacts to human health and safety from mechanical, chemical, and re-vegetation treatments would be the primarily the same as those described for Alternative A and B. The main difference is that mechanical and chemical treatments on the core battlefield area of PALO would need to be sustained at increased levels since Alternative C does not allow for the use prescribed fire. Regardless, the impacts to human health and safety as a result of the vegetation management treatments prescribed in Alternative C would be direct, site-specific, short-term, negligible adverse impacts for the personnel carrying-out these treatments, while there would be no impact to human health and safety for the visitor at the park.

Cumulative Effects: Current and increased traffic congestion may increase the risk to human health and safety for park visitors, staff, contractors and volunteers entering and leaving either park unit. The park has minimal control over this, but can mitigate some of the risk by maintaining safe entrances and exits. In addition, some projects, such as the proposed 2014 resaca and adjacent wetland prairie project or unforeseen construction projects, may contribute to increase the risk to human health and safety, by increased activity. However, the increase in risk would only be during the implementation of the project and would be primarily for the personnel carrying-out the work.

Conclusions: The impacts to human health and safety by the implementation of the vegetation management strategies in Alternative C can be mitigated by strict adherence to established BMPs. Primarily, only the personnel carrying-out these treatments are at risks. Proper training, supervision, use of PPE, and a culture of safety should prevent accidents. Furthermore, there does not appear to be any true cumulative effects on human health and safety by implementing the vegetation management strategies proposed in Alternative C when considered with any past, present or future projects or activities. Therefore the impacts to human health and safety by implementing Alternative C would be direct, site-specific, short-term, negligible adverse impacts.

3.10 Visitor Use and Experience

3.10.1 Affected Environment

Visitors to PALO have access to the Visitor Center, which provides an interpretive video, museum exhibits, and a souvenir and bookstore. There is also a picnic table area and a living history demonstration area to the north of the Visitor Center, as well as a pedestrian trail system that provides visitor access onto the core battlefield. The REPA unit, which is currently open to the public only during scheduled tours and special events, has a half-mile loop trail, with a few small spur trails. There is also a large gazebo with picnic benches at REPA.

Scheduled school field trips, guided tours, living history demonstrations, and other park events occur at various times throughout the year. The park is open to visitor use year round from 8:00 am to 5:00 pm daily, save for a few holidays.

Intensity Level Definitions

Negligible: The effect on availability of desired visitor experiences, or the number of visitors affected, would be slight or nonexistent.

Minor: The effect on availability of desired visitor experiences, or the number of visitors affected, would be relatively small. The effect would be limited to relatively few individuals, be localized in area or short in duration, and/or affect recreation opportunities common in the park or region.

Moderate: The effect on availability of desired visitor experiences, or the number of visitors affected, would be intermediate. The effect would involve an intermediate number of visitors, portion of the park, duration, and/or affect recreation opportunities uncommon in the park or region. The visitor would likely be able to express an opinion about the changes.

Major: The effect on availability of desired visitor experiences, or the number of visitors affected, would be substantial. The effect would involve a substantial number of visitors, portion of the park, duration, and/or affect recreation opportunities

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uncommon or unique in the park or region. The visitor would likely be able to express a strong opinion about the changes.

Duration: Short-term effects last only during the proposed treatment period (i.e. treatment of a particular site at a particular point in time). Long-term effects refer to lasting longer than the treatment period.

3.10.2 Impact Analysis

3.10.2.1 Alternative A

While Alternative A utilizes the least intensive vegetation management strategies, this "no action" alternative would have the most deleterious impact on the visitor experience at core battlefield at PALO, while having a negligible impact on visitor use for the entire park. The mechanical and chemical treatments prescribed in Alternative A may have a minor to negligible impact on visitor use by restricting visitor access to specific areas of the park for short periods of time. However, whenever possible, vegetation management treatments requiring closure to any portion of the park where visitors have access would be timed in conjunction with historically low visitor use periods. Therefore continuing the current vegetation management program would have a direct, site-specific, short-term, negligible adverse impact on visitor use at PAAL. However, not implementing management actions to reduce and remove the invasive native woody species or reintroduce gulf cordgrass on the core battlefield at Palo Alto would let the historic character of the site continue to degrade. This would have a direct, site-specific, long-term moderate adverse impact on the visitor experience at the core battlefield at Palo Alto.

Cumulative Effects: Past land management actions have had no impact on the visitor use patterns at PAAL. The development of the park by the NPS has had indirect, site-specific, long-term, moderate beneficial impact to visitor use, while having a direct, site-specific, short-term, negligible to minor adverse impact on visitor use. Furthermore, any proposed or foreseeable park management actions would appear to have direct, site-specific, short-term, negligible to minor adverse impacts on visitor use, while having indirect, site-specific, long-term, minor to moderate beneficial impacts on visitor use. Regardless, the primary impact the implementation of this Integrated Vegetation Management Plan would have on visitors, would be to their experience on the core battlefield at PALO. Therefore, the cumulative effects to be considered will concentrate on the effects to the visitor experience on the core battlefield at PALO.

Past land management activities at Palo Alto have removed portions of the gulf cordgrass prairie and introduced exotic grasses. Since gulf cordgrass grows in clumps, does not have a rhizome root system, stands of cordgrass tend not to spread outward or invade other areas. Therefore, if the gulf cordgrass is removed from areas, especially large expanses it generally won't come back on its own. That said; if left unassisted gulf cordgrass might gradually reoccupy the area, but this process could take decades or even centuries depending on the extent of the area they were removed from, as well as numerous other natural and cultural influences. This is evident in the time the cordgrass has taken to come back into those long linear features on the core battlefield of Palo Alto. It has been almost 40 years since those features were created and the gulf cordgrass has reestablished itself in less than 10% of the area of those features. If no

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management actions are implemented to reintroduce gulf cordgrass to the areas of the core battlefield they will not come back on their own, at least not for the foreseeable future.

This situation is further exacerbated by twentieth century drainage activities and road construction, which have substantially altered the hydrologic regime by lowering the water table and truncating the historic floodplain. This is allowing low water tolerant native species, like the mesquite and the prickly pear cactus to invade and dominate the former wetland prairies. If the current vegetation management activities are continued as is, the cultural landscape would continue to degrade until the once open prairie where the two armies met would no longer be recognizable.

The 2014 proposed project to remove twentieth century water features from a portion of the Resaca de Palo Alto and restore the adjacent wetland prairies by planting gulf cordgrass on the newly exposed historic levee elevations would have direct beneficial long term effects on the cultural landscape of the core battlefield area of Palo Alto. However, the entire project area is in the neighborhood of 60 acres. So without any other management actions to restore and maintain the cultural landscape, this project would have a minor impact and would do little to improve the visitor experience at the core battlefield at Palo Alto.

Conclusions: Alternative A would have most long-term, moderate adverse impacts on the cultural landscape at Palo Alto of the three alternatives considered. With this No Action alternative, prickly pear cactus and woody vegetation would continue to invade and overtake the open grassland prairie. The cumulative effect of this alternative on the cultural landscape of the core battlefield at PALO would be to move the condition of the cultural landscape further and further away from the desired condition. The selection of Alternative A would have a direct, site-specific, short-term, negligible adverse impact on the visitor use patterns by temporary closing small areas of the park, but would have an indirect, local, long-term, moderate adverse impact on the visitor experience at PALO by putting forth no management strategies that would effectively restore and maintain the cultural landscape of the core battlefield area of Palo Alto.

3.10.2.2 Alternative B

The vegetation management strategies prescribed in Alternative B are designed to restore and maintain the cultural landscape of the core battlefield of Palo Alto utilizing a full battery of management techniques. Overall, the implementation of these vegetation management actions would have a direct, site-specific, short-term, negligible adverse impact on visitor use at PAAL by temporary closing sections of the park. However, they would have a direct and indirect, site-specific, short and long-term, moderate beneficial impact on the visitor experience at the core battlefield of PALO.

Management actions proposed in Alternative B start with the mechanical reduction and removal of the woody vegetation that has invaded the historic grassland prairie. The tree tops would be strategically left in the field to serve as fuel for prescribed burning. Prickly pear cactus would be cut and removed from the site using shovels and pitch forks without disturbing the soil. This would have a direct, site-specific, short to long-term, moderate beneficial impact on the visitor experience at the core battlefield of PALO by opening up the viewshed, and helping the site to appear as it did in 1846. Although the tree tops may stick up some above the surrounding grasses

for a few months, the overall appearance of the site would be open. Once the area has been burned, this issue should be significantly reduced, if not eliminated.

Alternative B also calls for the herbicide treatment of cut tree stumps to kill the root ball and prevent future growth. This would have indirect, site-specific, long-term, moderate beneficial impact on the visitor experience by substantially reducing the amount of resprouts. Herbicide applications would also be used to control and eliminate exotic plants. This would have a direct, site-specific, long-term, moderate beneficial impact on the visitor experience at core battlefield area at Palo Alto by eliminating plant species that were not present at the time of the battle.

In addition, Alternative B calls for an active program of reestablishing gulf cordgrass on the historic coastal prairies of the core battlefield area of Palo Alto. This would have a direct, site specific, long-term, moderate beneficial impact on the visitor experience at the core battlefield area of Palo Alto. The reintroduction of gulf cordgrass in areas where it has been removed in the core battlefield area of Palo Alto would help restore the site to its' historic appearance, but it would take a few years before the plants mature and truly resemble the 1846 environment. The actual planting efforts might negatively impact the historic scene by having large crews and vehicles and/or equipment carrying out the effort. But these efforts would only last a few days at the most. Therefore any adverse impacts to the visitor experience from that planting process would be of short duration and of negligible intensity. Eventually these young plugs of gulf cordgrass will mature and dominate the area where they are planted, as illustrated in Texas A&M's test plots. Therefore the overall impact on the visitor experience as a result of reestablishing the gulf cordgrass at PALO would be a direct, site-specific, long-term, moderate beneficial impact.

Alternative B also calls for a cyclical prescribed fire program to promote the health and density of the gulf cordgrass, and reduce and stop the growth and spread of exotic grasses, prickly pear cactus, and woody vegetation. This management practice is the primary management action that separates Alternative B from the other alternatives. Eventually cyclical prescribed burning at longer intervals, mimicking the natural fire regime, would be able to maintain the restored cultural landscape with a reduced need for the other vegetation management practices. The prescribed fire events might have a negative impact on the historic scene by having modern fire engines and crews present. In addition, the immediate but temporary reduction of the vegetation on the prairie as result of fire might also be considered a negative impact on historic scene, even though portions of the prairie caught fire during the battle. Nonetheless, the prescribed fire events will only last a day or two, while the targeted gulf cordgrass would flourish more rapidly as a result of this management practice, and the invasive native and exotic species would be reduced and controlled. Consequently, the implementation of a prescribed fire program to restore and maintain the cultural landscape of the core battlefield would be a direct, site-specific, long-term, moderate beneficial impact on the visitor experience.

Lastly, Alternative B calls for both qualitative (e.g. photo-stations/repeat photography) and quantitative vegetation monitoring (e.g. nested frequency plots) to be established to provide the park continual feedback on all vegetation and restoration management activities. Specific multi-purpose and targeted vegetation monitoring protocols would be developed and implemented in coordination with the NPS personnel of the Gulf Coast Inventory and Monitoring Network, Gulf

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Coast Exotic Plant Management Team, and fire ecologists to: (1) define the effectiveness of specific vegetation management treatments, (2) provide early detection of newly invading species, (3) determine fire effects on native and non-native vegetation, and (4) determine cultural landscape restoration success in the core battlefield of Palo Alto. This would allow the park to adjust its efforts so the best results can be achieved with the least amount of effort and impact to the environment. Therefore, this management practice would have an indirect, site-specific, long-term, moderate beneficial impact on the visitor experience at PALO.

Cumulative Effects: Past land management actions have had no impact on the visitor use patterns at PAAL. The development of the park by the NPS has had direct and indirect, site-specific, long-term, moderate beneficial impact to visitor use, while also having a direct, site-specific, short-term, negligible to minor adverse impact on visitor use. Furthermore, any proposed or foreseeable park management actions would appear to have direct, site-specific, short-term, negligible to minor adverse impacts on visitor use, while having indirect, site-specific, long-term, minor to moderate beneficial impacts on visitor use. Regardless, the primary impact the implementation of this Integrated Vegetation Management Plan would have on visitors, would be to their experience on the core battlefield at PALO. Therefore, the cumulative effects to be considered will concentrate on the effects to the visitor experience on the core battlefield at PALO.

Past land management activities at Palo Alto have removed portions of the gulf cordgrass prairie and introduced exotic grasses. Since gulf cordgrass grows in clumps, stands of cordgrass tend not to spread outward or invade other areas. Therefore, if the gulf cordgrass is removed from areas, especially large expanses it generally won't come back on its own. That said; if left unassisted gulf cordgrass might gradually reoccupy the area, but this process could take decades or even centuries depending on the extent of the area they were removed from, as well as numerous other natural and cultural influences. This is evident in the time the cordgrass has taken to come back into those long linear features on the core battlefield of Palo Alto. It has been almost 40 years since those features were created and the gulf cordgrass has reestablished itself in less than 10% of the area of those features. If no management actions are implemented to reintroduce gulf cordgrass to the areas of the core battlefield they will not come back on their own, at least not for the foreseeable future.

This situation is further exacerbated by twentieth century drainage activities and road construction, which have substantially altered the hydrologic regime by lowering the water table and truncating the historic floodplain. This is allowing low water tolerant native species, like the mesquite and the prickly pear cactus to invade and dominate the former wetland prairies. If the current vegetation management activities are continued as is, the cultural landscape would continue to degrade until the once open prairie where the two armies met would no longer be recognizable.

The 2014 proposed project to remove twentieth century water features from a portion of the Resaca de Palo Alto and restore the adjacent wetland prairies by planting gulf cordgrass on the newly exposed historic levee elevations would have direct beneficial long term effects on the cultural landscape of the core battlefield area of Palo Alto. However, the entire project area is in the neighborhood of 60 acres. Therefore, the implementation of Alternative B would

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exponentially improve the impact this project would have on the visitor experience on the core battlefield at Palo Alto.

Conclusion: The implementation of the vegetation management strategies prescribed in Alternative B would have temporary, negligible adverse impacts on the visitor use patterns at PAAL, while having a long-term, moderate beneficial impact on the visitor experience at the core battlefield of PALO. Alternative B provides PAAL with the most efficient and effective strategy for restoring and maintaining the historic character of the core battlefield of Palo Alto, which allows the park visitors the best opportunity to view the landscape of the core battlefield as looked in 1846, with the least amount of impacts to their experience and access, as well as to the environment. Consequently, Alternative B is the environmentally preferred alternative.

3.10.2.3 Alternative C

The vegetation management strategies prescribed in Alternative C are designed to restore and maintain the cultural landscape of the core battlefield of Palo Alto utilizing a restrictive battery of management techniques. Overall, the implementation of these vegetation management actions would have a direct, site-specific, short-term, negligible adverse impact on visitor use at PAAL by temporary closing sections of the park. However, they would have a direct and indirect, site-specific, short and long-term, moderate beneficial impact on the visitor experience at the core battlefield of PALO.

Management actions proposed in Alternative C start with the mechanical reduction and removal of the woody vegetation that has invaded the historic grassland prairie. Prickly pear cactus would be cut and removed from the site using shovels and pitch forks without disturbing the soil. This would have a direct, site-specific, short to long-term, moderate beneficial impact on the visitor experience at the core battlefield of PALO by opening up the viewshed, and helping the site to appear as it did in 1846. Although similar to the strategy of Alternative B, this will require more effort to remove the tree tops from the field. Also, without the use of prescribed fire, mechanical removal of prickly pear cactus and woody vegetation would have to be sustained for the foreseeable future.

Alternative C also calls for the herbicide treatment of cut tree stumps to kill the root ball and prevent future growth. This would have indirect, site-specific, long-term, moderate beneficial impact on the visitor experience by substantially reducing the amount of resprouts. Herbicide applications would also be used to control and eliminate exotic plants. This would have a direct, site-specific, long-term, moderate beneficial impact on the visitor experience at core battlefield area at Palo Alto by eliminating plant species that were not present at the time of the battle.

In addition, Alternative C calls for an active program of reestablishing gulf cordgrass on the historic coastal prairies of the core battlefield area of Palo Alto. This would have a direct, site specific, long-term, moderate beneficial impact on the visitor experience at the core battlefield area of Palo Alto. The reintroduction of gulf cordgrass in areas where it has been removed in the core battlefield area of Palo Alto would help restore the site to its' historic appearance, but it would take a few years before the plants mature and truly resemble the 1846 environment. The actual planting efforts might negatively impact the historic scene by having large crews and vehicles and/or equipment carrying out the effort. But these efforts would only last a few days at

the most. Therefore any adverse impacts to the visitor experience from that planting process would be of short duration and of negligible intensity. Eventually these young plugs of gulf cordgrass will mature and dominate the area where they are planted, as illustrated in Texas A&M's test plots. Therefore the overall impact on the visitor experience as a result of reestablishing the gulf cordgrass at PALO would be a direct, site-specific, long-term, moderate beneficial impact.

Lastly, Alternative C calls for vegetation monitoring to be implemented, but would remain limited to more basic qualitative "change over time" analyses (e.g. establishment of photo-stations and repeat photography). No quantitative monitoring would be established to address (1) the effectiveness of vegetation management treatments, (2) early detection of newly invading species, (3) determine cultural landscape restoration success in the core battlefield of Palo Alto. This reduced vegetation monitoring would essentially limit PAAL's ability to efficiently and effectively restore and maintain cultural landscape of the core battlefield. Therefore, this management practice would have an indirect, site-specific, long-term, minor beneficial impact on the visitor experience of the core battlefield at PALO.

Cumulative Effect: Past land management actions have had no impact on the visitor use patterns at PAAL. The development of the park by the NPS has had direct and indirect, site-specific, long-term, moderate beneficial impact to visitor use, while also having a direct, site-specific, short-term, negligible to minor adverse impact on visitor use. Furthermore, any proposed or foreseeable park management actions would appear to have direct, site-specific, short-term, negligible to minor adverse impacts on visitor use, while having indirect, site-specific, long-term, minor to moderate beneficial impacts on visitor use. Regardless, the primary impact the implementation of this Integrated Vegetation Management Plan would have on visitors, would be to their experience on the core battlefield at PALO. Therefore, the cumulative effects to be considered will concentrate on the effects to the visitor experience on the core battlefield at PALO.

Past land management activities at Palo Alto have removed portions of the gulf cordgrass prairie and introduced exotic grasses. Since gulf cordgrass grows in clumps, stands of cordgrass tend not to spread outward or invade other areas. Therefore, if the gulf cordgrass is removed from areas, especially large expanses it generally won't come back on its own. That said; if left unassisted gulf cordgrass might gradually reoccupy the area, but this process could take decades or even centuries depending on the extent of the area they were removed from, as well as numerous other natural and cultural influences. This is evident in the time the cordgrass has taken to come back into those long linear features on the core battlefield of Palo Alto. It has been almost 40 years since those features were created and the gulf cordgrass has reestablished itself in less than 10% of the area of those features. If no management actions are implemented to reintroduce gulf cordgrass to the areas of the core battlefield they will not come back on their own, at least not for the foreseeable future.

This situation is further exacerbated by twentieth century drainage activities and road construction, which have substantially altered the hydrologic regime by lowering the water table and truncating the historic floodplain. This is allowing low water tolerant native species, like the mesquite and the prickly pear cactus to invade and dominate the former wetland prairies. If the

current vegetation management activities are continued as is, the cultural landscape would continue to degrade until the once open prairie where the two armies met would no longer be recognizable.

The 2014 proposed project to remove twentieth century water features from a portion of the Resaca de Palo Alto and restore the adjacent wetland prairies by planting gulf cordgrass on the newly exposed historic levee elevations would have direct beneficial long term effects on the cultural landscape of the core battlefield area of Palo Alto. However, the entire project area is in the neighborhood of 60 acres. Therefore, the implementation of Alternative B would greatly improve the impact this project would have on the visitor experience on the core battlefield at Palo Alto.

Conclusions: The implementation of the vegetation management strategies prescribed in Alternative C would have temporary, negligible adverse impacts on the visitor use patterns at PAAL, while having a long-term, moderate beneficial impact on the visitor experience at the core battlefield of PALO. However, since this alternative does not allow for prescribed fire, it would require the park to sustain an increased effort to maintain the historic character of PALO, which would have increased direct, temporary adverse impacts to visitor use and access, as well as possibly have temporary adverse impacts to the visitor experience.

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SECTION 4: CONSULTATION AND COORDINATION

4.1 Internal Scoping

Palo Alto Battlefield NHP initiated the internal scoping process by assembling a diverse Interdisciplinary Team of professionals to guide the development of this Vegetation Management Plan, and to identify and assess the impacts on the human environment by the implementation of the proposed alternatives presented in this plan. The team consisted of the following members:

Team Member	Duty Station	Title\Area of Expertise
Mary Kralovec	Palo Alto Battlefield NHP	Superintendent
Douglas Murphy	Palo Alto Battlefield NHP	Chief of Operations\Historian
Rolando L. Garza	Palo Alto Battlefield NHP	Chief of Resource Management\Archeologist
Eric Worsham	Gulf Coast Exotic Plant Management Team	Liason
Pamela Benjamin	Intermountain Regional Office (D)	Vegetation Ecologist
Jill Cowley	Intermountain Regional Office (SF)	Cultural Landscape Architect
Richard Gatewood	Big Bend National Park	Fire Ecologist
John Morlock	Big Bend National Park	Regional Fire Management Officer
Patrick Pearson	Lower Rio Grande NWR (FWS)	Regional Fire Management Officer

Four of the original members of the team have taken other positions and were replaced on the team by the individuals who filled the positions they vacated. The following are the additional members of the team:

Mark Spier	Palo Alto Battlefield NHP	Superintendent
Ed Waldron	Big Bend National Park	Regional Fire Management Officer
Thad Herzberger	Lower Rio Grande NWR (FWS)	Regional Fire Management Officer
Kim Wahl	Lower Rio Grande NWR (FWS)	Plant Ecologist

On July 9, 2008 the Interdisciplinary Team conducted a formal meeting to review and refine the three draft alternatives of the Vegetation Management Plan, and to assess their impacts on the human environment in order to determine what level of NEPA compliance would be necessary. The team utilized the NPS Environmental Screening Form (ESF) as the primary tool for carrying out this task (Appendix A). In consultation with the NPS Intermountain Region's Environmental Quality Program it was determined that an Environmental Assessment would be the appropriate

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format of NEPA compliance for this document. In addition, the team recommended a list of impacts topics to be analyzed and set roles and responsibilities for the various members of the team.

The list of impact topics that the team recommended consisted of: Air Quality; Cultural Landscapes; Soundscapes; Wildlife or Quantity; Floodplains or Wetlands; Rare or Unusual Vegetation; Species of Special Concern; Visitor Experience; and Threatened and Endangered Species.

4.2 External Scoping

During the entire process of developing and refining the alternatives presented in this plan, park staff consulted with numerous regional experts from various disciplines. These regional experts represented various non NPS agencies or organizations which included, but were not limited to, U.S. Fish and Wildlife Service; Texas Parks and Wildlife Department; U.S. Department of Agriculture Research Extension Center; The Nature Conservancy; University of Texas at Brownsville; Colorado State University Department of Forest, Rangeland, and Watershed Stewardship; and University of Georgia Savannah River Ecology Laboratory.

Site visits and continuing dialogue was conducted with the following regional experts:

- James Everitt, Plant Ecologist, U.S. Department of Agriculture Extension Service Center, Weslaco, Texas.
- Robert Lonard, Plant Ecologist, University of Texas Pan American, Edinburg, Texas.
- Maxwell Pons, Plant Ecologist/Manager of the Nature Conservancy's Southmost Preserve, Brownsville, Texas.
- Mick Castillo, Plant Ecologist, Lower Rio Grande Valley National Wildlife Refuge, Alamo, Texas.
- Leo Gustafson, Wetland Biologist, Laguna Atascosa National Wildlife Refuge, Los Fresnos, Texas.
- Kim Wahl, Plant Ecologist, Lower Rio Grande Valley National Wildlife Refuge, Alamo, Texas.
- Jude Benavides, Hydrologist, Univeristy of Texas at Brownsville and Texas Southmost College, Brownsville, Texas.
- Joe Meiman, Hydrologist, NPS Gulf Coast Inventory and Monitoring Network , Mammoth Cave, Kentucky.
- Robert Woodman, NPS Gulf Coast Inventory and Monitoring Network , Lafayette, Louisiana.
- Kurt Buhlmann, Wildlife Biologist, University of Georgia Savannah River Ecology Laboratory.
- Tracey Tuberville, Wildlife Biologist, University of Georgia Savannah River Ecology Laboratory.
- Bill Berry, Nursery Manager, Lower Rio Grande Valley, National Wildlife Refuge, Alamo, Texas.

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- Chris Hathcock, new Nursery Manager, Lower Rio Grande Valley, National Wildlife Refuge, Alamo, Texas.
- Katherine Miller, Wildlife Biologist, Resaca de la Palma State Park, Brownsville, Texas.
- John Lloyd-Reilly, Plant Ecologist, Kike de la Garza Plant Materials Center, USDA Natural Resource Conservation Services, Kingsville, Texas.

At the beginning of 2009 PAAL entered into a Cooperative Ecosystem Studies Unit (CESU) Task Agreement with Joel Wagner, Hydrologist, NPS Water Resources Division, and Dr. David Cooper, Plant Ecologist, Department of Rangeland, Forest and Watershed Stewardship, Colorado State University to develop a final restoration plan and contract specifications for restoring a modified portion of the resaca in the core battlefield and its adjacent wetland prairies.

In the fall of 2009 PAAL entered into a CESU Task Agreement with Dr. Christopher Keyes, Director, and Thomas Perry, Research Forrester, Applied Forest Management Program, College of Forestry & Conservation, University of Montana to assist with the research and development of this Vegetation Management Plan and Environmental Assessment. An initial draft of this VMP EA was completed in December of 2010. The task agreement was fulfilled and the involvement of Christopher Keyes and Thomas Perry ended. Unfortunately the draft document did not meet the NEPA and NPS requirements for an EA.

A public scoping letter was posted on the NPS Public, Environment and Public Comment Web-Based Database (PEPC) on February 12, 2013 with a response deadline of March 15, 2013. On February 16, 2013 hard copy of this letter was mailed to approximately 40 potentially interested parties culled from the park's mailing list.

The letters contained a please respond with comments by March 18, 2013 date. Only one individual responded. It was a person who received a hard copy of the letter. The response was submitted in PEPC and it expressed general support for the park's effort to manage the battlefield.

4.3 Agency Consultation

PAAL initiated the Agency Consultation process through phone conversations discussing the proposed vegetation management strategies and the forthcoming Environmental Assessment with the following individuals:

- Ernesto Reyes, Texas DOI State Border Coordinator, Alamo Ecological Service Sub-Office, U.S. Fish and Wildlife Service.
- Debra Beene, Project Reviewer, Division of Archeology, Texas Historical Commission.
- Kim Barker, Project Reviewer, Division of Architecture, Texas Historical Commission.
- Jeff Durst, South and East Texas Regional Archeologist, Texas Historical Commission.
- Kendall Keyes, Regional Natural Resource Coordinator, Texas Parks and Wildlife Department.
- Russell Hooten, Wildlife Habitat Assessment Program, Texas Parks and Wildlife Department.

With regards to the Endangered Species Act of 1973, the preliminary determination is that the implementation of the preferred alternative of this plan would benefit the one endangered species, the Aplomado Falcon, which is present in the park by restoring the native gulf cordgrass prairie. In addition, allowing the brush in the Resource Protection Zone to develop could provide essential cover for a transient endangered cat making its way through the area.

With regards to the National Historic Preservation Act of 1966, the preliminary determination is that the implementation of the preferred alternative of this plan would have no adverse effects on the sites of Palo Alto Battlefield and Resaca de la Palma.

At the present, these various agency representatives are awaiting a final draft of this plan for review.

4.4 Tribal Consultation

On February 20, 2013 PAAL mailed letters that discussed the proposed Integrated Vegetation Management Plan and Environmental Assessment and requesting any to the following Tribes:

- Mescalero Apache Tribe of the Mescalero Reservation, New Mexico.
- Alabama-Coushatta Tribes of Texas.
- San Carlos Apache Tribe of the San Carlos Reservation, Arizona.
- Kickapoo Traditional Tribe of Texas.

The letters contained a please respond with comments by March 22, 2013 date. No responses were received.

4.5 Environmental Assessment Review and List of Recipients

4.6 List of Preparers

Rolando L. Garza: Palo Alto Battlefield National Historical Park

Christopher Keyes: University of Montana

Thomas Perry: University of Montana

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SECTION 5: REFERENCES

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APPENDIX A
Rare, threatened, and endangered plant species of Cameron County, Texas

Plant		Status		
Common Name	**Scientific Name**	**Federal**	**State**	
Bailey's ballmoss*	*Tillandsia baileyi**			epiphytic on various trees and tall shrubs, perhaps most common in mottes of live oak on vegtated dunes and flats in coastal portions of the South Texas Sand Sheet, but also on evergreen sub-tropical woodlands along resacas in the Lower Rio Grande Valley; flowering (February-)April-May, but conspicuous throughout the year
Green Island echeandia	*Echeandia texensis*			on somewhat saline clays of lomas along the Gulf Coast near the mouth of Rio Grande, a habitat shared with *E. chandleri*; both species grow in areas dominated by herbaceous species with scattered brush and stunted trees, or in grassy openings in subtropical thorn shrublands; flowers April, June, and November, and likely in other months as well
Lila de los llanos	*Echeandia chandleri*			most commonly encountered among shrubs or in grassy openings in subtropical thorn shrublands on somewhat saline clays of lomas along Gulf Coast near mouth of Rio Grande; also observed in a few upland coastal prairie remnants on clay soils over the Beaumont Formation at inland sites well to the north and along railroad right-of-ways and cemeteries; flowering (May-) September-December, fruiting October-December
Mexican mud-plantain	*Heteranthera mexicana*			wet clayey soils of resacas and ephemeral wetlands in South Texas and along margins of playas in the Panhandle; flowering June-December, only after sufficient rainfall
Plains gumweed	*Grindelia oolepis*			coastal prairies on heavy clay (blackland) soils, often in depressional areas, sometimes persisting in areas where management (mowing) may maintain or mimic natural prairie disturbance regimes; 'crawfish lands'; on nearly level Victoria clay, Edroy clay, claypan, possibly Greta within Orelia fine sandy loam over the Beaumont Formation, and Harlingen clay; roadsides, railroad rights-of-ways, vacant lots in urban areas, cemeteries; flowering April-December

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Runyon's cory cactus	*Coryphantha macromeris* var *runyonii*			gravelly to sandy or clayey, calcareous, sometimes gypsiferous or saline soils, often over the Catahoula and Frio formations, on gentle hills and slopes to the flats between, at elevations ranging from 10 to 150 m (30 to 500 ft); ?late spring or early summer, November, fruit has been collected in August
Runyon's water-willow	*Justicia runyonii*			margins of and openings within subtropical woodlands or thorn shrublands on calcareous, alluvial, silty or clayey soils derived from Holocene silt and sand floodplain deposits of the Rio Grande Delta; can be common in narow openings such as those provided by trails through dense ebony woodlands and is sometimes restricted to microdepressions; flowering (July-) September-November
Shinners' rocket	*Thelypodiopsis shinnersii*			mostly along margins of Tamaulipan thornscrub on clay soils of the Rio Grande Delta, including lomas near the mouth of the river; Tamaulipas, Mexico specimens are from mountains, with no further detail; flowering mostly March-April, with one collection in December
South Texas ambrosia	*Ambrosia cheiranthifolia*	LE	E	grasslands and mesquite-dominated shrublands on various soils ranging from heavy clays to lighter textured sandy loams, mostly over the Beaumont Formation on the Coastal Plain; in modified unplowed sites such as railroad and highway right-of-ways, cemeteries, mowed fields, erosional areas along small creeks; flowering July-November
Star cactus	*Astrophytum asterias*	LE	E	gravelly clays or loams, possibly of the Catarina Series (deep, droughty, saline clays), over the Catahoula and Frio formations, on gentle slopes and flats in sparsely vegetated openings between shrub thickets within mesquite grasslands or mesquite-blackbrush thorn shrublands; plants sink into or below ground during dry periods; flowering from mid March-May, may also flower in warmer months after sufficient rainfall, flowers most reliably in early April; fruiting mid April-June
Texas ayenia	*Ayenia limitaris*	LE	E	Subtropical thorn woodland or tall shrubland on loamy soils of the Rio Grande Delta; known site soils include well-drained, calcareous, sandy clay loam (Hidalgo Series) and neutral to moderately alkaline, fine sandy loam (Wouldacy Series); also under or among taller shrubs in thorn woodland/thorn shrubland; flowering throughout the year with sufficient rainfall
Vasey's adelia	*Adelia vaseyi*			mostly subtropical evergreen/deciduous woodlands on loamy soils of Rio Grande Delta, but occasionally in shrublands on more xeric sandy to gravelly upland sites; flowering January-June

"***Blank***"- rare; "***E***"-endangered; "***LE***"-locally endangered; "***T***"-threatened. "*****"-occurs at PAAL.

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APPENDIX B
Herbicide Specimen Labels

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Specimen Label

Dow AgroSciences

Garlon® 4

Specialty Herbicide

®Trademark of Dow AgroSciences LLC

For the control of woody plants and annual and perennial broadleaf weeds in non-crop industrial manufacturing and storage sites, rights-of-way such as electrical power lines, communication lines, pipelines, roadsides, railroads, forests and in the establishment and maintenance of wildlife openings. Use on these sites may include application to grazed areas.

Active Ingredient:	
triclopyr: 3,5,6-trichloro-2- pyridinyloxyacetic acid, butoxyethyl ester	61.6%
Other Ingredients	38.4%
Total	100.0%

Contains petroleum distillates
Acid equivalent: triclopyr - 44.3% - 4 lb/gal

EPA Reg. No. 62719-40

Keep Out of Reach of Children

CAUTION PRECAUCION

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

Precautionary Statements

Hazards to Humans and Domestic Animals

Causes Moderate Eye Irritation • Harmful If Swallowed • Prolonged Or Frequently Repeated Skin Contact May Cause Allergic Reactions In Some Individuals

Avoid contact with eyes or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, or using tobacco.

Personal Protective Equipment (PPE)

Applicators and other handlers who handle this pesticide must wear:

- Long-sleeved shirt and long pants
- Shoes plus socks

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables are given, use detergent and hot water. Keep and wash PPE separately from other laundry.

Engineering Controls

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS (40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS.

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

First Aid

If in eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
If swallowed: Immediately call a poison control center or doctor. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give **any** liquid to the person. Do not give anything by mouth to an unconscious person.

Note to Physician: This product may pose an aspiration pneumonia hazard. Contains petroleum distillates.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-992-5994 for emergency medical treatment information.

Environmental Hazards

This pesticide is toxic to fish. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwater or rinsate.

This chemical has properties and characteristics associated with chemicals detected in groundwater. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination.

Physical or Chemical Hazards

Combustible. Do not use or store the product near heat or open flame.

Notice: Read the entire label. Use only according to label directions. **Before using this product, read Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies elsewhere on this label If terms are unacceptable, return at once unopened.**

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.dowagro.com.

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read all Directions for Use carefully before applying.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Agricultural Use Requirements

The requirements in this box apply to forestry uses.

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 12 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls
- Chemical-resistant gloves
- Shoes plus socks
- Protective eyewear

Non-Agricultural Use Requirements

The requirements in this box apply to all use sites on this label except for forestry uses.

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for Agricultural Pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

Entry Restrictions for Non-WPS Uses: For applications to non-cropland areas, do not allow entry into areas until sprays have dried.

Storage and Disposal

Do not contaminate water, food, or feed by storage and disposal. Open dumping is prohibited.
Pesticide Storage: Store above 28°F or agitate before use.
Pesticide Disposal: Wastes resulting from the use of this product must be disposed of on site or at an approved waste disposal facility.

Storage and Disposal (Cont.)

Nonrefillable containers 5 gallons or less:
Container Reuse: Nonrefillable container. Do not reuse or refill this container. Offer for recycling if available.
Triple rinse or pressure rinse container (or equivalent) promptly after emptying. **Triple rinse** as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. **Pressure rinse** as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 psi for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

Refillable containers 5 gallons or larger:
Container Reuse: Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into application equipment or a mix tank. Fill the container about 10% full with water and, if possible, spray all sides while adding water. If practical, agitate vigorously or recirculate water with the pump for two minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times.

Nonrefillable containers 5 gallons or larger:
Container Reuse: Nonrefillable container. Do not reuse or refill this container. Offer for recycling if available.
Triple rinse or pressure rinse container (or equivalent) promptly after emptying. **Triple rinse** as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container 1/4 full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times. **Pressure rinse** as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 psi for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

General Information

Use Garlon® 4 specialty herbicide for the control of woody plants and annual and perennial broadleaf weeds in non-crop industrial manufacturing and storage sites, rights-of-way such as electrical power lines, communication lines, pipelines, roadsides, railroads, forests and in the establishment and maintenance of wildlife openings. Use on these sites may include application to grazed areas.

Garlon 4 is an oil soluble, emulsifiable liquid product containing the herbicide triclopyr. Garlon 4 may be applied to woody or herbaceous broadleaf plants as a foliar spray or as a basal bark or cut stump application to woody plants. As a foliar spray, Garlon 4 controls only herbaceous plants that have emerged from the soil or woody plants that are in full leaf at the time of application. Small amounts of Garlon 4 can kill or injure many broadleaf plants. To prevent damage to crops and other desirable plants, follow all directions and precautions.

General Use Precautions and Restrictions

In Arizona: The state of Arizona has not approved Garlon 4 for use on plants grown for commercial production; specifically forests grown for commercial timber production, or on designated grazing areas.

When applying this product in tank mix combination, follow all applicable use directions, precautions, and limitations on each manufacturer's label.

Chemigation: Do not apply this product through any type of irrigation system.

Apply no more than 1/2 gallon of Garlon 4 (2 lb ae of triclopyr) per acre per growing season on rights-of-way or any area where grazing or harvesting is allowed.

On forestry sites, Garlon 4 may be used at rates up to 6 quarts (6 lb ae of triclopyr) per acre per year.

Garlon 4 may be used at rates up to 8 quarts (8 lb ae of triclopyr) per acre per year on non-crop industrial manufacturing and storage sites, rights-of-way such as electrical power lines, communication lines, pipelines, roadsides and railroads, fence rows, non-irrigation ditch banks. Portions of grazed areas that intersect treated non-cropland, rights-of-way and forestry sites may be treated at up to 8 lb ae per acre if the area to be treated on the day of application comprises no more than 10% of the total grazable area.

Do not apply Garlon 4 directly to, or otherwise permit it to come into direct contact with, cotton, grapes, peanuts, soybeans, tobacco, vegetable crops, flowers, citrus, or other desirable broadleaf plants. Do not permit spray mists containing Garlon 4 to drift onto such plants.

It is permissible to treat non-irrigation ditch banks, seasonally dry wetlands (such as flood plains, deltas, marshes, swamps, or bogs) and transitional areas between upland and lowland sites where surface water is not present except in isolated pockets due to uneven or unlevel conditions. Do not apply to open water (such as lakes, reservoirs, rivers, streams, creeks, salt water bays, or estuaries).

Do not apply on ditches currently being used to transport irrigation water. Do not apply where runoff or irrigation water may flow onto agricultural land as injury to crops may result.

Do not apply this product using mist blowers unless a drift control additive, high viscosity inverting system, or equivalent is used to control spray drift.

Sprays applied directly to Christmas trees may result in conifer injury. When treating unwanted vegetation in Christmas tree plantations, care should be taken to direct sprays away from conifers.

Garlon 4 is formulated as a low volatile ester. However, the combination of spray contact with impervious surfaces, such as roads and rocks, and increasing ambient air temperatures, may result in an increase in the volatility potential for this herbicide, increasing a risk for off-target injury to sensitive crops such as grapes and tomatoes.

Grazing and Haying Restrictions
Except for lactating dairy animals, there are no grazing restrictions following application of this product.

- **Grazing Lactating Dairy Animals:** Do not allow lactating dairy animals to graze treated areas until the next growing season following application of this product.
- Do not harvest hay for 14 days after application.
- Portions of grazed areas that intersect treated non-cropland, rights-of-way and forestry sites may be treated at up to 8 lb ae per acre if the area to be treated on the day of application comprises no more than 10% of the total grazable area.

Slaughter Restrictions: During the season of application, withdraw livestock from grazing treated grass at least 3 days before slaughter.

Avoiding Injurious Spray Drift
Make applications only when there is little or no hazard from spray drift. Small quantities of spray, which may not be visible, may seriously injure susceptible plants. Do not spray when wind is blowing toward susceptible crops or ornamental plants that are near enough to be injured. It is suggested that a continuous smoke column at or near the spray site or a smoke generator on the spray equipment be used to detect air movement, lapse conditions, or temperature inversions (stable air). If the smoke layers or indicates a potential of hazardous spray drift, do not spray.

Aerial Application: Garlon 4 may be aerially applied by fixed wing aircraft or helicopter. For aerial application on rights-of-way or other areas near susceptible crops, apply through a Microfoil† or Thru-Valve boom†, or use an agriculturally labeled drift control additive. Other drift reducing systems or thickened sprays prepared by using high viscosity inverting systems may be used if they are made as drift-free as mixtures containing agriculturally labeled thickening agents or applications made with the Microfoil or Thru Valve boom. Do not use a thickening agent with the Microfoil or Thru Valve booms, or other systems that cannot accommodate thick sprays. Spray only when the wind velocity is low (follow state regulations). Avoid application during air inversions. If a spray thickening agent is used, follow all use recommendations and precautions on the product label.

†Reference within this label to a particular piece of equipment produced by or available from other parties is provided without consideration for use by the reader at its discretion and subject to the reader's independent circumstances, evaluation, and expertise. Such reference by Dow AgroSciences is not intended as an endorsement of such equipment, shall not constitute a warranty (express or implied) of such equipment, and is not intended to imply that other equipment is not available and equally suitable. Any discussion of methods of use of such equipment does not imply that the reader should use the equipment other than is advised in directions available from the equipment's manufacturer. The reader is responsible for exercising its own judgment and expertise, or consulting with sources other than Dow AgroSciences, in selecting and determining how to use its equipment.

Spray Drift Management

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment and weather related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions.

The following drift management requirements must be followed to avoid off-target drift movement from aerial applications:

1. The distance of the outer most operating nozzles on the boom must not exceed 3/4 the length of the rotor.
2. Nozzles must always point backward parallel with the air stream and never be pointed downwards more than 45 degrees.

Where states have more stringent regulations, they should be observed.

The applicator should be familiar with and take into account the information covered in the following Aerial Drift Reduction Advisory. [This information is advisory in nature and does not supersede mandatory label requirements.]

Aerial Drift Reduction Advisory

Information on Droplet Size: The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see Wind, Temperature and Humidity, and Temperature Inversions).

Controlling Droplet Size:

- **Volume** - Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets.
- **Pressure** - Do not exceed the nozzle manufacturer's recommended pressures. For many nozzle types lower pressure produces larger droplets. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.
- **Number of Nozzles** - Use the minimum number of nozzles that provide uniform coverage.
- **Nozzle Orientation** - Orienting nozzles so that the spray is released parallel to the airstream produced larger droplets than other orientations and is the recommended practice. Significant deflection from horizontal will reduce droplet size and increase drift potential.
- **Nozzle Type** - Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce the largest droplets and the lowest drift.

Boom Length: For some use patterns, reducing the effective boom length to less than 3/4 of the wingspan or rotor length may further reduce drift without reducing swath width.

Application Height: Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces exposure of droplets to evaporation and wind.

Swath Adjustment: When applications are made with a crosswind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind, smaller drops, etc.).

Wind: Drift potential is lowest between wind speeds of 2 to 10 mph. However, many factors, including droplet size and equipment type determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. **Note:** Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect spray drift.

Temperature and Humidity: When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions: Applications should not occur during a local, low level temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of the smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

Sensitive Areas: The pesticide should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas).

Ground Equipment: To aid in reducing spray drift, Garlon 4 should be used in thickened (high viscosity) spray mixtures using an agriculturally labeled drift control additive, high viscosity invert system, or equivalent as directed by the manufacturer. When using a spray thickening or inverting additive, follow all use directions and precautions on the product label. With ground equipment, spray drift can be reduced by keeping the spray boom as low as possible; by applying 20 gallons or more of spray per acre; by keeping the operating spray pressures at the lower end of the manufacturer's recommended pressures for the specific nozzle type used (low pressure nozzles are available from spray equipment manufacturers); and by spraying when wind velocity is low. In hand-gun applications, select the minimum spray pressure that will provide adequate plant coverage (without forming a mist). Do not apply with nozzles that produce a fine droplet spray. Select nozzles and pressures which provide adequate plant coverage, but minimize the production of fine spray particles.

High Volume Leaf-Stem Treatment: To minimize spray drift, keep sprays no higher than brush tops and keep spray pressures low enough to provide coarse spray droplets. An agriculturally labeled thickening agent may be used to reduce drift.

Mixing Directions

Garlon 4 may be foliarly applied by diluting with water or by preparing an oil-water emulsion. For woody plant control, an oil-water emulsion performs more dependably under a broader range of conditions than a straight water dilution and is recommended for aerial applications.

Oil-Water Mixture Sprays
Prepare a premix of oil, surfactant and Garlon 4 in a separate container using diesel fuel, fuel oil, or kerosene plus an emulsifier such as Sponto 712 or Triton X-100. Use a jar test to check spray mix compatibility before preparing oil-water emulsion sprays in the mixing tank. Do not allow any water or mixtures containing water to get into the premix or Garlon 4 since a thick "invert" (water in oil) emulsion may form that will be difficult to break. Such an emulsion may also be formed if the premix or Garlon 4 is put into the mixing tank before the addition of water. Fill the spray tank about one-half full with water, then slowly add the premix with continuous agitation and complete filling the tank with water. Continue moderate agitation.

Ground Application: Add oil to the spray mix at a rate of 5 to 10% of the total mix, up to a maximum of 1 gallon of oil per acre, using agricultural spray emulsifiers according to mixing instructions below.

Aerial Application: Use oil and water in the spray mixture in a 1:5 ratio (1 part oil to 5 parts water), up to a maximum of 1 gallon of oil per acre according to mixing instructions below.

Oil Mixture Sprays for Basal Treatment
Prepare oil-based spray mixtures using either diesel fuel, No. 1 or No. 2 fuel oil, kerosene or a commercially available basal oil. Substitute other oils or diluents only as recommended by the oil or diluent's manufacturer. When preparing an oil mixture, read and follow the use directions and precautions on the manufacturer's product label. Add Garlon 4 to the required amount of oil in the spray tank or mixing tank and mix thoroughly. If the mixture stands over 4 hours, reagitation is required.

Oil Mixtures of Garlon 4 and Tordon K: Tordon K and Garlon 4 may be used in tank mix combination for basal bark treatment of woody plants. These herbicides are incompatible and will not form a stable mixture when mixed together directly in oil. Make a stable tank mixture for basal bark application by first combining each product with a compatibility agent prior to final mixing in the desired ratio. (See product bulletin for mixing instructions.) Tordon K is not registered for use in the states of California and Florida.

Water Dilutions
For water dilutions, an agricultural surfactant at the manufacturer's recommended rate may be added to the spray mixture to provide improved wetting of foliage. To help minimize spray drift, a drift control and deposition aid cleared for application to growing crops is recommended.

Tank Mixing
Garlon 4 may be applied in tank mix combination with labeled rates of other herbicides provided (1) the tank mix product is labeled for the timing and method of application for the use site to be treated; and (2) tank mixing is not prohibited by the label of the tank mix product. When tank mixing Garlon 4 with other materials, a compatibility test (jar test) using relative proportions of the tank mix ingredients should be conducted prior to mixing ingredients in the spray tank. Use a clear glass quart jar with lid and mix the tank mix ingredients in the required order and their relative proportions. Invert the jar containing the mixture several times and observe the mixture for approximately 1/2 hour. If the mixture balls-up, forms flakes, sludges, jels, oily films or layers, or other precipitates, it is not compatible and the tank mix combination should not be used.

Mixing Order for Tank Mixes: Add one-half of the needed water to the mixing tank and start agitation. Add different materials in the order indicated below, allowing time for complete dispersion and mixing after addition of each product.

1. Water soluble herbicide (if used)
2. Premix of oil, emulsifier, Garlon 4 and other oil-soluble herbicide (if used); see below

Add the remaining water. During the final filling of the tank, add a drift control and deposition aid cleared for application to growing crops (if used), plus an agricultural surfactant (if a water dilution rather than an oil-water emulsion spray is used). Maintain continuous agitation of the spray mixture during mixing, final filling and throughout application to ensure spray uniformity.

Premixing: Prepare a premix of oil, emulsifier (if oil-water emulsion), and Garlon 4 plus other oil-soluble herbicide (if used), e.g., 2,4-D ester. **Note:** Do not allow water or mixtures containing water to get into the premix or Garlon 4 since a thick "invert" (water in oil) emulsion may form that will be difficult to break. Such an emulsion may also be formed if the premix or Garlon 4 is put into the mixing tank before the addition of water.

Tank Mixing Precautions:

- Read carefully and follow all applicable use directions, precautions, and limitations on the respective product labels.
- Do not exceed recommended application rates. If products containing the same active ingredient are tank mixed, do not exceed the maximum allowable active ingredient use rates.
- For direct injection or other spray equipment where the product formulations will be mixed in undiluted form, special care should be taken to ensure tank mix compatibility.
- Always perform a (jar) test to ensure the compatibility of products to be used in tank mixture.

Mixing with Liquid Fertilizer for Broadleaf Weed Control
Garlon 4 may be tank mixed with liquid nitrogen fertilizer and foliarly applied for weed control and fertilization of grass pastures. Use Garlon 4 in accordance with recommendations for grass pastures as given on this label. Apply at rates recommended by supplier or Extension Service Specialist. **Note:** Garlon 4 is not recommended for use with liquid fertilizer on woody plants (brush). Foliage burn caused by liquid fertilizer may reduce herbicide effectiveness on woody plants. Test for mixing compatibility using desired procedure and spray mix proportions in clear glass jar before mixing in spray tank. A compatibility aid such as Unite or Compex may be needed in some situations. **Compatibility is best with straight liquid nitrogen fertilizer solutions. Mixing with N-P-K solutions or suspensions may not be satisfactory even with the addition of compatibility aid.** Premixing Garlon 4 with 1 to 4 parts water may help in difficult situations.

Fill in the spray tank about half full with the liquid fertilizer, then add the herbicide with agitation and complete filling the tank with fertilizer. Apply immediately and continue agitation in the spray tank during application. **Do not store liquid fertilizer spray mixtures.** Application during very cold weather (near freezing) is not advisable. The likelihood of mixing or compatibility problems with liquid fertilizer increases under cold conditions.

Note: Do not use spray equipment for other applications to land planted, or to be planted, to susceptible crops or desirable plants **unless** it has been determined that all phytotoxic herbicide residue has been removed by thoroughly cleaning the equipment.

Plants Controlled by Garlon 4

Woody Plant Species

alder
arrowwood
ash
aspen
bear clover (bearmat)
beech
birch
blackberry
blackbrush
blackgum
boxelder[1]
Brazilian pepper
buckthorn
cascara
ceanothus
cherry[3]
chinquapin
choke cherry
cottonwood
crataegus (hawthorn)
dogwood
Douglas-fir
elderberry
elm (except winged elm)
gallberry
gorse
granjeno
guajillo
guava[3]
hazel
hickory
hornbeam
huisache (suppression)
kudzu[2]
locust
madrone
maple (except bigleaf, vine[3])
milkweed vine[3]
mulberry
oaks
osage orange
pepper vine[3]
persimmon, eastern
pine
poison ivy
poison oak
poplar
salmonberry
saltbush
(*Braccharis* spp.)[3]
salt cedar[1]
sassafras
scotch broom
sumac
sweetbay magnolia
sweetgum
sycamore
tanoak
thimbleberry
tree-of-heaven
(*Ailanthus*)[1]
trumpet creeper[2]
tulip poplar
twisted acacia
Virginia creeper[3]
wax myrtle (top growth)
wild rose
willow
willow primrose
winged elm

[1]For best control, use either a basal bark or cut stump treatment.
[2]For complete control, re-treatment may be necessary.
[3]Basal or dormant stem applications only.

Annual, Biennial and Perennial Broadleaf Weeds

Note: Numbers in parentheses refer to footnotes below table.

black medic
bull thistle
burdock
Canada thistle
chicory
cinquefoil
clover
creeping beggarweed
curly dock
dandelion (top growth)
dogfennel
field bindweed
goldenrod
ground ivy
lambsquarters
lespedeza
matchweed
mustard
Oxalis
plantain
purple loosestrife
ragweed
sericea lespedeza (1)
smartweed
sulfur cinquefoil (2)
sweet clover
tropical soda apple (3)
vetch
wild carrot
(Queen Anne's lace)
wild lettuce
wild violet
yarrow

1. **Sericea lespedeza:** Apply 1 to 2 pints of Garlon 4 per acre. For best results, apply after maximum foliage development in the late spring to early summer, but prior to bloom.
2. **Sulfur cinquefoil:** Apply 1 to 2 pints of Garlon 4 per acre. For best results, apply to plants in the rosette stage.
3. **Tropical soda apple:** Apply 2 pints of Garlon 4 per acre when tropical soda apple plants reach the first flower stage. For best results, apply in a total spray volume of 40 gallons per acre using ground equipment. An agricultural surfactant may be added at the manufacturer's recommended rate to provide more complete wetting and coverage of the foliage. Spot treatments may be used to control sparse plant stands. For spot treatment use a 1 to 1.5% solution of Garlon 4 in water (1 to 1 1/2 gallons of Garlon 4 in 100 gallons total spray mixture) and spray the entire plant to completely wet the foliage. **In Florida**, control of tropical soda apple may be improved by using the following management practices:

- Mow plants to a height of 3 inches every 50 to 60 days or whenever they reach flowering. Continue the mowing operation through April.
- In late May to June (50 to 60 days after the April mowing), apply Garlon 4 as a broadcast treatment.
- Use spot treatment to control any remaining plants or thin stands of plants that germinate following a broadcast treatment.

Application Methods

Use Garlon 4 at rates of 1 to 8 quarts per acre to control broadleaf weeds and woody plants. It is suggested that rates higher in this rate range be used to control woody plants. In all cases, use the amount specified in enough water to give uniform and complete coverage of the plants to be controlled. The order of addition to the spray tank is water, spray thickening agent (if used), surfactant (if used), additional herbicide (if used), and Garlon 4. If a standard agricultural surfactant is used, use at a rate of 1 to 2 quarts per acre. Use continuous adequate agitation.

Before using any recommended tank mixtures, read the directions and all precautions on both labels.

For best results apply when woody plants and weeds are actively growing. When hard to control species such as ash, blackgum, choke cherry, elm, maples (other than vine or big leaf), oaks, pines, or winged elm are prevalent, during applications made during late summer when the plants are mature, or during drought conditions, use the higher rates of Garlon 4 alone or in combination with Tordon® 101 Mixture specialty herbicide or Tordon K herbicide. Tordon 101 Mixture and Tordon K are restricted use pesticides. Tordon 101 Mixture and Tordon K are not registered for use in the states of California and Florida.

When using Garlon 4 in combination with 2,4-D low volatile ester herbicide, generally the higher rates of Garlon 4 should be used for satisfactory brush control.

Use the higher dosage rates when brush approaches an average of 15 feet in height or when the brush covers more than 60% of the area to be treated. If lower rates are used on hard to control species, resprouting may occur the year following treatment.

On sites where easy to control brush species dominate, rates less than those listed may be effective. Consult state or local extension personnel for such information.

Foliage Treatment With Ground Equipment

Use sufficient spray volume to completely and uniformly cover foliage. For ground application, apply 10 gallons or more of total spray volume per acre. Use higher spray volumes for ground applications to ensure adequate coverage with increased depth and density of foliage, particularly for treatment of woody plants.

High Volume Foliage Treatment

For control of woody plants, use Garlon 4 at the rate of 2 to 6 quarts per 100 gallons of spray mixture, or Garlon 4 at 2 to 4 quarts may be tank mixed with labeled rates of 2,4-D low volatile ester herbicide, Tordon 101 Mixture, or Tordon K and diluted to make 100 gallons of spray. Do not apply more than 2 gallons of Garlon 4 per acre. On rangeland and permanent pasture sites, make 1 application per year and apply no more than 2 quarts of Garlon 4 (2 lb ae of triclopyr) per acre. Apply at a volume of 100 to 400 gallons of total spray per acre depending upon size and density of woody plants. Tordon 101 Mixture and Tordon K are not registered for use in the states of California and Florida. When tank mixing, follow applicable use directions and precautions on each manufacturer's label.

Depending upon the size and density of the woody plants, apply sufficient spray volume to thoroughly wet all leaves, stems, and root collars. To minimize spray drift, select the minimum spray pressure that provides adequate plant coverage without forming a mist and direct sprays no higher than the top of the target plants. Use a drift control additive cleared for application to growing crops to reduce spray drift. Before using any tank mixture, read the directions and use precautions on both labels. For best results, apply when woody plants and weeds are actively growing.

Table 1: The following table is provided as a guide to the user to achieve the proper rate of Garlon 4.

Total Spray Volume (gallons/acre)	Rate of Garlon 4	
	Forestry Sites (qt/100 gallons of spray)[1]	Non-Cropland Sites (qt/100 gallons of spray)[2]
400	1.5	2
300	2	2.7
200	3	4
100	6	8
50	12	16
40	15	20
30	20	26.7
20	30	40
10	60	80

[1]Do not exceed the maximum use rate of 6 qt of Garlon 4 (6 lb ae of triclopyr) per acre per year.

[2]Do not exceed the maximum use rate of 8 qt of Garlon 4 (8 lb ae of triclopyr) per acre per year for non-grazable areas, or 2 qt (2 lb ae of triclopyr) per acre per year for grazed areas, except on portions of grazed areas that meet the following requirement. Portions of grazed areas that intersect treated non-cropland, rights-of-way and forestry sites may be treated at up to 8 lb ae per acre if the area to be treated on the day of application comprises no more than 10% of the total grazable area.

Table 2

Application Rates per 100 Gallons of Spray		
Garlon 4	**Plus Tank Mix Product**	**Rate (qt)**
1 - 4 qt	--	--
1 - 2 qt	Grazon® P+D specialty herbicide	4
1 - 2 pt	2,4-D low volatile ester herbicide	1 - 2
1 - 2 qt	Tordon 22K	1 - 2
2 qt	Reclaim® specialty herbicide[1,2]	2

[1]Reclaim is registered for use only in Arizona, Texas, Oklahoma and New Mexico.
[2]See directions for Mesquite Control Using High Volume Foliage Treatment below.

Mesquite Control Using High Volume Foliage Treatment: For control of mesquite infestations of low to moderate density, apply Garlon 4 and Reclaim in a tank mixture to individual plants with backpack or hand-held sprayers or a vehicle-mounted sprayer with hand-held spray wand or spray gun. For individual plant treatment, use 2 quarts of Garlon 4 in combination with 2 quarts of Reclaim per 100 gallons of total spray solution (1/2% v/v of each product). Apply in water or as an oil-water emulsion as described in Mixing Directions. If using an oil-water emulsion, add the oil at a rate of 5% of the total spray volume. Apply as a complete spray-to-wet foliar application, including all leaves. Thorough coverage is necessary for good results, but do not spray to the point of runoff. Do not apply when mesquite foliage is wet. The total amount of Garlon 4 applied should not exceed 1 1/3 pints per acre. For best results, follow information given elsewhere in this label concerning effect of environmental conditions and application timing on control. This application method works best for brush less than 8 feet tall since efficient treatment and thorough coverage of taller brush is difficult to achieve with this method. To minimize drift, select a spray nozzle and pressure that provides good coverage while forming a coarse spray. Additionally, drift may be reduced by using the minimum pressure necessary to obtain plant coverage without forming a mist and by directing sprays no higher than the top of target plants. If desired, a spray dye may be added to the spray mixture to mark the treated plants.

Low Volume Foliage Treatment

To control susceptible woody plants, mix up to 20 quarts of Garlon 4 in 10 to 100 gallons of finished spray. The spray concentration of Garlon 4 and total spray volume per acre should be adjusted according to the size and density of target woody plants and kind of spray equipment used. With low volume sprays, use sufficient spray volume to obtain uniform coverage of target plants including the surfaces of all foliage, stems, and root collars (see General Use Precautions and Restrictions). For best results, a surfactant should be added to all spray mixtures. Match equipment and delivery rate of spray nozzles to height and density of woody plants. When treating tall, dense brush, a truck mounted spray gun with spray tips that deliver up to 2 gallons per minute at 40 to 60 psi may be required. Backpack or other types of specialized spray equipment with spray tips that deliver less than 1 gallon of spray per minute may be appropriate for short, low to moderate density brush.

Tank Mixing: As a low volume foliage spray, up to 12 quarts of Garlon 4 may be applied in tank mix combination with labeled rates of Tordon K or Tordon 101 Mixture in 10 to 100 gallons of finished spray. Tordon 101 Mixture and Tordon K are not registered for use in the states of California and Florida.

Broadcast Applications With Aerial or Ground Equipment

Environmental conditions and application timing influence brush and weed control results. For best results, apply when woody plants and weeds are actively growing. For woody species, apply after the rapid growth period of early spring when leaf tissue is fully expanded and terminal growth has slowed. Brush regrowth should be at least 4 ft high prior to treatment to insure adequate foliage for herbicide absorption. Adequate soil moisture before and after treatment as well as the presence of healthy foliage at the time of application are important factors contributing to optimal herbicidal activity.

Use sufficient spray volume to completely and uniformly cover foliage. For ground application, apply 10 gallons or more of total spray volume per acre. For aerial application, apply at least 2 gallons of total spray volume per acre. Use higher spray volumes for ground or aerial applications to ensure adequate coverage with increased depth and density of foliage, particularly for treatment of woody plants.

Mesquite: The herbicidal response of mesquite is strongly influenced by foliage condition, growth stage and environmental conditions. For best results, apply when new growth foliage has turned from light to dark green, when the soil temperature is above 75°F at a depth of 12 to 18 inches, and soil moisture is adequate for plant growth. Apply within 60 days after the 75ºF minimum soil temperature at the 12- to 18-inch depth has been reached. Product performance may be adversely affected if application is made before mesquite foliage has turned from light to dark green or if foliage has been injured or removed by late frost, insects, hail or plant diseases. Do not treat if mesquite exhibits new (light green) terminal growth in response to recent heavy rainfall during the growing season. Rate of soil warm-up at the 12- to 18-inch depth may vary with soil texture and drainage. Coarse-textured (sandy) soils warm up sooner than fine-textured (clay) soils and dry soils warm up more quickly than wet soils. Mesquite regrowth should be at least 4 ft high prior to treatment to insure adequate foliage for herbicide absorption.

Mesquite Only

Apply 1/2 to 1 pint of Garlon 4 per acre in combination with 2/3 to 1 1/3 pint per acre of Reclaim. See label for Reclaim for additional treatment recommendations and information on mesquite control. Apply aerially as an oil:water emulsion in 4 gallons or more total volume per acre or with ground equipment in 10 gallons or more total volume per acre. Use a maximum of 1 gallon of oil per acre for aerial or ground application.

Mesquite and Pricklypear Cactus

If pricklypear cactus is a target species in association with mesquite, apply a tank mix of 1/2 to 1 pint of Garlon 4 with 1 to 2 pints of Tordon 22K per acre. (The 2 pint per acre rate of Tordon 22K provides a higher and more uniform plant kill of pricklypear.) Tordon 22K may also be applied in combination with Reclaim to control pricklypear while providing improved control of mesquite. See labels for Tordon 22K and Reclaim for additional information and treatment recommendations. Apply aerially as an oil:water emulsion in 4 gallons or more total volume per acre or with ground equipment in 10 or gallons or more total volume per acre. If mesquite canopy is dense, use higher spray volumes. Use a maximum of 1 gallon of oil per acre for aerial or ground application.

South Texas Mixed Brush (Mesquite, Pricklypear Cactus, Blackbrush, Twisted Acacia and Granjeno)

Use 1 to 2 pints of Garlon 4 in a tank mix with 2 pints of Tordon 22K per acre if pricklypear is a problem, or with 2/3 to 1 1/3 pints of Reclaim per acre if mesquite is the prevalent species. Garlon 4 contributes to the control of non-legume species such as granjeno and oaks. However, if woody legume species are predominate, apply 2 pints of Tordon 22K per acre in combination with 2/3 to 1 1/3 pints of Reclaim per acre for improved control. See labels for Tordon 22K and Reclaim for additional information and treatment recommendations. Apply aerially in an oil:water emulsion in 4 gallons or more total volume per acre or with ground equipment in 15 gallons or more total volume per acre. Use a maximum of 1 gallon of oil per acre for aerial or ground application. The use of an oil:water emulsion is critical and good spray coverage is essential for acceptable brush control.

Sand Shinnery Oak Suppression

In Texas, New Mexico and Oklahoma, apply Garlon 4 alone at a rate of 1/2 to 2 pints per acre for suppression of shinnery oak growing on sandy soils. Grass response following suppression may be impressive where rainfall is adequate. Grazing deferment following application together with proper grazing management is recommended to allow for the reestablishment of grass stands.

Post Oak and Blackjack Oak - Regrowth Stands

Apply in the late spring (May) to early summer (June-July) when oak leaves are fully developed (expanded). Use 2 quarts of Garlon 4 alone or in tank mix combination with 0.5 to 1 pints of 2,4-D low-volatile ester herbicide per acre. Apply in an oil:water emulsion or water surfactant dilution in sufficient total volume per acre to assure thorough coverage, usually 5 gallons or more per acre by fixed-wing aircraft or helicopter or 15 to 25 gallons per acre by ground equipment. Use a maximum of 1 gallon of oil per acre for aerial or ground application. Lower rates may be used for suppression only. Control will require at least 3 consecutive treatments. **Note:** Regrowth plants have a large root mass relative to top growth when compared to undisturbed plants. In order for top growth to intercept and translocate enough herbicide to control the roots, delay broadcast treatment until top growth is at least 4 ft tall.

High Volume Foliage Treatment: For regrowth less than 4 ft tall, apply 2 quarts of Garlon 4 per 100 gallons of water and 2 quarts of ag surfactant alone or in tank mix combination with 1 gallon of Grazon P+D or 1 quart of Tordon 22K. Apply as a high volume leaf-stem treatment to individual plants using ground equipment.

Post Oak and Blackjack Oak - Mature Stands

For control of mature stands (greater than 5 ft tall), apply 2 quarts of Garlon 4 per acre in late spring (May) to early summer (June-July) when oak leaves are fully developed (expanded). Understory species such as winged elm, buckbrush, tree huckleberry and ash occurring in some areas will not be controlled (only suppressed or defoliated) by using Garlon 4 alone. Where these understory species occur, control may be improved by tank mixing 2 quarts of Garlon 4 with 1 quart of Tordon 22K or 4 quarts of Grazon P+D per acre. For best results, apply as an oil:water emulsion in a total volume of 5 gallons per acre or more by fixed-wing aircraft or helicopter.

Other Susceptible Woody Plants

Apply 2 to 4 pints of Garlon 4 alone or in combination with 2 to 3 quarts of 3.8 lb/gal 2,4-D low volatile ester or amine formulation per acre. If difficult to control species such as ash, choke cherry, elm, maple or oaks are prevalent, and during applications made when plants are mature late in the summer or during drought conditions, use the higher rates of Garlon 4, alone or with 2,4-D. Garlon 4 may also be applied in a tank mixture with Grazon P+D or Tordon 22K for increased control of certain species. See labels for Grazon P+D and Tordon 22K for additional information and treatment recommendations. Apply aerially in 4 gallons or more total volume per acre or with ground equipment in 10 gallons or more total volume per acre. For best results on blackberry, apply during or after bloom. For management of kudzu, apply 1 quart of Garlon 4 per acre. Repeat application may be necessary to achieve desired level of control.

Susceptible Broadleaf Weeds

Use 2 pints of Garlon 4 per acre in a water spray. Apply as a broadcast spray in a total volume of 10 gallons or more per acre by ground equipment or aerially in a total volume of 2 gallons or more per acre. Apply anytime the weeds are actively growing. Garlon 4 at 1/2 to 3 pints may be tank mixed with 1 to 2 quarts of 3.8 lb/gal 2,4-D amine or low volatile ester.

Woody Plant Control

Foliage Treatment: Use 4 to 8 quarts of Garlon 4 in enough water to make 5 gallons or more per acre of total spray, or 1 1/2 to 3 quarts of Garlon 4 may be combined with labeled rates of 2,4-D low volatile ester, Tordon 101 Mixture, or Tordon K in sufficient water to make 5 gallons or more per acre of total spray. Tordon 101 Mixture and Tordon K are not registered for use in the states of California and Florida.

Broadleaf Weed Control

Use Garlon 4 at rates of 1 to 4 quarts in a total volume of 5 gallons or more per acre as a water spray mixture. Apply anytime weeds are actively growing. Garlon 4 at 0.25 to 3 quarts may be tank mixed with labeled rates of 2,4-D amine or low volatile ester, Tordon K, or Tordon 101 Mixture to improve the spectrum of activity. For thickened (high viscosity) spray mixtures, Garlon 4 can be mixed with diesel oil or other inverting agent. When using an inverting agent, read and follow the use directions and precautions on the product label. Tordon 101 Mixture and Tordon K are not registered for use in the states of California and Florida.

Foliage Treatment (Utility and Pipeline Rights-of-Way)

Use 4 to 8 quarts of Garlon 4 alone, or 3 to 4 quarts of Garlon 4 in a tank mix combination with labeled rates of 2,4-D low volatile ester, Tordon 101 Mixture or Tordon K and apply in a total spray volume of 10 to 30 gallons per acre. Use the higher rates and volumes when plants are dense or under drought conditions. Tordon 101 Mixture and Tordon K are not registered for use in the states of California and Florida.

Portions of grazed areas that intersect treated non-cropland, rights-of-way and forestry sites may be treated at up to 8 lb ae per acre if the area to be treated on the day of application comprises no more than 10% of the total grazable area.

Basal Bark, Dormant Stem and Cut Surface Treatments

Individual plant treatments such as basal bark and cut surface applications may be used on any use site listed on this label at a maximum use rate of 8 lb ae of triclopyr per acre. These types of applications are made directly to ungrazed parts of plants and, therefore, are not restricted by the grazing maximum rate of 2 lb ae of triclopyr per acre.

Basal Bark Treatment

To control susceptible woody plants with stems less than 6 inches in basal diameter, mix 1 to 5 gallons of Garlon 4 in enough oil to make 100 gallons of spray mixture. Apply with knapsack sprayer or power spraying equipment using low pressure (20 to 40 psi). Spray the basal parts of brush and tree trunks to a height of 12 to 15 inches from the ground, thoroughly wetting the indicated area. Spray until runoff at the ground line is noticeable. Old or rough bark requires more spray than smooth young bark. Apply anytime, including the winter months, except when snow or water prevent spraying to the ground line. **Mixing with oil requires vigorous agitation to form an oil solution.** Once a solution is formed it will stay stable.

Low Volume Basal Bark Treatment

To control susceptible woody plants with stems less than 6 inches in basal diameter, mix 20 to 30 gallons of Garlon 4 in enough oil to make 100 gallons of spray mixture. Apply with a backpack or knapsack sprayer using low pressure and a solid cone or flat fan nozzle. Spray the basal parts of brush and tree trunks to a height of 12 to 15 inches from the ground in a manner that thoroughly wets the lower stems, including the root collar area, but not to the point of runoff. Herbicide concentration should vary with size and susceptibility of species treated. Apply anytime, including the winter months, except when snow or water prevent spraying to the ground line or when stem surfaces are saturated with water. See Table 1 for relationship between mixing rate, spray volume and maximum application rate. **Note:** The addition of a soil active herbicide to a basal bark mixture with Garlon 4 may result in damage to surrounding non-target vegetation. Care should be taken to assess the areas in which these soil active herbicides are used in combination with Garlon 4 in basal bark applications. **Mixing with oil requires vigorous agitation to form an oil solution.** Once a solution is formed it will stay stable.

Garlon 4 Plus Tordon K in Oil Tank Mix: Garlon 4 and Tordon K may be used in tank mix combination as a low volume basal bark treatment to improve control of certain woody species such as ash, elm, maple, poplar, aspen, hackberry, oak, oceanspray, birch, hickory, pine, tanoak, cherry, locust, sassafras, and multiflora rose. (See product bulletin for mixing instructions.) Tordon K is not registered for use in the states of California and Florida.

Streamline Basal Bark Treatment (Southern States)

To control or suppress susceptible woody plants for conifer release, mix 20 to 30 gallons of Garlon 4 in enough oil to make 100 gallons of spray mixture. Streamline basal bark treatments are most effective on stems less than 4 inches in basal diameter. Apply with a backpack or knapsack sprayer using equipment that provides a directed straight stream spray. Apply the spray in a 2- to 3-inch wide band to one side of stems less than 3 inches in basal diameter. When the optimum amount of spray mixture is applied, the treated zone should widen to encircle the stem within approximately 30 minutes. Treat both sides of stems which are 3 to 4 inches in basal diameter. Direct the spray at bark that is approximately 12 to 24 inches above ground. Pines (loblolly, slash, shortleaf, and Virginia) up to 2 inches in diameter breast height (dbh) can be controlled by directing the spray at a point approximately 4 feet above ground. Vary spray mixture concentration with size and susceptibility of the species being treated. Better control is achieved when spray is applied to thin juvenile bark and above rough thickened mature bark. This technique is not recommended for scrub and live oak species, including blackjack, turkey, post, live, bluejack and laurel oaks, or bigleaf maple. Apply anytime, including winter months, except when snow or water prevents spraying at the desired height above ground level. **Note:** Best results with some hardwood species occur when applications are made from approximately 6 weeks prior to leaf expansion in the spring until approximately 2 months after leaf expansion is completed. **Mixing with oil requires vigorous agitation to form an oil solution.** Once a solution is formed it will stay stable.

Low Volume Stem Bark Band Treatment (North Central and Lake States)

To control susceptible woody plants with stems less than 6 inches in basal diameter, mix 20 to 30 gallons of Garlon 4 in enough oil to make 100 gallons of spray mixture. Apply with a backpack or knapsack sprayer using low pressure and a solid cone or flat fan nozzle. Apply the spray in a 6- to 10-inch wide band that completely encircles the stem. Spray in a manner that completely wets the bark, but not to the point of runoff. The treatment band may be positioned at any height up to the first major branch. For best results, apply the band as low as possible. Spray mixture concentration should vary with size and susceptibility of species to be treated. Applications may be made anytime, including winter months. **Mixing with oil requires vigorous agitation to form an oil solution.** Once a solution is formed it will stay stable.

Thinline Basal Bark Treatment

To control susceptible woody plants with stems less than 6 inches in diameter, apply Garlon 4, either undiluted or mixed at 50 to 75% v/v with oil, in a thin stream to all sides of the lower stems. The stream should be directed horizontally to apply a narrow band of Garlon 4 around each stem or clump. Use a minimum of 2 to 15 milliliters of Garlon 4 or oil mixture with Garlon 4 to treat single stems and from 25 to 100 milliliters to treat clumps of stems. Use an applicator metered or calibrated to deliver the small amounts required. **Mixing with oil requires vigorous agitation to form an oil solution.** Once a solution is formed it will stay stable.

Dormant Stem Treatment

Dormant stem treatments control susceptible woody plants and vines with stems less than 2 inches in diameter. Plants with stems greater than 2 inches in diameter may not be controlled and resprouting may occur. This treatment method is best suited for sites with dense, small diameter brush. Dormant stem treatments of Garlon 4 can also be used as a chemical side-trim for controlling lateral branches of larger trees that encroach onto roadside, utility, or other rights-of-way.

Mix 4 to 8 quarts of Garlon 4 in 2 to 3 gallons of crop oil concentrate or other recommended oil and add this mixture in enough water to make 100 gallons of spray solution. Use continuous adequate agitation. Apply with knapsack or power spraying equipment, using low pressure (20 to 40 psi). In western states, apply anytime after woody plants are dormant and most of the foliage has dropped. In other areas apply anytime within 10 weeks of budbreak, generally February through April. Thoroughly wet the upper parts of the stems and use the remainder to wet the lower 12 to 15 inches above the ground to the point of runoff. For root suckering species such as sumac, sassafras and locust, also spray the ground under the plant to cover small root suckers which may not be visible above the soild surface. For oil-water mixture application, mix 6 quarts of Garlon 4, 25 gallons of oil and 1.5 gallons of an approved agricultural spray emulsifier such as Sponto 712 or Triton X-100 as indicated in the mixing directions. Treat as above. Garlon 4 may be mixed with 4 quarts of Weedone 170 herbicide to improve the control of black cherry and broaden the spectrum of herbicidal activity. Do not apply to wet or saturated bark as poor control may result.

Cut Stump Treatment

To control resprouting, mix 20 to 30 gallons of Garlon 4 in enough oil to make 100 gallons of spray mixture. Apply with a backpack or knapsack sprayer using low pressures and a solid cone or flat fan nozzle. Spray the root collar area, sides of the stump, and the outer portion of the cut surface, including the cambium, until thoroughly wet, but not to the point of runoff. Spray mixture concentration should vary with the size and susceptibility of species treated. Apply anytime, including in winter months, except when snow or water prevent spraying to the ground line. **Mixing with oil requires vigorous agitation to form an oil solution.** Once a solution is formed it will stay stable.

Cut Stump Treatment in Western States

To control resprouting of salt cedar and other *Tamarix* species, bigleaf maple, tanoak, Oregon myrtle, and other susceptible species, apply undiluted Garlon 4 to wet the cambium and adjacent wood around the entire circumference of the cut stump. Treatments may be applied throughout the year; however, control may be reduced with treatment during periods of moisture stress as in late summer. Cut stumps so that they are approximately level to facilitate uniform coverage of Garlon 4. Use an applicator which can be calibrated to deliver the small amounts of material required.

Growing Point and Leaf Base (Crown) Treatment of Yucca

Prepare a 2% v/v solution of Garlon 4 in diesel or fuel oil (13 fl oz of Garlon 4 in 5 gallons of spray mixture). Thoroughly wet the center of the plant including growing point and leaf bases to the soil surface. Complete coverage of leaves is not necessary.

Forest Management Applications

For broadcast applications, apply 1 to 6 quarts of Garlon 4 per acre in a total spray volume of 5 to 25 gallons per acre by air or 10 to 100 gallons per acre by ground. Use spray volumes sufficient to provide thorough coverage of treated foliage. Nozzles or additives that produce larger droplets of spray may require higher spray volumes to provide adequate coverage.

Plant Back Interval for Conifers: Conifers planted sooner than 1 month after treatment with Garlon 4 at less than 4 quarts per acre or sooner than 2 months after treatment at 4 to 6 quarts per acre may be injured. When tank mixtures of herbicides are used for forest site preparation, labels for all products in the mixture should be consulted and the longest recommended waiting period before planting observed.

Forest Site Preparation (Not for Conifer Release)

Southern States including Alabama, Arkansas, Delaware, Florida, Georgia, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia: To control susceptible woody plants and broadleaf weeds, apply Garlon 4 at a rate of 4 to 6 quarts per acre. To broaden the spectrum of woody plants and broadleaf weeds controlled, apply 2 to 4 quarts of Garlon 4 per acre in tank mix combination with labeled rates of Tordon 101 Mixture or Tordon K. Tordon 101 Mixture and Tordon K are not registered for use in the state of Florida. Where grass control is also desired, Garlon 4, alone or in tank mix combination with Tordon K or Tordon 101 Mixture, may be applied with labeled rates of other herbicides registered for grass control in forests. Use of tank mix products must be in accordance with the most restrictive of label limitations and precautions. Do not exceed labeled application rates. Garlon 4 cannot be tank mixed with any product containing a label prohibition against such mixing.

Western, Northeastern, North Central, and Lake States (States not Listed Above as Southern States): To control susceptible woody plants and broadleaf weeds, apply Garlon 4 at a rate of 3 to 6 quarts per acre. To broaden the spectrum of woody plants and broadleaf weeds controlled, apply 1.5 to 3 quarts of Garlon 4 per acre in tank mix combination with labeled rates of Tordon 101 Mixture, Tordon K, or 2,4-D low volatile ester. Tordon 101 Mixture and Tordon K are not registered for use in the state of California. Where grass control is also desired, Garlon 4, alone or in tank mix combination with Tordon 101 Mixture or Tordon K, may be applied with labeled rates of other herbicides registered for grass control in forests. When applying tank mixes, follow applicable use directions and precautions on each product label.

Southern Coastal Flatwoods: To control susceptible broadleaf weeds and woody species such as gallberry and wax-myrtle, and for partial control of saw-palmetto, apply 2 to 4 quarts of Garlon 4 per acre. To broaden the spectrum of species controlled to include fetterbush, staggerbush, titi, and grasses, apply 2 to 3 quarts of Garlon 4 per acre in tank mix combination with labeled rates of Arsenal Applicator's Concentrate herbicide. Where control of gallberry, wax-myrtle, broadleaf weeds, and grasses is desired, apply 2 to 3 quarts of Garlon 4 per acre in tank mix combination with labeled rates of Accord Concentrate or Accord SP herbicide.

These treatments may be broadcast during site preparation of flat planted or bedded sites or, on bedded sites, applied in bands over the top of beds. For best results, apply in late summer or fall. Efficacy may not be satisfactory when applications are made in early season prior to August. **Note:** Do not apply after planting pines.

Directed Spray Applications for Conifer Release

To release conifers from competing hardwoods and brush such as red maple, sugar maple, striped maple, sweetgum, red and white oaks, ash, hickory, alder, birch, aspen, pin cherry, *Ceanothus* spp., blackberry, chinquapin, and poison oak, mix 4 to 20 quarts of Garlon 4 in enough water to make 100 gallons of spray mixture. This spray mixture should be directed onto foliage of competitive hardwoods using knapsack or backpack sprayers with flat fan nozzles or equivalent anytime after the hardwoods and brush have reached full leaf size, but before autumn coloration. The majority of treated hardwoods and brush should be less than 6 feet in height to ensure adequate spray coverage. Care should be taken to direct spray away from contact with conifer foliage, particularly foliage of desirable pines. See Table 1 for relationship between mixing rate, spray volume and maximum application rate.

Note: Spray may cause temporary damage and growth suppression where contact with conifers occurs; however, injured conifers should recover and grow normally. Over-the-top spray applications can kill pines.

Broadcast Applications for Mid-Rotation Understory Brush Control in Southern Coastal Flatwoods Pine Stands (Ground Equipment Only)

For control of susceptible species such as gallberry and wax-myrtle and broadleaf weeds, apply 2 to 4 quarts of Garlon 4 per acre. To broaden the spectrum of woody plants controlled to include fetterbush, staggerbush, and titi, apply 2 to 3 quarts of Garlon 4 per acre in tank mix combination with labeled rates of Arsenal Applicator's Concentrate. Saw-palmetto will be partially controlled by use of Garlon 4 at 4 quarts per acre or by mixtures of Garlon 4 at 2 to 3 quarts per acre in tank mix combination with either Arsenal Applicator's Concentrate or Escort herbicide. These mixtures should be broadcast applied over target understory brush species, **but to prevent injury to pines, make applications underneath the foliage of pines.** Apply sprays in 30 gallons or more per acre of total volume. For best results, apply in late summer or fall. Efficacy may not be satisfactory when applications are made in early season prior to August.

Broadcast Applications for Conifer Release in the Pacific Northwest and California

Dormant Conifers Before Bud Swell (Excluding Pines): To control or suppress deciduous hardwoods such as vine maple, bigleaf maple, alder, scotch broom, or willow **before leaf-out,** or evergreen hardwoods such as madrone, chinquapin, and *Ceanothus* spp., use Garlon 4 at 1 to 2 quarts per acre. Use diesel or fuel oil as a diluent, or use water plus 1 to 2 gallons per acre of diesel oil or a suitable surfactant or oil substitute at manufacturer's recommended rates. **Mixing with oil as the only diluent requires vigorous agitation to form an oil solution.** Once a solution is formed it will stay stable.

Conifer Plantations (Excluding Pines) After Hardwoods Begin Growth and Before Conifer Bud Break ("Early Foliar" Hardwood Stage): Use Garlon 4 at 1 to 1.5 quarts alone or with 2,4-D low volatile ester herbicide in water carrier to provide no more than 3 lb ae per acre from both products. After conifer bud break, these sprays may cause more serious injury to the crop trees. Use of a surfactant may cause unacceptable injury to conifers especially after bud break.

Conifer Plantations (Excluding Pines) After Conifers Harden Off in Late Summer and While Hardwoods are Still Actively Growing: Use Garlon 4 at rates of 1 to 1.5 quarts per acre alone or with 2,4-D low volatile ester to provide no more than 3 lb ae per acre from both products. Treat as soon after conifer bud hardening as possible so that hardwoods and brush are actively growing. Use of oil, oil substitute, or surfactant may cause unacceptable injury to the conifers.

Broadcast Applications for Conifer Release in the Eastern United States

To release spruce, fir, red pine, and white pine from competing hardwoods such as red maple, sugar maple, striped maple, alder, birch (white, yellow, and grey), aspen, ash, pin cherry, and *Rubus* spp. and perennial and annual broadleaf weeds, use Garlon 4 at rates of 1.5 to 3 quarts per acre alone or with 2,4-D amine or low volatile ester to provide no more than 4 lb ae per acre from both products. Apply in late summer or early fall after conifers have formed their overwintering buds and hardwoods are in full leaf and prior to autumn coloration.

Broadcast Applications for Conifer Release in the Lake States Region

To release spruce, fir, and red pine from competing hardwoods such as aspen, birch, maple, cherry, willow, oak, hazel, and *Rubus* spp. and perennial and annual broadleaf weeds, use Garlon 4 at rates of 1.5 to 3 quarts per acre. Apply in late summer or early fall after conifers have formed their overwintering buds and hardwoods are in full leaf and prior to autumn coloration.

Terms and Conditions of Use

If terms of the following Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. Otherwise, use by the buyer or any other user constitutes acceptance of the terms under Warranty Disclaimer, Inherent Risks of Use and Limitation of Remedies.

Warranty Disclaimer

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. Dow AgroSciences MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as unfavorable temperature, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of Dow AgroSciences or the seller. All such risks shall be assumed by buyer.

Limitation of Remedies

To the extent permitted by law, the exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at Dow AgroSciences' election, one of the following:

1. Refund of purchase price paid by buyer or user for product bought, or
2. Replacement of amount of product used.

To the extent permitted by law, Dow AgroSciences shall not be liable for losses or damages resulting from handling or use of this product unless Dow AgroSciences is promptly notified of such loss or damage in writing. To the extent permitted by law, in no case shall Dow AgroSciences be liable for consequential or incidental damages or losses.

The terms of the Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies cannot be varied by any written or verbal statements or agreements. No employee or sales agent of Dow AgroSciences or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or this Limitation of Remedies in any manner.

®Trademark of Dow AgroSciences LLC

Produced for Dow AgroSciences LLC • Indianapolis, IN 46268 USA

Label Code: D02-102-026
Replaces Label: D02-102-025
LOES Number: 010-00085

EPA accepted 04/18/07

Revisions:

1. Product may be applied by fixed wing aircraft or helicopter.
2. Added mixing directions section.
3. Added blackbrush, granjeno, guajillo, guava, milkweed vine, osage orange, pepper vine, trumpet creeper, twisted acacia, Virginia creeper and willow primrose to list of woody plants controlled.
4. Added biennial broadleaf weeds to list of weeds controlled.
5. Added dormant stem and cut surface treatments.

Product Bulletin

Dow AgroSciences

Dow AgroSciences LLC 9330 Zionsville Road Indianapolis, IN 46268-1054 USA

Garlon* 4

EPA Reg. No. 62719-40

2(ee) Recommendation †

For Distribution and Use in the State of Hawaii

Thinline Basal and Low Volume Basal Bark Applications on Miconia Trees 6" and Larger In Diameter

ATTENTION

- **†This recommendation is made as permitted under FIFRA 2(ee) and has not been reviewed or approved by the EPA.**
- This recommendation must be in the possession of the user at the time of application.
- Read the label affixed to the container for Garlon* 4 specialty herbicide before applying. Carefully follow all precautionary statements and applicable use directions except as specified below..
- Except as described this Section 2(ee) recommendation, use of Garlon 4 according to this product bulletin is subject to all use precautions and limitations imposed by the label affixed to the product container.

Directions for Use

To control Miconia trees larger then 6" in diameter, use Garlon 4 in a low volume basal bark application at a 10% to 20% concentration mixed with diesel fuel or other penetrating oils. Spray the complete basal circumference for a height of 12 to 15 inches above ground level. Lower use rates on larger diameter trees may reduce control.

To control Miconia trees larger then 6" in diameter, use Garlon 4 in a thinline basal bark application. Apply Garlon 4 either undiluted or mixed at 50-75% v/v with diesel fuel or other penetrating oils in a thin stream to all sides of the basal trunk area. The stream should be directed horizontally to apply a narrow band around each stem. Use a minimum of 2 to 25 milliliters of undiluted Garlon 4 or of the oil mixture with Garlon 4. Use an applicator metered or calibrated to deliver the small amounts required. Lower use rates on larger diameter trees may reduce control.

*Trademark of Dow AgroSciences LLC

R102-001
Issued: 02/04/04
Initial printing.

Specimen Label

Dow AgroSciences

Remedy®

Specialty Herbicide

®Trademark of Dow AgroSciences LLC

For the control of woody plants and broadleaf weeds on rangeland, permanent grass pastures, and conservation reserve program (CRP) acres (including fence rows and non-irrigation ditch banks within these areas).

Active Ingredient:	
triclopyr: 3,5,6-trichloro-2- pyridinyloxyacetic acid, butoxyethyl ester	61.6%
Inert Ingredients	38.4%
Total	100.0%

Contains petroleum distillates
Acid Equivalent: triclopyr - 44.3% - 4 lb/gal

EPA Reg. No. 62719-70

Keep Out of Reach of Children

CAUTION PRECAUCION

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

Precautionary Statements

Hazards to Humans and Domestic Animals

Causes Moderate Eye Irritation • Harmful If Swallowed • Prolonged Or Frequently Repeated Skin Contact May Cause Allergic Reactions In Some Individuals

Avoid contact with eyes or clothing. Wear protective eyewear. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, or using tobacco.

Personal Protective Equipment (PPE)

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- Shoes plus socks

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables are given, use detergent and hot water. Keep and wash PPE separately from other laundry.

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

First Aid

If in eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

If swallowed: Immediately call a poison control center or doctor. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give **any** liquid to the person. Do not give anything by mouth to an unconscious person.

Note to Physician: Contains petroleum distillate. Vomiting may cause aspiration pneumonia.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-992-5994 for emergency medical treatment information.

Environmental Hazards

This pesticide is toxic to fish. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when cleaning equipment or disposing of equipment washwater or rinsate.

This chemical has properties and characteristics associated with chemicals detected in groundwater. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination.

Physical or Chemical Hazards

Combustible. Do not use or store near heat or open flame.

Notice: Read the entire label. Use only according to label directions. **Before using this product, read Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies elsewhere on this label. If terms are unacceptable, return at once unopened.**

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.dowagro.com.

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Spray Drift Management

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment and weather related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions.

The following drift management requirements must be followed to avoid off-target drift movement from aerial applications:

1. The distance of the outer most operating nozzles on the boom must not exceed 3/4 the length of the wingspan or rotor.
2. Nozzles must always point backward parallel with the air stream and never be pointed downwards more than 45 degrees.

Where states have more stringent regulations, they should be observed.

The applicator should be familiar with and take into account the information covered in the following Aerial Drift Reduction Advisory. [This information is advisory in nature and does not supersede mandatory label requirements.]

Aerial Drift Reduction Advisory

Information on Droplet Size: The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see Wind, Temperature and Humidity, and Temperature Inversions).

Controlling Droplet Size:

- **Volume** - Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets.
- **Pressure** - Do not exceed the nozzle manufacturer's recommended pressures. For many nozzle types, lower pressure produces larger droplets. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.
- **Number of Nozzles** - Use the minimum number of nozzles that provide uniform coverage.
- **Nozzle Orientation** - Orienting nozzles so that the spray is released parallel to the airstream produces larger droplets than other orientations and is the recommended practice. Significant deflection from horizontal will reduce droplet size and increase drift potential.
- **Nozzle Type** - Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce the largest droplets and the lowest drift.

Boom Length: For some use patterns, reducing the effective boom length to less than 3/4 of the wingspan or rotor length may further reduce drift without reducing swath width.

Application Height: Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces exposure of droplets to evaporation and wind.

Swath Adjustment: When applications are made with a crosswind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind, smaller drops, etc.)

Wind: Drift potential is lowest between wind speeds of 2 to 10 mph. However, many factors, including droplet size and equipment type, determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. **Note:** Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect spray drift.

Temperature and Humidity: When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions: Applications should not occur during a local, low level temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of the smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

Sensitive Areas: The pesticide should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas).

Ground Equipment: With ground equipment, spray drift can be reduced by keeping the spray boom as low as possible; by applying 20 gallons or more of spray per acre; by keeping the operating spray pressures at the lower end of the manufacturer's recommended pressures for the specific nozzle type used (low pressure nozzles are available from spray equipment manufacturers); and by spraying when wind velocity is low (follow state regulations). In hand-gun applications, select the minimum spray pressure that will provide adequate plant coverage (without forming a mist). Do not apply with nozzles that produce a fine-droplet spray.

Mixing Directions

Remedy may be foliarly applied by diluting with water or by preparing an oil-water emulsion. For woody plant control, an oil-water emulsion performs more dependably under a broader range of conditions than a straight water dilution and is recommended for aerial applications.

Oil-Water Emulsions

Prepare oil-water emulsions using diesel fuel, fuel oil, or kerosene plus an emulsifier such as Sponto 712 or Triton X-100. Use a jar test to check spray mix compatibility before preparing oil-water emulsion sprays in the mixing tank.

Annual, Biennial and Perennial Broadleaf Weeds

Note: Numbers in parentheses refer to footnotes below table.

black medic
burdock
chicory
cinquefoil
clover
curly dock
dandelion (top growth)
dogfennel
lambsquarters
lespedeza
mustard
plantain
sericea lespedeza (1)
sulfur cinquefoil (2)
tropical soda apple (3)
vetch
wild carrot (top growth)
wild violet
yarrow

1. **Sericea lespedeza:** Apply 1 to 2 pints of Remedy per acre. For best results, apply after maximum foliage development in the late spring to early summer, but prior to bloom.
2. **Sulfur cinquefoil:** Apply 1 to 2 pints of Remedy per acre. For best results, apply to plants in the rosette stage.
3. **Tropical soda apple:** Apply 2 pints of Remedy per acre when tropical soda apple plants reach the first flower stage. For best results, apply in a total spray volume of 40 gallons per acre using ground equipment. An agricultural surfactant may be added at the manufacturer's recommended rate to provide more complete wetting and coverage of the foliage. Spot treatments may be used to control sparse plant stands. For spot treatment use a 1 to 1.5% solution of Remedy in water (1 to 1 1/2 gallons of Remedy in 100 gallons total spray mixture) and spray the entire plant to completely wet the foliage. **In Florida**, control of tropical soda apple may be improved by using the following management practices:
   - Mow plants to a height of 3 inches every 50 to 60 days or whenever they reach flowering. Continue the mowing operation through April.
   - In late May to June (50 to 60 days after the April mowing), apply Remedy as a broadcast treatment.
   - Use spot treatment to control any remaining plants or thin stands of plants that germinate following a broadcast treatment.

Application Methods

Foliage Treatment With Ground Equipment

Use sufficient spray volume to completely and uniformly cover foliage. For ground application, apply 10 gallons or more of total spray volume per acre. Use higher spray volumes for ground applications to ensure adequate coverage with increased depth and density of foliage, particularly for treatment of woody plants.

High-Volume Foliage Treatment

For control of susceptible woody plants, use Remedy alone or in tank mix combination at the recommended rate to make 100 gallons of spray mixture. On rangeland and permanent pasture sites, make 1 application per year and apply no more than 2 quarts of Remedy (2 lb ae of triclopyr) per acre. To control a broader spectrum of woody plants and broadleaf weeds, Remedy may be tank mixed with other herbicides at recommended rates (see application rates table below). When tank mixing, follow all applicable use directions, precautions, and limitations on the respective product labels.

Depending upon the size and density of the woody plants, apply sufficient spray volume to thoroughly wet all leaves, stems, and root collars. To minimize spray drift, select the minimum spray pressure that provides adequate plant coverage without forming a mist and direct sprays no higher than the top of the target plants. Use a drift control additive cleared for application to growing crops to reduce spray drift. Before using any tank mixture, read the directions and use precautions on both labels. For best results, apply when woody plants and weeds are actively growing.

Application Rates per 100 Gallons of Spray		
Remedy	**Plus Tank Mix Product**	**Rate (qt)**
1 - 4 qt	--	--
1 - 2 qt	Grazon® P+D specialty herbicide	4
1 - 2 pt	2,4-D low volatile ester herbicide	1 - 2
1 - 2 qt	Tordon® 22K specialty herbicide	1 - 2
2 qt	Reclaim® specialty herbicide[1,2]	2

[1]Reclaim is registered for use only in Arizona, Texas, Oklahoma and New Mexico.
[2]See directions for Mesquite Control Using High Volume Foliage Treatment below.

Mesquite Control Using High Volume Foliage Treatment: For control of mesquite infestations of low to moderate density, apply Remedy and Reclaim in a tank mixture to individual plants with backpack or hand-held sprayers or a vehicle-mounted sprayer with hand-held spray wand or spray gun. For individual plant treatment, use 2 quarts of Remedy in combination with 2 quarts of Reclaim per 100 gallons of total spray solution (1/2% v/v of each product). Apply in water or as an oil-water emulsion as described in Mixing Directions. If using an oil-water emulsion, add the oil at a rate of 5% of the total spray volume. Apply as a complete spray-to-wet foliar application, including all leaves. Thorough coverage is necessary for good results, but do not spray to the point of runoff. Do not apply when mesquite foliage is wet. The total amount of Reclaim applied should not exceed 1 1/3 pints per acre. For best results, follow information given elsewhere in this label concerning effect of environmental conditions and application timing on control. This application method works best for brush less than 8 feet tall since efficient treatment and thorough coverage of taller brush is difficult to achieve with this method. To minimize drift, select a spray nozzle and pressure that provides good coverage while forming a coarse spray. Additionally, drift may be reduced by using the minimum pressure necessary to obtain plant coverage without forming a mist and by directing sprays no higher than the top of target plants. If desired, a spray dye may be added to the spray mixture to mark the treated plants.

Broadcast Application With Aerial or Ground Equipment

Environmental conditions and application timing influence brush and weed control results. For best results, apply when woody plants and weeds are actively growing. For woody species, apply after the rapid growth period of early spring when leaf tissue is fully expanded and terminal growth has slowed. Brush regrowth should be at least 4 ft high prior to treatment to insure adequate foliage for herbicide absorption. Adequate soil moisture before and after treatment as well as the presence of healthy foliage at the time of application are important factors contributing to optimal herbicidal activity.

Susceptible Broadleaf Weeds

Use 2 pints of Remedy per acre in a water spray. Apply as a broadcast spray in a total volume of 10 gallons or more per acre by ground equipment or aerially in a total volume of 2 gallons or more per acre. Apply anytime the weeds are actively growing. Remedy at 1/2 to 3 pints may be tank mixed with 1 to 2 quarts of 3.8 lb/gal 2,4-D amine or low volatile ester.

Basal Bark and Dormant Brush Treatments

For non-foliar applications, apply no more than 2 quarts of Remedy (2 lb ae of triclopyr) per acre per year.

Low Volume Basal Bark Treatment

To control susceptible woody plants such as mesquite, huisache, red maple, red and white oak, birches and aspen with stems less than 6 inches in basal diameter, mix 20 to 30 gallons of Remedy in enough oil to make 100 gallons of spray mixture. Apply with a backpack or knapsack sprayer using low pressure and a solid cone or flat fan nozzle. Spray the basal parts of brush and tree trunks to a height of 12 to 15 inches from the ground in a manner which thoroughly wets the lower stem, including the root collar area, but not to the point of runoff. Herbicide concentration should vary with size and susceptibility of species treated. Apply anytime, including the winter months, except when snow or water prevent spraying to the ground line or when stem surfaces are saturated with water.

Streamline Basal Bark Treatment

To control or suppress susceptible woody plants such as mesquite, huisache, red maple, white and red oak, elbowbush, greenbriar, hackberry, pricklyash, yaupon and wild grape, mix 25 to 30 gallons of Remedy with 10% penetrant such as Cidekick in enough oil to make 100 gallons of spray mixture. Streamline basal bark treatments are most effective on stems less than 4 inches in basal diameter. Apply with a backpack or knapsack sprayer using equipment which provides a directed straight stream spray. Apply the spray in a 2- to 3-inch wide band to one side of stems less than 3 inches in basal diameter. When the optimum amount of spray mixture is applied, the treated zone should widen to encircle the stem within approximately 30 minutes. Treat both sides of stems which are 3 to 4 inches in basal diameter. Direct the spray at bark that is approximately 12 to 24 inches above ground. Vary spray mixture concentration with size and susceptibility of the species being treated. Better control is achieved when spray is applied to thin juvenile bark and above rough thickened mature bark. Apply anytime, including winter months, except when snow or water prevents spraying at the desired height above ground level. **Note:** Best results with some hardwood species occur when applications are made from approximately 6 weeks prior to leaf expansion in the spring until approximately 2 months after leaf expansion is completed.

Cut Stump Treatment in California

To control resprouting, apply undiluted Remedy to wet the cambium and adjacent wood around the entire circumference of cut stumps. Treatments may be applied throughout the year; however, control may be reduced with treatment during periods of moisture stress as in late summer. Cut stumps so that they are approximately level to facilitate uniform coverage of Remedy. Use an applicator which can be calibrated to deliver the small amounts of material required.

Cut Stump Treatment

To control resprouting, mix 20 to 30 gallons of Remedy in enough oil to make 100 gallons of spray mixture. Apply with a backpack or knapsack sprayer using low pressures and a solid cone or flat fan nozzle. Spray the root collar area, sides of the stump, and the outer portion of the cut surface, including the cambium, until thoroughly wet, but not to the point of runoff. Spray mixture concentration should vary with the size and susceptibility of species treated. Apply anytime, including in winter months, except when snow or water prevent spraying to the ground line.

Dormant Stem Treatment

Mix 3 to 6 quarts of Remedy in enough oil to make 100 gallons of spray solution. Apply with knapsack or power spraying equipment, using low pressure (20 to 40 psi). Treat anytime when brush is dormant and most of the foliage has dropped. Do not apply when snow or water prevent spraying to the ground line. Thoroughly wet the upper parts of the stems and use the remainder to wet the lower 12 to 15 inches above the ground to the point of runoff. For root suckering species such as sumac, sassafras and locust, also spray the ground under the plant to cover small root suckers which may not be visible above the soil surface. For oil-water mixture application, mix 6 quarts of Remedy, 25 gallons of oil and 1.5 gallons of an approved agricultural spray emulsifier such as Sponto 712 or Triton X-100 as indicated in the mixing directions. Treat as above.

Thinline Basal Bark Treatment

To control susceptible woody plants such as red maple, blackberry, dogwood, red and white oak with stems less than 6 inches in diameter, apply undiluted Remedy in a thin stream to all sides of the lower stems. The stream should be directed horizontally to apply a narrow band of Remedy around each stem or clump. Use a minimum of 2 to 15 ml of Remedy to treat single stems and 25 to 100 ml of Remedy to treat clumps of stems. Use an applicator metered or calibrated to deliver the small amounts required.

Growing Point and Leaf Base (Crown) Treatment of Yucca

Prepare a 2% v/v solution of Remedy in diesel or fuel oil (13 fl oz of Remedy in 5 gallons of spray mixture). Thoroughly wet the center of the plant including growing point and leaf bases to the soil surface. Complete coverage of leaves is not necessary.

Conservation Reserve Program (CRP) for Established Permanent Grass Stands

Use Remedy on CRP acres only after perennial grasses are well established.

Broadcast Application Ground or Aerial: Apply 1 to 2 pints of Remedy per acre for small weed control or up to 1 1/2 quarts of Remedy per acre for deep-rooted perennial and susceptible woody species control. Use enough water to deliver 10 gallons or more per acre by ground or 2 gallons or more per acre by air of total spray volume.

Supplemental Labeling

Dow AgroSciences

Dow AgroSciences LLC 9330 Zionsville Road Indianapolis, IN 46268-1054 USA

Remedy*

EPA Reg. No. 62719-70

For Distribution and Use Only in the State of Florida

Extension of Use Sites in Florida

ATTENTION

- t is a violation of Federal law to use this product in a manner inconsistent with its labeling.
- This labeling must be in the possession of the user at the time of application.
- Read the label affixed to the container for Remedy before applying. Carefully follow all precautionary statements and applicable use directions.
- Except as described below, use of Remedy is subject to all use precautions and limitations imposed by the label affixed to the container for Remedy.

Directions for Use

In Florida, in addition to those uses listed on the label, Remedy* herbicide may be applied to non-irrigation ditchbanks and fencerows on farms and ranches. All Directions for Use, precautions and limitations on the product label for Remedy must be followed.

*Trademark of Dow AgroSciences LLC

123-22-002N (Reissued 01/01/98 for company name change)
Approved: 06/13/95
Replaces 123-22-002.

Amendments:

1. Use sites for Remedy in the state of Florida are expanded to include non-crop areas on farms and ranches.

ATTENTION:

This specimen label is provided for general information only.

- This pesticide product may not yet be available or approved for sale or use in your area.
- It is your responsibility to follow all federal, state and local laws and regulations regarding the use of pesticides.
- Before using any pesticide, be sure the intended use is approved in your state or locality.
- Your state or locality may require additional precautions and instructions for use of this product that are not included here.
- Monsanto does not guarantee the completeness or accuracy of this specimen label. The information found in this label may differ from the information found on the product label. You must have the EPA approved labeling with you at the time of use and must read and follow all label directions.
- You should not base any use of a similar product on the precautions, instructions for use or other information you find here.
- Always follow the precautions and instructions for use on the label of the pesticide you are using.

21136F2-48

Roundup PRO®

Herbicide

GROUP	9	HERBICIDE

The complete broad-spectrum postemergence professional herbicide for industrial, turf and ornamental weed control.

Complete Directions for Use

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, GREEN STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION IS LIKELY TO RESULT.

EPA Reg. No. 524-475 2007-1

Read the entire label before using this product.

Use only according to label instructions.

Not all products recommended on this label are registered for use in California. Check the registration status of each product in California before using.

Read the **LIMIT OF WARRANTY AND LIABILITY** statement at the end of the label before buying or using. If terms are not acceptable, return at once unopened.

THIS IS AN END-USE PRODUCT. MONSANTO DOES NOT INTEND AND HAS NOT REGISTERED IT FOR REFORMULATION. SEE INDIVIDUAL CONTAINER LABEL FOR REPACKAGING LIMITATIONS.

1.0 INGREDIENTS

ACTIVE INGREDIENT:	
*Glyphosate, N-(phosphonomethyl)glycine, in the form of its isopropylamine salt	41.0%
OTHER INGREDIENTS (including surfactant):	59.0%
	100.0%

*Contains 480 grams per liter or 4 pounds per U.S. gallon of the active ingredient glyphosate, in the form of its isopropylamine salt. Equivalent to 356 grams per liter or 3 pounds per U.S. gallon of the acid, glyphosate.

This product is protected by U.S. Patent Nos. 5,683,958; 5,703,D15; 6,063,733; 6,121,199; 6,121,200. No license granted under any non-U.S. patent(s).

2.0 IMPORTANT PHONE NUMBERS

1. FOR PRODUCT INFORMATION OR ASSISTANCE IN USING THIS PRODUCT, CALL TOLL-FREE,

   1-800-332-3111.

2. IN CASE OF AN EMERGENCY INVOLVING THIS PRODUCT, OR FOR MEDICAL ASSISTANCE, CALL COLLECT, DAY OR NIGHT,

   (314)-694-4000.

3.0 PRECAUTIONARY STATEMENTS

3.1 Hazards to Humans and Domestic Animals

Keep out of reach of children.

CAUTION!

CAUSES EYE IRRITATION.

Avoid contact with eyes or clothing.

FIRST AID: Call a poison control center or doctor for treatment advice.	
IF IN EYES	• Hold eye open and rinse slowly and gently with water for 15 - 20 minutes. • Remove contact lenses if present after the first 5 minutes then continue rinsing eye.
• Have the product container or label with you when calling a poison control center or doctor, or going for treatment.	
• You may also contact **(314) 694-4000**, collect day or night, for emergency medical treatment information.	
• This product is identified as **Roundup PRO® herbicide, EPA Registration No. 524-475.**	

DOMESTIC ANIMALS: This product is considered to be relatively nontoxic to dogs and other domestic animals; however, ingestion of this product or large amounts of freshly sprayed vegetation may result in temporary gastrointestinal irritation (vomiting, diarrhea, colic, etc.). If such symptoms are observed, provide the animal with plenty of fluids to prevent dehydration. Call a veterinarian if symptoms persist for more than 24 hours.

Personal Protective Equipment (PPE)

Applicators and other handlers must wear: long-sleeved shirt and long pants, shoes plus socks. Follow manufacturer's instructions for cleaning/maintaining Personal Protective Equipment (PPE). If there are no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them.

When handlers use closed systems, enclosed cabs or aircraft in a manner that meets the requirements listed in Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d) (4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

IMPORTANT: When reduced PPE is worn because a closed system is being used, handlers must be provided all PPE specified above for "applicators and other handlers" and have such PPE immediately available for use in an emergency, such as spill or equipment breakdown.

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

3.2 Environmental Hazards

Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when cleaning equipment or disposing of equipment washwaters.

3.3 Physical or Chemical Hazards

Spray solutions of this product should be mixed, stored and applied using only stainless steel, aluminum, fiberglass, plastic or plastic-lined steel containers.

DO NOT MIX, STORE OR APPLY THIS PRODUCT OR SPRAY SOLUTIONS OF THIS PRODUCT IN GALVANIZED STEEL OR UNLINED STEEL (EXCEPT STAINLESS STEEL) CONTAINERS OR SPRAY TANKS. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling. This product can only be used in accordance with the Directions for Use on this label or in separately published Monsanto Supplemental Labeling. Supplemental labeling may be found on the www.cdms.net or www.greenbook.net websites or obtained by contacting your Authorized Monsanto Retailer or Monsanto Company representative.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulations.

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about Personal Protective Equipment (PPE) and restricted entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 4 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is: coveralls, chemical resistant gloves greater than 14 mils in thickness composed of materials such as butyl rubber, natural rubber, neoprene rubber, or nitrile rubber, shoes plus socks.

Non-Agricultural Use Requirements

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard (40 CFR Part 170) for agricultural pesticides. The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries or greenhouses.

Keep people and pets off treated areas until spray solution has dried.

4.0 STORAGE AND DISPOSAL

PESTICIDE STORAGE: Do not contaminate water, foodstuffs, feed or seed by storage or disposal. Keep container closed to prevent spills and contamination.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product that cannot be used or chemically reprocessed should be disposed of in a landfill approved for pesticide disposal or in accordance with applicable Federal, state, or local procedures.

CONTAINER DISPOSAL: Emptied container retains vapor and product residue. Observe all labeled safeguards until container is cleaned, reconditioned, or destroyed.

FOR PLASTIC 1-WAY CONTAINERS & BOTTLES:
Do not reuse container. Triple rinse container, then puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

FOR ONE-WAY DRUMS:
Do not reuse container. Return container per the Monsanto container return program. If not returned, triple rinse container, then puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

FOR REFILLABLE PORTABLE (MINI-BULK) CONTAINERS:
This container must only be refilled with pesticide product. **Do not reuse this container for any other purpose.**

Final disposal must be in compliance with state and local regulations. If not refilled, returned, or recycled, triple rinse or pressure rinse, puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

Do not transport this container if it is damaged or leaking. If the container is damaged, leaking or obsolete or to obtain information about recycling portable refillable containers, contact Monsanto Company at 1-800-ROUNDUP (1-800-768-6387).

Users: When the container is empty, replace the cap and seal all openings that have been made during usage, and return the container to the point of purchase, or to an alternate location designated by the manufacturer at the time of purchase of this product. If not returned, triple rinse or pressure rinse the empty container and offer it for recycling if available.

Refillers: Do not reuse this mini-bulk container except for refill in accordance with a valid Monsanto Repackaging or Toll Repackaging Agreement. Prior to refilling, inspect carefully for damage such as cracks, punctures, abrasions, worn-out threads and closure devices. Check for leaks after refilling and before transporting.

FOR REFILLABLE STATIONARY BULK CONTAINERS:
This container must only be refilled with pesticide product. **Do not reuse this container for any other purpose.**

Prior to refilling, inspect carefully for damage such as cracks, punctures, abrasions, worn-out threads and closure devices.

Final disposal must be in compliance with state and local regulations. If not refilled, triple rinse or pressure rinse container and offer for recycling or reconditioning if possible. If burned, stay out of smoke.

5.0 GENERAL INFORMATION
(How This Product Works)

Product Description: This product is a postemergence, systemic herbicide with no soil residual activity. It gives broad-spectrum control of many annual weeds, perennial weeds, woody brush and trees. It is formulated as a water-soluble liquid containing surfactant and no additional surfactant is needed or recommended.

Time to Symptoms: This product moves through the plant from the point of foliage contact to and into the root system. Visible effects are a gradual wilting and yellowing of the plant, which advances to complete browning of aboveground growth and deterioration of underground plant parts. Effects are visible on most annual weeds within 2 to 4 days, but on most perennial weeds, effects may not be visible for 7 days or more. Extremely cool or cloudy weather following treatment may slow activity of this product and delay development of visual symptoms.

Mode of Action in Plants: The active ingredient in this product inhibits an enzyme found only in plants and microorganisms that is essential to the formation of specific amino acids.

Cultural Considerations: Reduced control may result when applications are made to annual or perennial weeds that have been mowed, grazed or cut, and have not been allowed to regrow to the recommended stage for treatment.

Rainfastness: Heavy rainfall soon after application may wash this product off of the foliage and a repeat application may be required for adequate control.

No Soil Activity: Weeds must be emerged at the time of application to be controlled by this product. Weeds germinating from seed after application will not be controlled. Unemerged plants arising from unattached underground rhizomes or rootstocks of perennials will not be affected by this herbicide and will continue to grow.

Tank Mixing: This product does not provide residual weed control. For subsequent residual weed control, follow a label-approved herbicide program. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used. Use according to the most restrictive precautionary statements for each product in the mixture.

When this label recommends a tank mixture with a single generic active ingredient such as diuron, 2,4-D or dicamba, the user is responsible for ensuring that the mixture product's label allows the specific application.

Buyer and all users are responsible for all loss or damage in connection with the use or handling of mixtures of this product with herbicides or other materials that are not expressly recommended in this label. Mixing this product with herbicides or other materials not recommended on this label may result in reduced performance.

Annual Maximum Use Rate: The combined total of all treatments must not exceed 10.6 quarts of this product per acre per year. The maximum use rates stated throughout this product's labeling apply to this product combined with the use of all other herbicides containing glyphosate as the active ingredient, whether applied as mixtures or separately. Calculate the application rates and ensure that the total use of this and other glyphosate containing products does not exceed stated maximum use rates.

ATTENTION

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, GREEN STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION MAY RESULT.

AVOID DRIFT. EXTREME CARE MUST BE USED WHEN APPLYING THIS PRODUCT TO PREVENT INJURY TO DESIRABLE PLANTS AND CROPS.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended. The likelihood of injury occurring from the use of this product increases when winds are gusty, as wind velocity increases, when wind direction is constantly changing or when there are other meteorological conditions that favor spray drift. When spraying, avoid combinations of pressure and nozzle type that will result in splatter or fine particles (mist) that are likely to drift. AVOID APPLYING AT EXCESSIVE SPEED OR PRESSURE.

NOTE: Use of this product in any manner not consistent with this label may result in injury to persons, animals or crops, or have other unintended consequences.

5.1 Weed Resistance Management

GROUP	9	HERBICIDE

Glyphosate, the active ingredient in this product, is a Group 9 herbicide based on the mode of action classification system of the Weed Science Society of America. Any weed population may contain plants naturally resistant to Group 9 herbicides. Weed species resistant to Group 9 herbicides may be effectively managed utilizing another herbicide from a different Group or using other cultural or mechanical practices.

To minimize the occurrence of glyphosate-resistant biotypes observe the following general weed management recommendations:

- Scout your application site before and after herbicide applications.
- Control weeds early when they are relatively small.
- Incorporate other herbicides and cultural or mechanical practices as part of your weed control system where appropriate.
- Utilize the recommended label rate for the most difficult weed in the site. Avoid tank-mixtures with other herbicides that reduce this product's efficacy (through antagonism) or tank mixture recommendations which encourage rates of this product below the label recommendations.
- Control weed escapes and prevent weeds from setting seeds.
- Clean equipment before moving from site to site to minimize spread of weed seed.
- Use new commercial seed as free of weed seed as possible.
- Report any incidence of repeated non-performance of this product on a particular weed to your Monsanto representative, local retailer, or county extension agent.

5.2 Management Recommendations for Glyphosate Resistant Weed Biotypes

NOTE: Appropriate testing is critical in order to confirm weed resistance to glyphosate. Contact your Monsanto representative to determine if resistance has been confirmed to any particular weed biotype in your area. Control recommendations for biotypes confirmed as resistant to glyphosate are made available on separately published supplemental labeling or fact sheets for this product and may be obtained from your local retailer or Monsanto representative.

Follow good weed management practices to avoid the spread of confirmed resistant biotypes.

- If a naturally occurring resistant biotype is present at your site, this product may be tank-mixed or applied sequentially with an appropriately labeled herbicide with a different mode of action to achieve control.
- Cultural and mechanical control practices may also be used as appropriate.
- Scout treated sites after herbicide applications and control escapes of resistant biotypes before they set seed.
- Thoroughly clean equipment before leaving sites known to contain resistant biotypes.

6.0 MIXING

Clean sprayer parts immediately after using this product by thoroughly flushing with water.

NOTE: REDUCED RESULTS MAY OCCUR IF WATER CONTAINING SOIL IS USED, SUCH AS VISIBLY MUDDY WATER OR WATER FROM PONDS AND DITCHES THAT IS NOT CLEAR.

6.1 Mixing with Water

This product mixes readily with water. Mix spray solutions of this product as follows: Begin filling the mixing tank or spray tank with the required amount of clean water. Add the recommended amount of this product near the end of the filling process and mix well. Use caution to avoid siphoning back into the carrier source. Use approved anti-back-siphoning devices where required by state or local regulations. During mixing and application, foaming of the spray solution may occur. To prevent or minimize foam, avoid the use of mechanical agitators, terminate by-pass and return lines at the bottom of the tank and, if needed, use an approved anti-foam or defoaming agent.

6.2 Tank Mixing Procedure

When tank mixing, read and carefully observe label directions, cautionary statements and all information on the labels of all products used. Add the tank-mix product to the tank as directed by the label. Maintain agitation and add the recommended amount of this product.

Maintain good agitation at all times until the contents of the tank are sprayed. If the spray mixture is allowed to settle, thorough agitation may be required to resuspend the mixture before spraying is resumed.

Keep by-pass line on or near the bottom of the tank to minimize foaming. Screen size in nozzle or line strainers should be no finer than 50-mesh.

Always predetermine the compatibility of labeled tank mixtures of this product with water carrier by mixing small proportional quantities in advance. Ensure that the specific tank mixture product is registered for application at the desired site.

Refer to the **Tank Mixing** section for additional precautions.

6.3 Mixing for Hand-Held Sprayers

Prepare the desired volume of spray solution by mixing the amount of this product as indicated in the following table with water:

Spray Solution

Desired Volume	Amount of Roundup PRO herbicide					
	1/2 %	1%	1 1/2 %	2%	5%	10%
1 gal	2/3 oz	1 1/3 oz	2 oz	2 2/3 oz	6 1/2 oz	13 oz
25 gal	1 pt	1 qt	1 1/2 qt	2 qt	5 qt	10 qt
100 gal	2 qt	1 gal	1 1/2 gal	2 gal	5 gal	10 gal
2 tablespoons = 1 fluid ounce						

For use in backpack, knapsack or pump-up sprayers, it is recommended that the appropriate amount of this product be mixed with water in a larger container and then filling the sprayer with the mixed solution.

6.4 Colorants or Dyes

Colorants or marking dyes may be added to spray solutions of this product; however they may reduce product performance at lower rates or dilution. Use colorants or dyes according to the manufacturer's recommendations.

7.0 APPLICATION EQUIPMENT AND TECHNIQUES

Do not apply this product through any type of irrigation system.

APPLY THESE SPRAY SOLUTIONS IN PROPERLY MAINTAINED AND CALIBRATED EQUIPMENT CAPABLE OF DELIVERING DESIRED VOLUMES.

7.1 Aerial Equipment

DO NOT APPLY THIS PRODUCT USING AERIAL SPRAY EQUIPMENT EXCEPT UNDER CONDITIONS SPECIFIED IN THIS LABEL or in separately published Monsanto Supplemental Labeling.

Use the recommended rates of this herbicide in 3 to 25 gallons of water per acre. When used according to label directions, this product will give control or partial control of herbaceous weeds, woody brush and trees listed in the **WEEDS CONTROLLED** section of this label.

Coarse sprays are less likely to drift; therefore, do not use nozzles or nozzle configurations that dispense spray as fine spray droplets. Do not angle nozzles forward into the airstream and do not increase spray volume by increasing nozzle pressure. Drift control additives may be used. When a drift control additive is used, read and carefully observe the cautionary statements and all other information appearing on the additive label.

FOR AERIAL APPLICATION IN CALIFORNIA OR ARKANSAS, REFER TO THE FEDERAL SUPPLEMENTAL LABEL FOR AERIAL APPLICATIONS IN THAT STATE FOR SPECIFIC INSTRUCTIONS, RESTRICTIONS AND REQUIREMENTS.

Avoid direct application to any body of water.

Ensure uniform application. To avoid streaked, uneven or overlapped application, use appropriate marking devices.

Aircraft Maintenance: PROLONGED EXPOSURE OF THIS PRODUCT TO UNCOATED STEEL SURFACES MAY RESULT IN CORROSION AND POSSIBLE FAILURE OF THE PART. The maintenance of an organic coating (paint) which meets aerospace specification MIL-C-38413 may prevent corrosion. To prevent corrosion of exposed parts, thoroughly wash aircraft after each day of spraying to remove residues of this product accumulated during spraying or from spills. Landing gear is most susceptible.

SPRAY DRIFT MANAGEMENT

AVOID DRIFT. EXTREME CARE MUST BE USED WHEN APPLYING THIS PRODUCT TO PREVENT INJURY TO DESIRABLE PLANTS AND CROPS.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended.

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment- and weather-related factors determines the potenbal for spray drift. The applicator and the grower are/is responsible for considering all these factors when making decisions.

AERIAL SPRAY DRIFT MANAGEMENT

The following drift management requirements must be followed to avoid off-target drift movement from aerial applications to agricultural field crops.

1. The distance of the outermost nozzles on the boom must not exceed 3/4 the length of the wingspan or rotor.
2. Nozzles must always point backward parallel with the airstream and never be pointed downwards more than 45 degrees. Where states have more stringent regulations, they should be observed.

Importance of droplet size

The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see the **Wind, Temperature and Humidity**, and **Temperature Inversion** sections of this label).

Controlling droplet size

- **Volume:** Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with the higher rated flows produce larger droplets.
- **Pressure:** Use the lower spray pressures recommended for the nozzle. Higher pressure reduces droplet size and does not improve canopy penetration. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.
- **Number of nozzles:** Use the minimum number of nozzles that provide uniform coverage.
- **Nozzle orientation:** Orienting nozzles so that the spray is released backwards, parallel to the airstream, will produce larger droplets than other orientations. Significant deflection from the horizontal will reduce droplet size and increase drift potential.
- **Nozzle type:** Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce larger droplets than other nozzle types.
- **Boom length:** For some use patterns, reducing the effective boom length to less than 3/4 of the wingspan or rotor length may further reduce drift without reducing swath width.
- **Application height:** Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces the exposure of the droplets to evaporation and wind.

Swath Adjustment

When applications are made with a crosswind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind speed, smaller droplets, etc.).

Wind

Drift potential is lowest between wind speeds of 2 to 10 miles per hour. However, many factors, including droplet size and equipment type determine drift potential at any given wind speed. Application should be avoided when wind speeds are below 2 miles per hour due to variable wind direction and high inversion potential. **NOTE:** Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect drift.

Temperature and Humidity

When making applications in low relative humidity, adjust equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions

Applications should not be made during a temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, movement of smoke produced by a ground source or an aircraft smoke generator can also identify temperature inversions. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

Sensitive Areas

Apply this product only when the potential for drift to sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas).

7.2 Ground Broadcast Equipment

Use the recommended rates of this product in 3 to 40 gallons of water per acre as a broadcast spray unless otherwise specified. As density of weeds increases, spray volume should be increased within the recommended range to ensure complete coverage. Carefully select proper nozzles to avoid spraying a fine mist. For best results with ground application equipment, use flat-fan nozzles. Check for even distribution of spray droplets.

7.3 Backpack or Hand-Held Equipment

Apply to foliage of vegetation to be controlled on a spray-to-wet basis; do not spray to the point of runoff. Spray coverage should be uniform and complete. Use coarse sprays only.

7.4 Selective Equipment

This product may be diluted with water and applied through recirculating spray systems, shielded applicators, hooded sprayers, wiper applicators or sponge bars, to listed weeds growing in any non-crop site specified on this label.

A recirculating spray system directs the spray solution onto weeds growing above desirable vegetation, while spray solution not intercepted by weeds is collected and returned to the spray tank for reuse.

AVOID CONTACT OF HERBICIDE WITH DESIRABLE VEGETATION. Contact of this product with desirable vegetation may result in unwanted plant damage or destruction.

Application equipment used above desired vegetation should be adjusted so that the lowest spray stream or wiper contact point is at least 2 inches above the desirable vegetation. Droplets, mist, foam or splatter of the herbicide solution settling on desirable vegetation is likely to result in discoloration, stunting or destruction.

Better results may be obtained when more of the weed is exposed to the herbicide solution. Weeds not contacted by the herbicide solution will not be affected. This may occur in dense clumps, severe infestations or when the height of the weeds varies so that not all weeds are contacted. In these instances, repeat treatment may be necessary.

Shielded and Hooded Applicators

A shielded or hooded applicator directs the herbicide solution onto weeds, while shielding desirable vegetation from the herbicide. Use nozzles that provide uniform coverage within the treated area. Keep shields on these sprayers adjusted to protect desirable vegetation. EXTREME CARE MUST BE EXERCISED TO AVOID CONTACT OF HERBICIDE WITH DESIRABLE VEGETATION.

Wiper Applicators and Sponge Bars

A wiper or sponge applicator applies the herbicide solution onto weeds by rubbing the weed with an absorbent material containing the herbicide solution. Equipment must be designed, maintained and operated to prevent the herbicide solution from contacting desirable vegetation. Operate this equipment at ground speeds no greater than 5 miles per hour. Performance may be improved by reducing speed in areas of heavy weed infestations to ensure adequate wiper saturation. Better results may be obtained if two (2) applications are made in opposite directions.

Avoid leakage or dripping onto desirable vegetation. Adjust height of applicator to ensure adequate contact with weeds. Keep wiping surfaces clean. Be aware that, on sloping ground, the herbicide solution may migrate, causing dripping on the lower end and drying of the wicks on the upper end of a wiper applicator.

Do not use wiper applicators when weeds are wet.

Mix only the amount of solution to be used during a 1-day period, as reduced activity may result from use of leftover solutions. Clean wiper parts immediately after using this product by thoroughly flushing with water.

For Rope or Sponge Wick Applicators: Use solutions ranging from 33 to 75 percent of this product in water.

For Panel Applicators and Pressure-Feed Systems: Use solutions ranging from 33 to 100 percent of this product in water.

When applied as recommended above, this product CONTROLS the following weeds:

Corn, volunteer
Panicum, Texas
Rye, common
Shattercane
Sicklepod
Spanishneedles
Starbur, bristly

When applied as recommended above, this product SUPPRESSES the following weeds:

Beggarweed, Florida
Bermudagrass
Dogbane, hemp
Dogfennel
Guineagrass
Johnsongrass
Milkweed
Nightshade, silverleaf
Pigweed, redroot
Ragweed, common
Ragweed, giant
Smutgrass
Sunflower
Thistle, Canada
Thistle, musk
Vaseygrass
Velvetleaf

7.5 Injection Systems

This product may be used in aerial or ground injection spray systems. It may be used as a liquid concentrate or diluted prior to injecting into the spray stream. Do not mix this product with the undiluted concentrate of other products when using injection systems unless specifically recommended.

7.6 CDA Equipment

The rate of this product applied per acre by controlled droplet application (CDA) equipment must not be less than the amount recommended in this label when applied by conventional broadcast equipment. For vehicle-mounted CDA equipment, apply in 2 to 15 gallons of water per acre.

CDA equipment produces a spray pattern that is not easily visible. Extreme care must be exercised to avoid spray or drift contacting the foliage or any other green tissue of desirable vegetation, as damage or destruction is likely to result.

8.0 SITE AND USE RECOMMENDATIONS

Unless otherwise specified, applications may be made to control any weeds listed in the **WEEDS CONTROLLED** section of this label. Refer also to the **Selective Equipment** section.

8.1 Cut Stumps

Cut stump treatments may be made on any site listed on this label. This product will control many types of woody brush and tree species, some of which are listed below. Apply this product using suitable equipment to ensure coverage of the entire cambium. Cut trees or resprouts close to the soil surface. Apply a 50 to 100 percent solution of this product to the freshly-cut surface **immediately after** cutting. Delays in application may result in reduced performance. For best results, applications should be made during periods of active growth and full leaf expansion.

Alder	Saltcedar
Eucalyptus	Sweetgum
Madrone	Tan oak
Oak	Willow
Reed, giant	

DO NOT MAKE CUT STUMP APPLICATIONS WHEN THE ROOTS OF DESIRABLE WOODY BRUSH OR TREES MAY BE GRAFTED TO THE ROOTS OF THE CUT STUMP. Some sprouts, stems, or trees may share the same root system. Adjacent trees having a similar age, height and spacing may signal shared roots. Whether grafted or shared, injury is likely to occur to non-treated stems/trees when one or more trees sharing common roots are treated.

8.2 Forestry Site Preparation

This product is recommended for the control or partial control of woody brush, trees and herbaceous weeds in forestry. This product is also recommended for use in preparing or establishing wildlife openings within these sites and maintaining logging roads.

This product is recommended for use in site preparation prior to planting any tree species, including Christmas trees, eucalyptus, hybrid tree cultivars and silvicultural nursery sites.

Refer to the **WEEDS CONTROLLED** and **Woody Brush and Trees** sections of this label for specific application rates and instructions.

Use higher rates of this product within the recommended range for control or partial control of woody brush, trees and hard-to-control perennial herbaceous weeds. For best results, apply to actively growing woody brush and trees after full leaf expansion and before fall color and leaf drop. Increase rates within the recommended range for control of perennial herbaceous weeds any time after emergence and before seedheads, flowers or berries appear.

Use the lower rates of this product within the recommended range for control of annual herbaceous weeds and actively growing perennial herbaceous weeds after seedheads, flowers or berries appear. Apply to the foliage of actively growing annual herbaceous weeds any time after emergence.

This product has no herbicidal or residual activity in the soil. Where repeat applications are necessary, do not exceed 10.6 quarts of this product per acre per year.

Unless otherwise directed, do not apply this product as an over-the-top broadcast spray for forestry conifer or hardwood release.

TANK MIXTURES

Tank mixtures of this product may be used to increase the spectrum of vegetation controlled. This product may be tank-mixed with the following products provided that the specific product is registered for use on the target site. Refer to these product labels for approved sites and application rates. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used. Use according to the most restrictive precautionary statements for each product in the mixture.

NOTE: For forestry site preparation, make sure the tank-mix product is approved for use prior to planting the desired species. Observe planting interval restrictions.

Any recommended rate of this product may be used in a tank mix with the following products for forestry site preparation.

Arsenal™ Applicators Concentrate	Garlon™ 3A
Chopper™	Garlon 4
Escort™	Oust™
Escort XP	Oust XP

8.3 General Non-crop Areas and Industrial Sites

Use in areas such as airports, apartment complexes, Christmas tree farms, commercial sites, Conservation Reserve Program (CRP) areas, ditch banks, dry ditches, dry canals, fencerows, golf courses, greenhouses, industrial sites, landscape areas, lumber yards, manufacturing sites, municipal sites, natural areas, office complexes, ornamentals, parks, parking areas, pastures, petroleum tank farms and pumping installations, plant nurseries, public areas, railroads, rangeland, recreational areas, residential areas, rights-of-way, roadsides, schools, sod or turf seed farms, sports complexes, storage areas, substations, turfgrass areas, utility sites, warehouse areas, and wildlife management areas.

General Weed Control, Trim-and-Edge, Bare Ground

This product may be used in general non-crop areas. It may be applied with any application equipment described in this label. This product may be used to trim-and-edge around objects in non-crop sites, for spot treatment of unwanted vegetation and to eliminate unwanted weeds growing in established shrub beds or ornamental plantings. This product may be used prior to planting an area to ornamentals, flowers, turfgrass (sod or seed), or prior to laying asphalt or beginning construction projects.

Repeated applications of this product may be used, as weeds emerge, to maintain bare ground.

TANK MIXTURES: This product may be tank-mixed with the following products provided that the specific product is registered for use on the target site. Refer to these product labels for approved sites and application rates. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used. Use according to the most restrictive precautionary statements for each product in the mixture.

User is responsible for ensuring that the mixture product's label allows the specific applications when tank mixing with a single generic active ingredient listed below.

Arsenal	Landmark II MP
atrazine	Oust
Barricade™ 65WG	Oust XP
Certainty®	Outrider®
Crossbow® L	pendimethalin
dicamba*	Plateau™
diuron	Poast™
Endurance™	Ronstar™ 50WP
Escort	simazine
Escort XP	Surflan™ AS
Gallery® 75DF	Surflan WDG
Garlon 3A	Telar™ DF
Garlon 4	Transline®
Goal® 2XL	Velpar® DF
Krovar™ I DF	Velpar L
Landmark® II	2,4-D

* This product plus dicamba tank mixtures may not be applied by air in California.

When applied as a tank mixture for bare ground, this product provides control of the emerged annual weeds and control or partial control of emerged perennial weeds, woody brush and trees.

For control or partial control of the following perennial weeds, apply 1 to 2 quarts of this product plus 2 to 4 ounces of Oust or Oust XP per acre.

Bahiagrass	Dock, curly	Poorjoe
Bermudagrass	Dogfennel	Quackgrass
Broomsedge	Fescue, tall	Vaseygrass
Dallisgrass	Johnsongrass	Vervain, blue

Chemical Mowing - Perennials

This product will suppress perennial grasses listed in this section to serve as a substitute for mowing. Use 8 fluid ounces of this product per acre when treating tall fescue, fine fescue, orchardgrass, quackgrass or reed canarygrass covers. Use 6 fluid ounces of this product per acre when treating Kentucky bluegrass. Apply treatments in 10 to 40 gallons of spray solution per acre.

Use only in areas where some temporary injury or discoloration of perennial grasses can be tolerated.

Chemical Mowing - Annuals

For growth suppression of some annual grasses, such as annual ryegrass, wild barley and wild oats growing in coarse turf on roadsides or other industrial areas, apply 4 to 5 fluid ounces of this product in 10 to 40 gallons of spray solution per acre. Applications should be made when annual grasses are actively growing and before the seedheads are in the boot stage of development. Treatments may cause injury to the desired grasses.

***Bromus* Species and Medusahead in Pastures and Rangelands**

***Bromus* species.** This product may be used to treat downy brome *(Bromus tectorum)*, Japanese brome *(Bromus japonicus)*, soft chess *(Bromus mollis)* and cheatgrass *(Bromus secalinus)* found in industrial, rangeland and pasture sites. Apply 8 to 16 fluid ounces of this product per acre on a broadcast basis.

For best results, treatment should coincide with early seedhead emergence of the most mature plants. Delaying the application until this growth stage will maximize the emergence of other weedy grass flushes. Applications should be made to the same site each year until seed banks are depleted and the desirable perennial grasses can become reestablished on the site.

Medusahead. To treat medusahead, apply 16 fluid ounces of this product per acre as soon as plants are actively growing, and prior to the 4-leaf stage. Applications may be made in the fall or spring.

Applications to brome and medusahead may be made using ground or aerial equipment. Aerial applications for these uses may be made using fixed wing or helicopter equipment. For aerial applications, apply in 2 to 10 gallons of water per acre. For applications using ground equipment, apply in 10 to 20 gallons of water per acre. When applied as directed in this label, there are no grazing restrictions.

Dormant Turfgrass

This product may be used to control or suppress many winter annual weeds and tall fescue for effective release of dormant bermudagrass and bahiagrass turf. Treat only when turf is dormant and prior to spring greenup.

Apply 8 to 64 fluid ounces of this product per acre. Apply the recommended rates in 10 to 40 gallons of water per acre. Use only in areas where bermudagrass or bahiagrass are desirable ground covers and where some temporary injury or discoloration can be tolerated.

Treatments in excess of 16 fluid ounces per acre may result in injury or delayed greenup in highly maintained areas, such as golf courses and lawns. DO NOT apply tank mixtures of this product plus Oust or Oust XP in highly maintained turfgrass areas. For further uses, refer to the **Roadsides** section of this label, which gives rates for dormant bermudagrass and bahiagrass treatments.

Actively Growing Bermudagrass

This product may be used to control or partially control many annual and perennial weeds for effective release of actively growing bermudagrass. DO NOT apply more than 16 fluid ounces of this product per acre in highly maintained turfgrass areas. DO NOT apply tank mixtures of this product plus Oust or Oust XP in highly maintained turfgrass areas. For further uses, refer to the **Roadsides** section of this label, which gives rates for actively growing bermudagrass treatments. Use only in areas where some temporary injury or discoloration can be tolerated.

Turfgrass Renovation, Seed, or Sod Production

This product controls most existing vegetation prior to renovating turfgrass areas or establishing turfgrass grown for seed or sod. For maximum control of existing vegetation, delay planting or sodding to determine if any regrowth from escaped underground plant parts occurs. Where repeat treatments are necessary, sufficient regrowth must be attained prior to application. For warm-season grasses such as bermudagrass, summer or fall applications provide the best control. Where existing vegetation is growing under mowed turfgrass management, apply this product after omitting at least one regular mowing to allow sufficient growth for good interception of the spray.

Desirable turfgrasses may be planted following the above procedures.

Hand-held equipment may be used for spot treatment of unwanted vegetation growing in existing turfgrass. Broadcast or hand-held equipment may be used to control sod remnants or other unwanted vegetation after sod is harvested.

PRECAUTIONS; RESTRICTIONS: Do not disturb soil or underground plant parts before treatment. Tillage or renovation techniques such as vertical mowing, coring or slicing should be delayed for 7 days after application to allow translocation into underground plant parts.

If application rates total 3 quarts per acre or less, no waiting period between treatment and feeding or livestock grazing is required. If the rate is greater than 3 quarts per acre, remove domestic livestock before application and wait 8 weeks after application before grazing or harvesting.

8.4 Habitat Management

Habitat Restoration and Management

This product may be used to control exotic and other undesirable vegetation in habitat management and natural areas, including rangeland and wildlife refuges. Applications can be made to allow recovery of native plant species, prior to planting desirable native species, and for similar broad-spectrum vegetation control requirements. Spot treatments can be made to selectively remove unwanted plants for habitat management and enhancement.

Wildlife Food Plots

This product may be used as a site preparation treatment prior to planting wildlife food plots. Any wildlife food species may be planted after applying this product, or native species may be allowed to repopulate the area. If tillage is needed to prepare a seedbed, wait 7 days after application before tillage to allow translocation into underground plant parts.

8.5 Injection and Frill (Woody Brush and Trees)

This product may be used to control woody brush and trees by injection or frill applications. Apply this product using suitable equipment that must penetrate into the living tissue. Apply the equivalent of 1/25 fluid ounce (1 mL) of this product per each 2 to 3 inches of trunk diameter at breast height (DBH). This is best achieved by applying a 50 to 100 percent concentration of this product either to a continuous frill around the tree or as cuts evenly spaced around the tree below all branches. As tree diameter increases in size, better results are achieved by applying diluted material to a continuous frill or more closely spaced cuttings. Avoid application techniques that allow runoff to occur from frilled or cut areas in species that exude sap freely. In species such as this, make the frill or cuts at an oblique angle to produce a cupping effect and use a 100 percent concentration of this product. For best results, application should be made during periods of active growth and after full leaf expansion. This product will control many species, some of which are listed below:

Control	Partial Control
Dogwood	Black gum
Oak	Hickory
Poplar	Maple, red
Sweetgum	
Sycamore	

8.6 Hollow-Stem Injection

This product may be applied through hand-held injection devices that deliver recommended amounts of this product into targeted hollow-stem plants growing in any non-crop site specified on this label. For control of the following hollow-stem plants, follow the use instructions below:

Japanese Knotweed, *Polygonum cuspidatum*

Inject 6 mL per stem of this product between second and third internode.

Bohemian Knotweed, *Polygonum bohemicum*

Inject 6 mL per stem of this product between second and third internode.

Giant Hogweed, *Heracleum mantegazzianum*

Inject one leaf cane per plant 12 inches above root crown with 6 mL of a 5% v/v solution of this product.

Poison Hemlock, *Conium maculatum*

Inject one leaf cane per plant 10 to 12 inches above root crown with 6 mL of a 5% v/v solution of this product.

Field horsetail, *Equisetum arvense*

Inject one segment above the root crown with 0.6 mL per stem of this product. Use a small syringe that calibrates to this rate.

Canada Thistle, *Cirsium arvense*

Cut 8 to 9 of the tallest plants at bud stage in a clump with clippers. Use a cavity needle that is pushed into the stem center and then slowly removed as 0.6 mL per stem of this product is injected into the stem.

NOTE: The combined total for all treatments must not exceed 10.6 quarts per acre of this product. At 6 mL per stem, 10.6 quarts should treat about 1600 stems per acre.

8.7 Ornamentals, Plant Nurseries, and Christmas Trees

Post-Directed, Trim-and-Edge

This product may be used as a post-directed spray around established woody ornamental species such as arborvitae, azalea, boxwood, crabapple, eucalyptus, euonymus, fir, douglas fir, jojoba, hollies, lilac, magnolia, maple, oak, poplar, privet, pine, spruce and yew. This product may also be used to trim-and-edge around trees, buildings, sidewalks and roads, potted plants and other objects in a nursery setting.

Desirable plants may be protected from the spray solution by using shields or coverings made of cardboard or other impermeable material. THIS PRODUCT IS NOT RECOMMENDED FOR USE AS AN OVER-THE-TOP BROADCAST SPRAY IN ORNAMENTALS AND CHRISTMAS TREES. Care must be exercised to avoid contact of spray, drift or mist with foliage or green bark of established ornamental species.

Site Preparation

This product may be used prior to planting any ornamental, nursery or Christmas tree species.

Wiper Applications

This product may be used through wick or other suitable wiper applicators to control or partially control undesirable vegetation around established eucalyptus or poplar trees. See the **Selective Equipment** section of this label for further information about the proper use of wiper applicators.

Greenhouse/Shadehouse

This product may be used to control weeds growing in and around greenhouses and shadehouses. Desirable vegetation must not be present during application and air circulation fans must be turned off.

8.8 Parks, Recreational and Residential Areas

This product may be used in parks, recreational and residential areas. It may be applied with any application equipment described in this label. This product may be used to trim-and-edge around trees, fences, and paths, around buildings, sidewalks, and other objects in these areas. This product may be used for spot treatment of unwanted vegetation. This product may be used to eliminate unwanted weeds growing in established shrub beds or ornamental plantings. This product may be used prior to planting an area to ornamentals, flowers, turfgrass (sod or seed), or prior to laying asphalt or beginning construction projects.

All of the instructions in the **General Non-crop Areas and Industrial Sites** section apply to park and recreational areas.

8.9 Railroads

The instructions in the **General Non-crop Areas and Industrial Sites** section may be used on railroads.

Bare Ground, Ballast and Shoulders, Crossings, and Spot Treatment

This product may be used to maintain bare ground on railroad ballast and shoulders. Repeat applications of this product may be used, as weeds emerge, to maintain bare ground. This product may be used to control tall-growing weeds to improve line-of-sight at railroad crossings and reduce the need for mowing along rights-of-way. For crossing applications, up to 80 gallons of spray solution per acre may be used.

TANK MIXTURES: This product may be tank-mixed with the following products for ballast, shoulder, spot, bare ground and crossing treatments provided that the specific product is registered for use on such sites. Refer to these product labels for approved non-crop sites and application rates. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used. Use according to the most restrictive precautionary statements for each product in the mixture.

User is responsible for ensuring the mixture product's label allows the specific applications when tank mixing with a single generic active ingredient listed below:

Arsenal	Hyvar™ X	simazine
atrazine	Hyvar XL	Spike™ 80DF
dicamba*	Krovar I DF	Telar DF
Escort	Oust	Transline
Escort XP	Oust XP	Velpar DF
Garlon 3A	Outrider	Velpar L
Garlon 4	Sahara® DG	2,4-D

*This product plus dicamba tank mixtures may not be applied by air in California.

Brush Control

This product may be used to control woody brush and trees on railroad rights-of-way. Apply 4 to 10 quarts of this product per acre as a broadcast spray, using boom-type or boomless nozzles. Up to 80 gallons of spray solution per acre may be used. Apply a 3/4 to 2 percent solution of this product when using high-volume spray-to-wet applications. Apply a 5 to 10 percent solution of this product when using low-volume directed sprays for spot treatment. This product may be mixed with the following products for enhanced control of woody brush and trees:

Arsenal	Krenite	Vanquish™
Escort	Telar DF	Velpar DF
Escort XP	Tordon® K	Velpar L
Garlon 3A	Tordon 22K	
Garlon 4	Transline	

Bermudagrass Release

This product may be used to control or partially control many annual and perennial weeds for effective release of actively growing bermudagrass. Apply 1 to 3 pints of this product in up to 80 gallons of spray solution per acre. Use the lower rate when treating annual weeds below 6 inches in height (or runner length). Use the higher rate as weeds increase in size or as they approach flower or seedhead formation. These rates will also provide partial control of the following perennial species:

Bahiagrass	Johnsongrass
Bluestem, silver	Trumpetcreeper
Fescue, tall	Vaseygrass

This product may be tank-mixed with Oust or Oust XP. If tank-mixed, use no more than 1 to 3 pints of this product with 1 to 2 ounces of Oust or Oust XP per acre. Use the lower rates of each product to control annual weeds less than 6 inches in height (or runner length) that are listed in this label and the Oust or Oust XP label. Use the higher rates as annual weeds increase in size and approach the flower or seedhead stages. These rates will also provide partial control of the following perennial weeds:

Bahiagrass	Fescue, tall
Blackberry	Johnsongrass
Bluestem, silver	Poorjoe
Broomsedge	Raspberry
Dallisgrass	Trumpetcreeper
Dewberry	Vaseygrass
Dock, curly	Vervain, blue
Dogfennel	

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment, but regrowth will occur under moist conditions. Repeat applications in the same season are not recommended, since severe injury may occur.

8.10 Roadsides

The instructions in the **General Non-crop Areas and Industrial Sites** section may apply to roadsides.

Shoulder Treatments

This product may be used on road shoulders. It may be applied with boom sprayers, shielded boom sprayers, high-volume off-center nozzles, hand-held equipment, and similar equipment.

Guardrails and Other Obstacles to Mowing

This product may be used to control weeds growing under guardrails and around signposts and immovable other objects along the roadside.

Spot Treatment

This product may be used as a spot treatment to control unwanted vegetation growing along roadsides.

TANK MIXTURES: This product may be tank-mixed with the following products for shoulder, guardrail, spot and bare ground treatments provided that the specific product is registered for use on such sites. Refer to these product labels for approved non-crop sites and application rates. Read and carefully observe the cautionary statement and all other information appearing on the labels of all herbicides used. Use according to the most restrictive precautionary statements for each product in the mixture.

User is responsible for ensuring that the mixture product's label allows the specific applications when tank mixing with a single generic active ingredient listed below.

atrazine	Landmark MP	Poast
Crossbow L	Landmark II MP	Ronstar 50 WSP
dicamba*	Landmark XP	Sahara DF
diuron	Oust	Surflan AS
Endurance	Oust XP	Surflan WDG
Escort	Outrider	Telar DF
Escort XP	pendimethalin	Velpar DF
Gallery 75DF	Plateau	Velpar L
Krovar I DF	Plateau OG	2,4-D

* This product plus dicamba tank mixtures may not be applied by air in California.

See the **General Non-crop Areas and Industrial Sites** section of this label for general instructions for tank mixing.

Release of Bermudagrass or Bahiagrass

Dormant Applications

This product may be used to control or partially control many winter annual weeds and tall fescue for effective release of dormant bermudagrass or bahiagrass. Treat only when turf is dormant and prior to spring greenup. This product may also be tank-mixed with Oust or Oust XP for residual control. Tank mixtures of this product with Oust or Oust XP may delay greenup.

For best results on winter annuals, treat when plants are in an early growth stage (below 6 inches in height) after most have germinated. For best results on tall fescue, treat when fescue is at or beyond the 4- to 6-leaf stage.

Apply 8 to 64 fluid ounces of this product in a tank mixture with 0.75 to 1.33 ounces of Outrider herbicide per acre. Read and follow all label directions for Outrider herbicide.

Apply 8 to 64 fluid ounces of this product per acre alone or in a tank mixture with 0.25 to 1 ounce per acre of Oust or Oust XP. Apply the recommended rates in 10 to 40 gallons of water per acre. Use only in areas where bermudagrass or bahiagrass are desirable ground covers and where some temporary injury or discoloration can be tolerated. To avoid delays in greenup and minimize injury, add no more than 1 ounce of Oust or Oust XP per acre on bermudagrass and no more than 1/2 ounce of Oust or Oust XP per acre on bahiagrass and avoid treatments when these grasses are in a semi-dormant condition.

Actively Growing Bermudagrass

This product may be used to control or partially control many annual and perennial weeds for effective release of actively growing bermudagrass. Apply 1 to 3 pints of this product in 10 to 40 gallons of spray solution per acre. Use the lower rate when treating annual weeds below 6 inches in height (or runner length). Use the higher rate as weeds increase in size or as they approach flower or seedhead formation. These rates will also provide partial control of the following perennial species:

Bahiagrass	Johnsongrass
Bluestem, silver	Trumpetcreeper
Fescue, tall	Vaseygrass

This product may be tank-mixed with Oust or Oust XP. If tank-mixed, use no more than 1 to 2 pints of this product with 1 to 2 ounces of Oust or Oust XP per acre. Use the lower rates of each product to control annual weeds less than 6 inches in height (or runner length) that are listed in this label and the Oust or Oust XP label. Use the higher rates as annual weeds increase in size and approach the flower or seedhead stages. These rates will also provide partial control of the following perennial weeds:

Bahiagrass	Fescue, tall
Bluestem, silver	Johnsongrass
Broomsedge	Poorjoe
Dallisgrass	Trumpetcreeper
Dock, curly	Vaseygrass
Dogfennel	Vervain, blue

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment, but regrowth will occur under moist conditions. Repeat applications of the tank mix in the same season are not recommended, since severe injury may occur.

Actively Growing Bahiagrass

For suppression of vegetative growth and seedhead inhibition of bahiagrass for approximately 45 days, apply 6 fluid ounces of this product in 10 to 40 gallons of water per acre. Apply 1 to 2 weeks after full greenup or after mowing to a uniform height of 3 to 4 inches. This application must be made prior to seedhead emergence.

For suppression up to 120 days, apply 4 fluid ounces of this product per acre, followed by an application of 2 to 4 fluid ounces per acre about 45 days later. Make no more than 2 applications per year.

This product may be used for control or partial control of Johnsongrass and other weeds listed on the Outrider herbicide label in actively growing bahiagrass. Apply 6.25 ounces of this product with 0.75 to 2.0 ounces of Outrider herbicide per acre. Use only on well-established bahiagrass.

A tank mixture of this product plus Oust or Oust XP may be used. Apply 6 fluid ounces of this product plus 0.5 to 1.0 ounce of Oust or Oust XP per acre 1 to 2 weeks following an initial spring mowing. Make only one application per year.

8.11 Utility Sites

In utilities, this product is recommended for use along electrical power, pipeline and telephone rights-of-way, and in other sites associated with these rights-of-way, such as substations, roadsides, railroads or similar rights-of-way that run in conjunction with utilities.

This product may be used in utility sites and substations for bare ground, trim-and-edge around objects, spot treatment of unwanted vegetation and to eliminate unwanted weeds growing in established shrub beds or ornamental plantings. This product may be used prior to planting a utility site to ornamentals, flowers, turfgrass (sod or seed), or beginning construction projects.

This product is also recommended for use in preparing or establishing wildlife openings within these sites, maintaining access roads and for side trimming along utility rights-of-way.

TANK MIXTURES: Tank mixtures of this product may be used to increase the spectrum of control for herbaceous weeds, woody brush and trees. This product may be tank-mixed with the following products. Refer to these products' labels for approved non-crop sites and application rates. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used. Use according to the most restrictive precautionary statements for each product in the mixture.

User is responsible for ensuring that the mixture product's label allows the specific applications when tank mixing with a single generic active ingredient listed below.

Arsenal	Krenite	Surflan AS
atrazine	Krovar I DF	Surflan WDG
dicamba[1]	Oust	Telar DF
diuron	Oust XP	Transline
Endurance	Outrider	Vanquish
Escort	pendimethalin	Velpar DF
Escort XP	Plateau	Velpar L
Garlon 3A*	Sahara DG	2,4-D
Garlon 4[2]	simazine	

[1] This product plus dicamba tank mixtures may not be applied by air in California.

[2] For side trimming treatments, it is recommended that this product be used alone or in tank mixture with Garlon 4.

*Ensure that Garlon 3A is thoroughly mixed with water according to label directions before adding this product. Have spray mixture agitating at the time this product is added to avoid spray compatibility problems.

Bare Ground and Trim-and-Edge

This product may be used in utility sites and substations for bare ground, trim-and-edge around objects, spot treatment of unwanted vegetation and to eliminate unwanted weeds growing in established shrub beds or ornamental plantings. This product may be used prior to planting a utility site to ornamentals, flowers, turfgrass (sod or seed), or beginning construction projects.

Repeated applications of this product may be used, as weeds emerge, to maintain bare ground.

This product may be tank-mixed with the following products. Refer to these products' labels for approved non-crop sites and application rates.

Arsenal	Plateau
Banvel	Princep™ DF
Barricade 65WG	Princep Liquid
diuron	Ronstar 50WP
Endurance	Sahara
Escort	simazine
Garlon 3A	Surflan

9.0 WEEDS CONTROLLED

Always use the higher rate of this product per acre within the recommended range when weed growth is heavy or dense or weeds are growing in an undisturbed (noncultivated) area.

Reduced results may occur when treating weeds heavily covered with dust. For weeds that have been mowed, grazed or cut, allow regrowth to occur prior to treatment.

For low-volume directed spray applications, use a 5 to 10 percent solution of this product for control or partial control of annual weeds, perennial weeds, or woody brush and trees. Spray coverage should be uniform with at least 50 percent of the foliage contacted. Coverage of the top one-half of the plant is important for best results. To ensure adequate spray coverage, spray both sides of large or tall woody brush and trees, when foliage is thick and dense, or where there are multiple resprouts.

Refer to the following label sections for recommended rates for the control of annual and perennial weeds and woody brush and trees. For difficult to control annual or perennial weeds and woody brush and trees, where plants are growing under stressed conditions, or where infestations are dense, this product may be used at 5 to 10 quarts per acre for enhanced results.

9.1 Annual Weeds

Use 1 quart per acre if weeds are less than 6 inches in height or runner length and 1.5 quarts to 4 quarts per acre if weeds are over 6 inches in height or runner length or when weeds are growing under stressed conditions. Use the higher rate for tough-to-control species regardless of the weed size at application. Treat tough-to-control weeds early when they are relatively small. This product may be tank mixed provided that the specific tank mix product is registered for use on the target site. Refer to these product labels for approved sites and application rates.

For spray-to-wet applications, apply a 1/2 percent solution of this product to weeds less than 6 inches in height or runner length. Apply prior to seedhead formation in grass or bud formation in broadleaf weeds. For annual weeds over 6 inches tall, or for smaller weeds growing under stressed conditions, use a 1 to 2 percent solution. Use the higher rate for tough-to-control species or for weeds over 24 inches tall.

WEED SPECIES

Anoda, spurred	Kochia
Barley*	Lamb's-quarters*
Barnyardgrass*	Little barley*
Bassia, fivehook	London rocket*
Bittercress*	Mayweed
Black nightshade*	Medusahead*
Bluegrass, annual*	Morningglory *(Ipomoea spp)*
Bluegrass, bulbous*	Mustard, blue*
Brome, downy*	Mustard, tansy*
Brome, Japanese*	Mustard, tumble*
Browntop panicum*	Mustard, wild*
Buttercup*	Oats
Carolina foxtail*	Pigweed*
Carolina geranium	Plains/Tickseed coreopsis*
Castor bean	Prickly lettuce*
Cheatgrass*	Puncturevine
Cheeseweed *(Malva parviflora)*	Purslane, common
Chervil*	Ragweed, common*
Chickweed*	Ragweed, giant
Cocklebur*	Red rice
Copperleaf, hophornbeam	Russian thistle
Corn*	Rye*
Corn speedwell*	Ryegrass*
Crabgrass*	Sandbur, field*
Dwarfdandelion*	Shattercane*
Eastern mannagrass*	Shepherd's-purse*
Eclipta*	Sicklepod
Fall panicum*	Signalgrass, broadleaf*
Falsedandelion*	Smartweed, ladysthumb*
Falseflax, smallseed*	Smartweed, Pennsylvania*
Fiddleneck	Sowthistle, annual
Field pennycress*	Spanishneedles
Filaree	Speedwell, purslane*
Fleabane, annual*	Sprangletop*
Fleabane, hairy *(Conyza bonariensis)**	Spurge, annual
	Spurge, prostrate*
Fleabane, rough*	Spurge, spotted*
Florida pusley	Spurry, umbrella*
Foxtail*	Starthistle, yellow
Goatgrass, jointed*	Stinkgrass*
Goosegrass	Sunflower*
Grain sorghum (milo)*	Teaweed/Prickly sida
Groundsel, common*	Texas panicum*
Hemp sesbania	Velvetleaf
Henbit	Virginia copperleaf
Horseweed/Marestail *(Conyza canadensis)*	Virginia pepperweed*
	Wheat*
Itchgrass*	Wild oats*
Johnsongrass, seedling	Witchgrass*
Junglerice	Woolly cupgrass*
Knotweed	Yellow rocket

*When using field broadcast equipment (aerial applications or boom sprayers using flat-fan nozzles) these species will be controlled or partially controlled using 1 pint of this product per acre. Applications must be made using 3 to 10 gallons of carrier volume per acre. Use nozzles that ensure thorough coverage of foliage and treat when weeds are in an early growth stage.

9.2 Perennial Weeds

Best results are obtained when perennial weeds are treated after they reach the reproductive stage of growth (seedhead initiation in grasses and bud formation in broad-leaves). For non-flowering plants, best results are obtained when the plants reach a mature stage of growth. In many situations, treatments are required prior to these growth stages. Under these conditions, use the higher application rate within the recommended range. Use a 2 percent solution on tough-to-control perennials such as bermudagrass, dock, field bindweed, hemp dogbane, milkweed and Canada thistle.

Ensure thorough coverage when using spray-to-wet treatments using hand-held equipment. When using hand-held equipment for low-volume directed spot treatments, apply a 5 to 10 percent solution of this product.

Allow 7 or more days after application before tillage.

Weed Species	Rate (Qt/A)	Hand-Held % Solution
Alfalfa*	1	2
Alligatorweed*	4	1.5
Anise (fennel)	2 – 4	1 – 2
Bahiagrass	3 – 5	2
Beachgrass, European *(Ammophila arenaria)*	–	5
Bentgrass*	1.5	2
Bermudagrass	5	2
Bermudagrass water (knotgrass)	1.5	2
Bindweed, field	4 – 5	2
Bluegrass, Kentucky	2	2
Blueweed, Texas	4 – 5	2
Brackenfern	3 – 4	1 – 1.5
Bromegrass, smooth	2	2
Bursage, woolly-leaf	–	2
Canarygrass, reed	2 – 3	2
Cattail	3 – 5	2
Clover; red, white	3 – 5	2
Cogongrass	3 – 5	2
Dallisgrass	3 – 5	2
Dandelion	3 – 5	2
Dock, curly	3 – 5	2
Dogbane, hemp	4	2
Fescue (except tall)	3 – 5	2
Fescue, tall	1 – 3	2
German ivy	2 – 4	1 – 2
Guineagrass	3	1
Horsenettle	3 – 5	2
Horseradish	4	2
Iceplant	2	1.5 – 2
Jerusalem artichoke	3 – 5	2
Johnsongrass	2 – 3	1
Kikuyugrass	2 – 3	2
Knapweed	4	2
Lantana	–	1 – 1.25
Lespedeza	3 – 5	2
Milkweed, common	3	2
Muhly, wirestem	2	2
Mullein, common	3 – 5	2
Napiergrass	3 – 5	2
Nightshade, silverleaf	2	2
Nutsedge; purple, yellow	3	1 – 2
Orchardgrass	2	2
Pampasgrass	3 – 5	1.5 – 2
Paragrass	3 – 5	2
Pepperweed, perennial	4	2
Phragmites*	3 – 5	1 – 2
Poison hemlock	2 – 4	1 – 2
Quackgrass	2 – 3	2
Redvine*	2	2
Reed, giant	4 – 5	2
Ryegrass, perennial	2 – 3	1
Smartweed, swamp	3 – 5	2
Spurge, leafy*	–	2
Sweet potato, wild*	–	2
Thistle, artichoke	2 – 3	1 – 2
Thistle, Canada	2 – 3	2
Timothy	2 – 3	2
Torpedograss*	4 – 5	2
Trumpetcreeper*	2 – 3	2
Vaseygrass	3 – 5	2
Velvetgrass	3 – 5	2
Wheatgrass, western	2 – 3	2

*Partial control

9.3 Woody Brush and Trees

Apply this product after full leaf expansion, unless otherwise directed. Use the higher rate for larger plants and/or dense areas of growth. On vines, use the higher rate for plants that have reached the woody stage of growth. Best results are obtained when application is made in late summer or fall after fruit formation.

In arid areas, best results are obtained when applications are made in the spring to early summer when brush species are at high moisture content and are flowering.

Ensure thorough coverage when using spray-to-wet treatments using hand-held equipment. When using hand-held equipment for low-volume directed-spray spot treatments, apply a 5 to 10 percent solution of this product.

Symptoms may not appear prior to frost or senescence with fall treatments.

Allow 7 or more days after application before tillage, mowing or removal. Repeat treatments may be necessary to control plants regenerating from underground parts or seed. Some autumn colors on undesirable deciduous species are acceptable provided no major leaf drop has occurred. Reduced performance may result if fall treatments are made following a frost.

Weed Species	Broadcast Rate (QT/A)	Hand-Held Spray-to-Wet % Solution
Alder	3 – 4	1 – 1.5
Ash*	2 – 5	1 – 2
Aspen, quaking	2 – 3	1 – 1.5
Bearclover (Bearmat)*	2 – 5	1 – 2
Beech*	2 – 5	1 – 2
Birch	2	1
Blackberry	3 – 4	1 – 1.5
Blackgum	2 – 5	1 – 2
Bracken	2 – 5	1 – 2
Broom; French, Scotch	2 – 5	1.5 – 2
Buckwheat, California*	2 – 4	1 – 2
Cascara*	2 – 5	1 – 2
Catsclaw*	–	1 – 1.5
Ceanothus*	2 – 5	1 – 2
Chamise*	2 – 5	1
Cherry; bitter, black, pin	2 – 3	1 – 1.5
Coyote brush	3 – 4	1.5 – 2
Deerweed	2 – 5	1
Dogwood*	2 – 5	1 – 2
Elderberry	2	1
Elm*	2 – 5	1 – 2
Eucalyptus	–	2
Gorse*	2 – 5	1 – 2
Hasardia*	2 – 4	1 – 2
Hawthorn	2 – 3	1 – 1.5
Hazel	2	1
Hickory*	2 – 5	1 – 2
Honeysuckle	3 – 4	1 – 1.5
Hornbeam, American*	2 – 5	1 – 2
Kudzu	4	2
Locust, black*	2 – 4	1 – 2
Madrone resprouts*	–	2
Manzanita*	2 – 5	1 – 2
Maple, red	2 – 4	1 – 1.5
Maple, sugar	–	1 – 1.5
Monkey flower*	2 – 4	1 – 2
Oak; black, white*	2 – 4	1 – 2
Oak, post	3 – 4	1 – 1.5
Oak; northern, pin	2 – 4	1 – 1.5
Oak, Scrub*	2 – 4	1 – 1.5
Oak; southern red	2 – 3	1 – 1.5
Peppertree, Brazilian (Florida holly)*	2 – 5	1 – 2
Persimmon*	2 – 5	1 – 2
Pine	2 – 5	1 – 2
Poison ivy	4 – 5	2
Poison oak	4 – 5	2
Poplar, yellow*	2 – 5	1 – 2
Redbud, eastern	2 – 5	1 – 2
Rose, multiflora	2	1
Russian olive*	2 – 5	1 – 2
Sage, black	2 – 4	1
Sage, white*	2 – 4	1 – 2
Sage brush, California	2 – 4	1
Salmonberry	2	1
Saltcedar*	2 – 5	1 – 2
Sassafras*	2 – 5	1 – 2
Sourwood*	2 – 5	1 – 2
Sumac; laurel, poison, smooth, sugarbush, winged*	2 – 4	1 – 2
Sweetgum	2 – 3	1 – 1.5
Swordfern*	2 – 5	1 – 2
Tallowtree, Chinese	–	1
Tan oak resprouts*	–	2
Thimbleberry	2	1
Tobacco, tree*	2 – 4	1 – 2
Toyon*	–	2
Trumpetcreeper	2 – 3	1 – 1.5
Vine maple*	2 – 5	1 – 2
Virginia creeper	2 – 5	1 – 2
Waxmyrtle, southern*	2 – 5	1 – 2
Willow	3	1
Yerba Santa*	–	2

*Partial control

10.0 LIMIT OF WARRANTY AND LIABILITY

Monsanto Company warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes set forth in the Complete Directions for Use label booklet ("Directions") when used in accordance with those Directions under the conditions described therein. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, NO OTHER EXPRESS WARRANTY OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY IS MADE. This warranty is also subject to the conditions and limitations stated herein.

To the extent consistent with applicable law, buyer and all users shall promptly notify this Company of any claims whether based in contract, negligence, strict liability, other tort or otherwise.

Buyer and all users are responsible for all loss or damage from use or handling which results from conditions beyond the control of this Company to the extent consistent with applicable law, including, but not limited to, incompatibility with products other than those set forth in the Directions, application to or contact with desirable vegetation, unusual weather, weather conditions which are outside the range considered normal at the application site and for the time period when the product is applied, as well as weather conditions which are outside the application ranges set forth in the Directions, application in any manner not explicitly set forth in the Directions, moisture conditions outside the moisture range specified in the Directions, or the presence of products other than those set forth in the Directions in or on the soil, crop or treated vegetation.

This Company does not warrant any product reformulated or repackaged from this product except in accordance with this Company's stewardship requirements and with express written permission from this Company.

TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF THE LIABILITY OF THIS COMPANY OR ANY OTHER SELLER FOR ANY AND ALL LOSSES, INJURIES OR DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT (INCLUDING CLAIMS BASED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE) SHALL BE THE PURCHASE PRICE PAID BY THE USER DR BUYER FOR THE QUANTITY OF THIS PRDDUCT INVOLVED, OR, AT THE ELECTION OF THIS COMPANY OR ANY OTHER SELLER, THE REPLACEMENT OF SUCH QUANTITY, OR, IF NOT ACQUIRED BY PURCHASE, REPLACEMENT OF SUCH QUANTITY. TO THE FULLEST EXTENT PERMITTED BY LAW, IN NO EVENT SHALL THIS COMPANY OR ANY OTHER SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES.

Upon opening and using this product, buyer and all users are deemed to have accepted the terms of this LIMIT OF WARRANTY AND LIABILITY which may not be varied by any verbal or written agreement. If terms are not acceptable, return at once unopened.

Roundup PRO, Certainty, Outrider, Monsanto and Vine symbol are trademarks of Monsanto Technology LLC.

All other trademarks are the property of their respective owners.

This product is protected by U.S. Patent Nos. 5,683,958; 5,703,015; 6,063,733; 6,121,199; 6,121,200. No license granted under any non-U.S. patent(s).

EPA Reg. No. 524-475

In case of an emergency involving this product,
or for medical assistance,
Call Collect, day or night, (314) 694-4000.

Packed For:
MONSANTO COMPANY
ST. LOUIS, MISSOURI, 63167 U.S.A.
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SUPPLEMENTAL LABELING

READ THE ENTIRE LABEL BEFORE PROCEEDING WITH THE USE DIRECTIONS CONTAINED IN THIS SUPPLEMENTAL LABELING.

When using Roundup PRO® herbicide as permitted according to this supplemental labeling, read and follow all applicable directions, restrictions, and precautions on the label booklet provided with the pesticide container and on this supplemental labeling. This supplemental labeling must be in the possession of the user at the time of pesticide application.

Roundup PRO® Herbicide

NO SURFACTANT NEEDED

TANK MIXTURES FOR NON-CROP AREAS

EPA Reg. No. 524-475

Roundup PRO and Roundup PRO & Design are trademarks of Monsanto Technology LLC.

Keep out of reach of children.

CAUTION!

In case of an emergency involving this product, Call Collect, day or night, 314-694-4000.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling.

This labeling must be in the possession of the user at the time of herbicide application.

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, GREEN STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION MAY RESULT.

Use in areas such as airports, apartment complexes, Christmas tree farms, commercial sites, Conservation Reserve Program (CRP) areas, ditch banks, dry ditches, dry canals, fencerows, golf courses, greenhouses, industrial sites, landscape areas, lumber yards, manufacturing sites, municipal sites, natural areas, office complexes, ornamentals, parks, parking areas, pastures, petroleum tank farms and pumping installations, plant nurseries, public areas, railroads, rangeland, recreational areas, residential areas, rights-of-way, roadsides, schools, sod or turf seed farms, sports complexes, storage areas, substations, turfgrass areas, utility sites, warehouse areas, and wildlife management areas.

See "GENERAL INFORMATION" and "MIXING" sections of the label booklet for Roundup PRO herbicide for essential product performance information.

Do not allow spray mixtures of this herbicide to mist, drip, drift or splash onto desirable vegetation since injury or destruction may occur. Do not apply when wind or other conditions favor drift.

See the "WEEDS CONTROLLED" section of the Roundup PRO herbicide label booklet for rate recommendations. For tough-to-control species, where dense stands occur, or where conditions for control are not ideal, up to 4 quarts per acre of this product may be used on annual weeds and up to 5 quarts per acre of this product may be used on perennial weeds for improved results.

TANK MIXTURES

This product provides control of the emerged weeds listed in the label booklet. When applied as a tank mixture, the following herbicides will provide preemergence and/or postemergence control of the weeds listed in the individual product labels.

This product may be tank mixed with the following products provided that the specific product is registered for use on the target site. Refer to these product labels

for approved sites and application rates. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used. Use according to the most restrictive precautionary statements for each product in the mixture.

2,4-D[1]
Arsenal®
atrazine[1]
Barricade® 65WG
Crossbow™ L
dicamba[1]
diuron[1]
Endurance®
Escort®
Escort XP
Gallery® 75 DF
Garlon® 3A
Garlon 4
Goal® 2XL
Hyvar® X
Hyvar X-L
Krenite®
Krovar® I DF
Landmark® II MP
Landmark MP
Landmark XP
Milestone™
Oust®
Oust XP
Outrider®
Overdrive®
pendimethalin[1]
Plateau®
Plateau DG
Poast®
Quicksilver™
Ronstar® 50 WSP
Sahara® DG
simazine[1]
Spike® 80 DF
Surflan AS
Surflan® WDG
Telar® DF
Transline®
Velpar® DF
Velpar L

[1] Tank mixtures with products containing this generic active ingredient may be made provided the specific product is registered for this use.

Maintain good agitation at all times during the mixing process. Ensure that the tank-mix products are well mixed with the spray solution before adding this product.

Mix only the quantity of spray solution that can be used during the same day. Tank mixtures allowed to stand overnight may result in reduced weed control.

Maintain good agitation at all times until the contents of the tank are sprayed. If the spray mixture is allowed to settle, thorough agitation is required to resuspend the mixture before spraying is resumed.

When used in combination as recommended by Monsanto Company, the liability of Monsanto shall in no manner extend to any damage, loss or injury not solely and directly caused by the inclusion of the Monsanto product in such combination use.

Read "LIMIT OF WARRANTY AND LIABILITY" in the label booklet for Roundup PRO herbicide before using this product. Those terms apply to this supplemental labeling and, if those terms are not acceptable, return the product unopened at once.

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