Urban Forest Management Plan
United States Army Garrison
Fort Campbell, KY
2008 - 2013

Directorate of Public Works
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1.0 INTRODUCTION

Fort Campbell, KY occupies approximately 104, 400 acres of Federal land used for our Country's military training and readiness capabilities. The landscape provides a variety of opportunities in meeting the military training requirements while many eco-types support habitats for a variety of plants and animal species. The Department of Defense policy is that lands provide for multiple, sustained use while supporting military training requirements.

The Directorate of Public Works (DPW) personnel are responsible for the preservation and maintenance of Fort Campbell's natural and cultural resources on unimproved grounds (training areas) and the cantonment area (i.e., improved and semi-improved grounds) of the installation. DPW staff insures availability of resources to meet Fort Campbell's military mission and insures safety for soldiers, their families, and post employees. This plan is designed to promote the sustainability of tree resources in the cantonment area on Fort Campbell.

Trees located in the cantonment area require management techniques that differ from trees located in less developed areas. Trees in the cantonment area are subject to greater stresses than those in more natural landscape situations (e.g., soil compaction, mechanical damage from mowing and weed eating, air and water pollution, wind, heat accumulation, vandalism). Because of the increased stresses, a rigorous urban forest program must be implemented to manage these resources. Urban forestry includes the monitoring of current species, replacement of species and maintenance of natural resources within the cantonment area. Trees are living organisms and are susceptible to many different problems such as storm and mechanical damage, insects and diseases, excessive age, and vandalism. These can cause the decline in the health of a tree to a point where it becomes a safety hazard. Hazard trees require immediate attention. Inspection, routine pruning, tree removal, and replacement of problem species are part of the installation's Urban Forest Management Plan and fall under the responsibility of Directorate of Public Works.

1.1 Purpose

This plan provides the technical information and recommendations for all authorized personnel and residents engaged in urban forest management on Fort Campbell. Properly applied, the principles and practices prescribed in this plan will complement ongoing management efforts, conserve natural resources while maintaining and improving the appearance of the installation, and promote operational safety and efficiency. The proper management of natural resources in urbanized areas of DoD installations is in conformance with current policy (Department of Defense, Urban Forestry Manual, August 1996). A wide array of environmental laws and regulatory requirements mandates the thoughtful preservation of natural resources (e.g., the Sikes Act of 1960, National Environmental Policy Act of 1969, Army Regulation 200 -1, Environmental Protection and Enhancement, 28 August 2007).

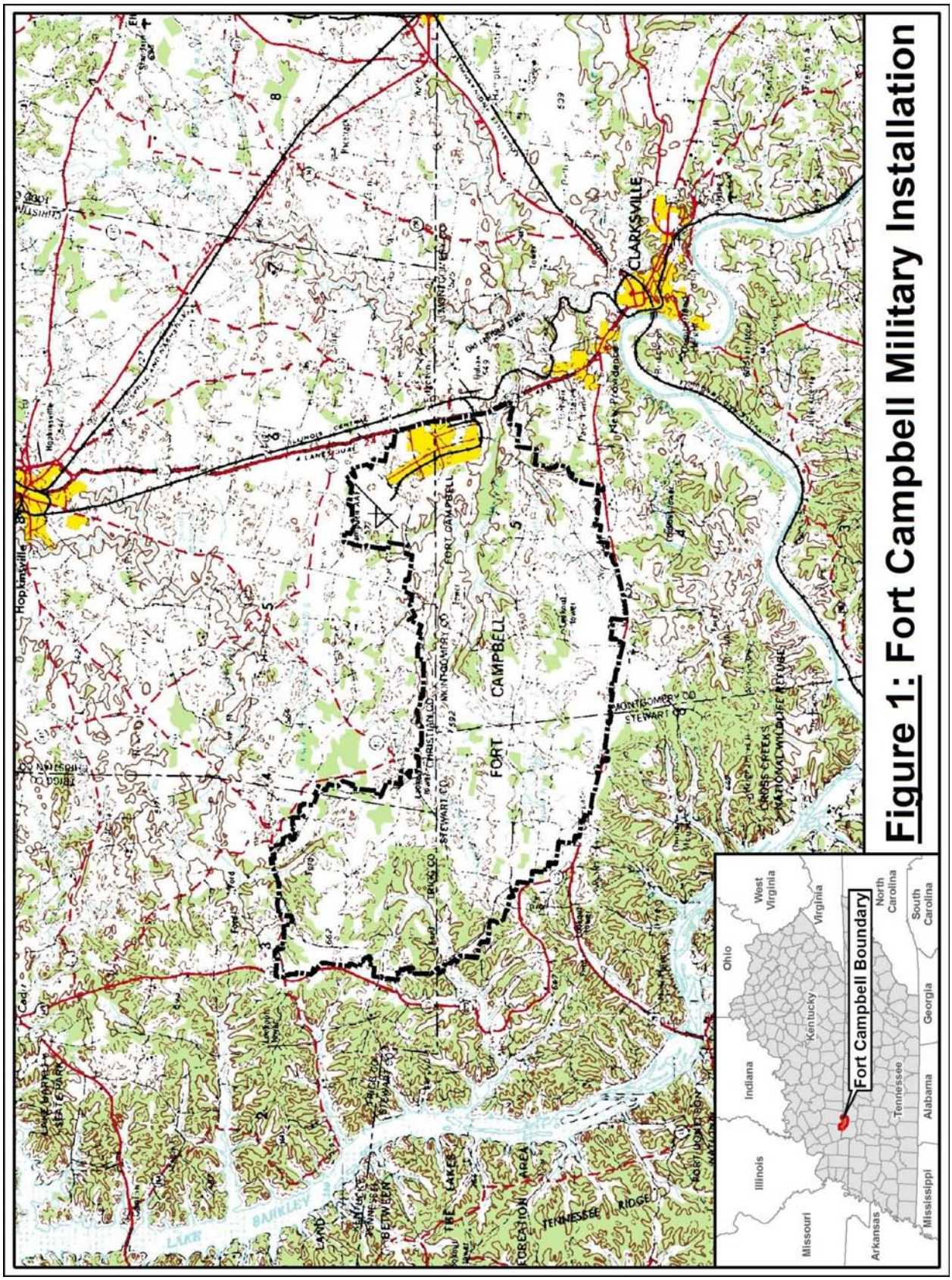

Figure 1. Fort Campbell Military Installation.

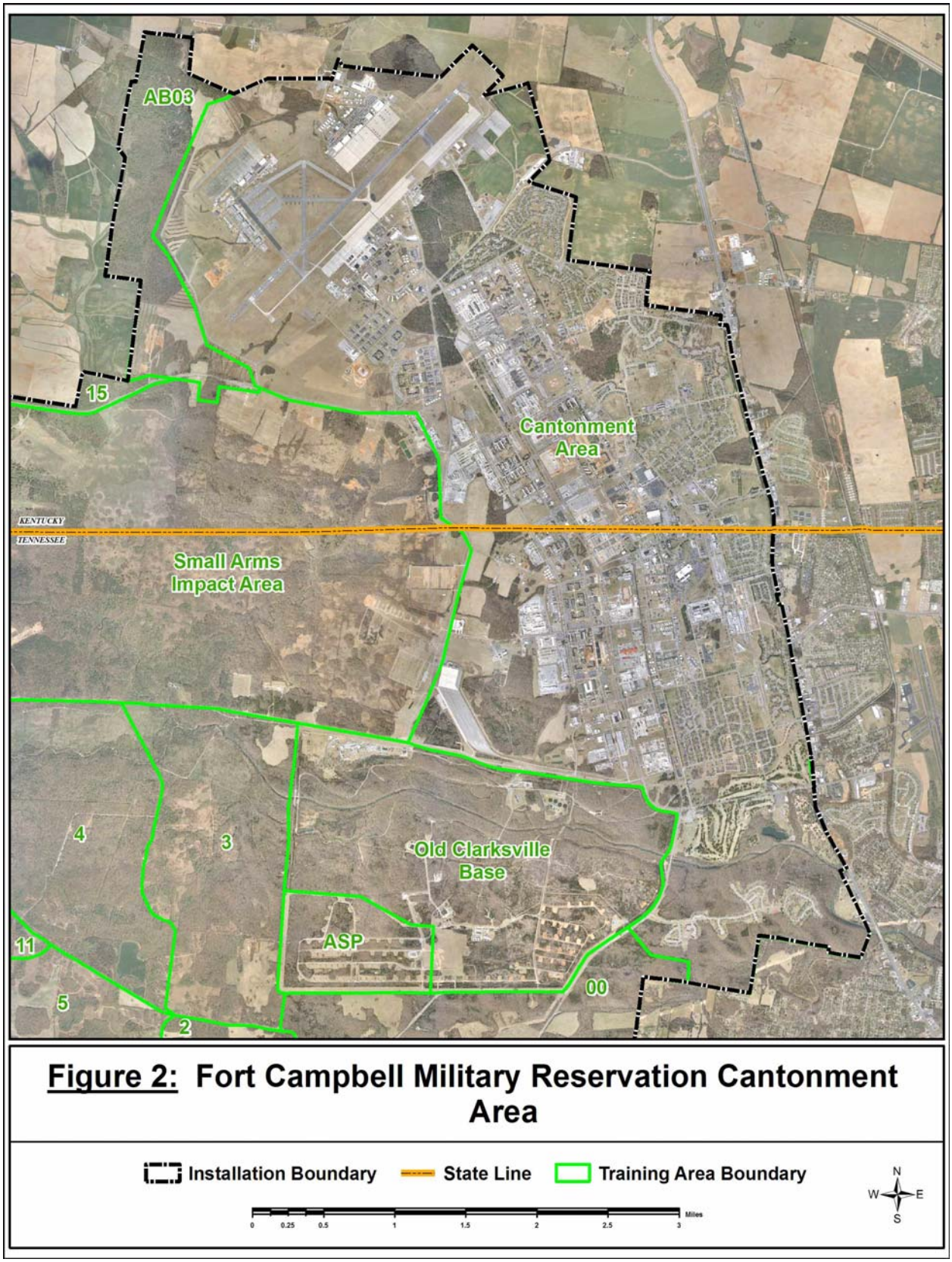

Figure 2. Fort Campbell Cantonment Area.

1.2 Scope

Urbanized trees require perpetual attention and maintenance. This plan is concerned with the resources' distinctive conservation and management needs on Fort Campbell. The plan provides general information on soil, climate, and cultural practices related to the conditions in which landscape trees and shrubs grow and examines and analyzes the 2006 tree inventory information for designated areas, including condition, management need and resource value. It concludes with management practices that will help sustain the urban forest resources.

1.3 Environmental Compliance

All urban forestry management activities on Fort Campbell will conform to applicable portions of environmental statutes, implementing regulations and Executive Orders as set forth in, but not limited to, Army Regulation 200 -1, Environmental Protection and Enhancement, August 2007.

2.0 Urban Forest Management Overview

2.1 Urban Forest Management Definition

Urban Forest Management is a specialized branch of forestry. It includes the planning, designing, establishing, maintaining, regulating, treating, conserving, and protecting of woody vegetation in urbanized areas. This woody vegetation is a collection of trees, shrubs, and vines growing within improved grounds and semi – developed grounds (i.e., the cantonment area). Further, urban forestry embraces a multi-managerial system that addresses issues related to watersheds including water management, wildlife habitat, outdoor recreation grounds, wood waste recycling yards, and individual tree care in general. Application of urban forest management must include measures for storm damage, wind and water erosion and sedimentation, fire hazards, construction damage, pollution, and insects and diseases detrimental to woody vegetation. Maintenance and improvements practices typical to urban forestry programs include care and development of urbanized trees, shrubs and vines, as well as turf surroundings, supplemental irrigation of vegetation requirements, required land drainage, and soil stabilization.

2.2 Department of Defense Objectives

Maintenance of resources is essential to the mission at Fort Campbell, KY. Welfare and morale of personnel are enhanced by healthy, pleasant surroundings, and suitable outdoor recreation facilities. To accomplish these objectives, maintenance operations should be conducted in an orderly sequence designed and adjusted to take advantage of the varied ecological factors involved, including climate, topography, soil, vegetation, and land use. The primary objective of the Department of Defense urban forest management program includes:

1. Develop, maintain, and manage all urban forest land (includes ground cover, soil, and appropriate water areas) under DoD jurisdiction in accordance with proven procedures, scientific methods and techniques to facilitate military missions and operations.

2. Protect land and tree investments from depreciation by adopting urban, land-use practices based upon soil capabilities.
3. Prevent installations from contributing to pollution through vegetative waste disposal or erosional debris.
4. Improve the appearance of installations and facilities through the preservation of the natural terrain and woody vegetation, and by appropriate new, urban forest plantings.
5. Prevent the damage or destruction of the urban forest from uncontrolled fire, careless construction methods, or misuse.
6. Assess the value of trees considering replacement value in kind, air pollution removal, cooling, and wind modification.

2.3 Responsibilities

The Fort Campbell Garrison Commander is responsible for the conservation, improvement, management, and protection of all urban forest resources. Implementation of the program is delegated to the Director of Public Works. Maintenance activities are then contracted out and scheduled by DPW Contract Management, Fort Campbell Family Housing, Directorate of Morale, Wellness and Recreation, and the Fort Campbell School System. Fort Campbell Family Housing and Actus Lend/Lease are partners in Residential Communities Initiative (RCI). In 2003 Fort Campbell leased the housing grounds through the Residential Communities Initiative as part of the 1996 Defense Authorization Act or the Military Housing Privatization Initiative. The privatization of army housing units is intended to provide world class residential areas while leveraging assets with limited funds and to take advantage of the private sector's expertise, creativity, innovation and capital. Though the lease, Fort Campbell Family Housing is responsible for care of grounds so safety, appearance and habitability of facilities is protected.

2.4 Classification of Grounds

Cantonment grounds are classified into three categories: improved, semi- improved and unimproved.

The majority of the cantonment area is classified as improved grounds. This land use includes the housing partnership, Fort Campbell Family Housing, LLC (FCFH), schools, recreation areas, Brigade Combat Training (BCT) facilities, Garrison operations and Campbell Army Air Field. Maintenance in these areas includes mowing, aerating, seeding, sodding, spraying, pruning, trimming, weed control, planting, and other urban forestry practices.

Semi-improved grounds consist of areas that have little maintenance requirements. These areas include the roughs at the golf course, edges of the airfield, and reclaimed waste disposal sites. Although these lands are available for use, many have restricted access and tight regulations governing them.

The last land classification is unimproved grounds. This includes areas that are not considered improved or semi-improved and are mainly unmanaged forest stands. These grounds are utilized for recreation, support unit training, and provide habitat for area wildlife. Some of the grounds

are presently quarantined from use due to a former *Histoplasmosis* contamination. Much of the unimproved grounds have been planned as future BCT facilities or FCFH.

3.0 Factors that Influence Plant Growth

3.1 Climate

Fort Campbell is located in southwestern Kentucky and northwestern Tennessee, occupying portions of four counties: Christian and Trigg counties in Kentucky and Montgomery and Stewart counties in Tennessee. Situated in a transition area, the Western Highland Rim physiographic province is between Kentucky farmlands to the north and gently rolling hills to the east. To the south and west is the steeply dissected and wooded Cumberland River rim. The climate is moderate, characterized by warm, wet conditions of the humid continental climate. Summer temperatures are influenced by Bermuda highs over the Atlantic Ocean, and winter temperatures are controlled by polar and arctic air masses out of the north. These factors can cause vast differences in air temperature and available moisture.

3.2 Temperature

Summer days are usually sunny, warm and humid, averaging forty days with temperatures above 90 degrees Fahrenheit. The hottest month is July and during the summer Fort Campbell receives sixty percent of the available sunlight. Winters are rarely harsh with average high temperatures of 44 degrees Fahrenheit and two days below zero degrees. January is normally the coldest month. Increased cloud cover allows forty percent of the available sunlight to hit the earth surface. This temperature range translates into a United States Department of Agriculture (USDA) plant hardiness zone of 6b. (Hardiness zone is a guide that aids with plant selection based on the lowest temperature a plant species will tolerate. Hardiness zone 6b has an average low temperature between -5 and 0 degrees Fahrenheit.) The spring and fall seasons are pleasant; however, westerly upper layer winds control weather fronts moving across the continent that can produce severe storms across the region.

3.3 Precipitation

Precipitation on the Western Pennyroyal Karst Plain is influenced from moisture drawn up from the Gulf of Mexico. Winds from the south push moisture up across Tennessee and Kentucky and create an average rainfall of 49 inches per year. Summer thunderstorms bring most of the precipitation. Winter snow storms can be expected between December and March with an average snow fall of 10 inches and snow cover usually not persistent more than one week.

3.4 Urban Soil Elements

Understanding soil characteristics and conditions is essential to the successful implementation of Fort Campbell’s urban tree program. The amount of water and nutrients in soil determines its ability to support vegetative growth. Soil is naturally formed by the weathering of rock. The five factors that influence soil development are parent material, climate, organisms, topography, and time. Physical (e.g. wind, heat, freezing and thawing) and chemical (e.g. rain, snow) weathering

break down the parent material and affect how fast or slow the soil formation process takes. The addition of organic matter formed by decomposition of dead plants and animals and worked in by microorganisms helps continue the transformation into a well developed soil. The complete process can take hundreds to thousands of years for weakly developed soil to transform into a well developed soil. The characteristics of soil texture determine how soil resists erosion and how much water can be retained for plant growth. Requirements for soil amendments and improvements depend upon the soil structure, soil pH, and available plant nutrients in a given soil.

3.4.1 Cantonment Area Soils Map and Data

The Natural Resource Conservation Service (NRCS) has developed a series of soil survey maps that give details on properties and characteristics of soil types found in each county of Fort Campbell.

Many different soils types are present on Fort Campbell's cantonment area. One of the largest soil types mapped in the cantonment is Udarents – urban land complex. This soil has been altered from its original soil profile during development of the post. The horizons have changed through construction projects, and the structure is varied; for this reason standard NRCS field data was not collected. The other dominant soil in the area is Pembroke silt loam.

Cantonment area soils have the following characteristics:

- Parent material varies depending on location in the landscape.
- Average depth to parent material is 65 inches.
- Soil structure is predominantly silt loam.
- Water capacity ranges from 0.18 to 0.23 inches.
- Drainage class is primarily well drained.
- Depth to water table ranges from 6 in. to 63 in.
- The pH ranges from 3.6 to 7.8.
- Organic matter for the A horizon ranges from .05 % to 4.0 %

With little basic information on the Udarents – urban land complex, when landscape materials are being planted, soil samples should be collected and analyzed for pH, soil fertility and soil structure. This will assist with plant selection for the site. Figure 3 shows a soils map of the cantonment area.

3.4.2 Undisturbed Soils

Undisturbed soils are areas that have not been disturbed by mechanical earth moving methods. Characteristics can include high organic matter and low bulk densities; structure is constant and soil profiles are easily discerned. These areas easily establish a variety of vegetation that attracts animals. Pore space is created as roots develop and grow penetrating the surface layer allowing water and air to enter the soil while reducing compaction. Organic matter is added back to the soil as plants and animals die and decompose on the surface. Soil microorganisms breakdown dead tissue, converting it to waste products and working the nutrients into the soil. Vegetation and leaf litter help protect the soil surface from water and wind erosion. Training areas outside the cantonment area are considered unimproved and may have undisturbed soils.

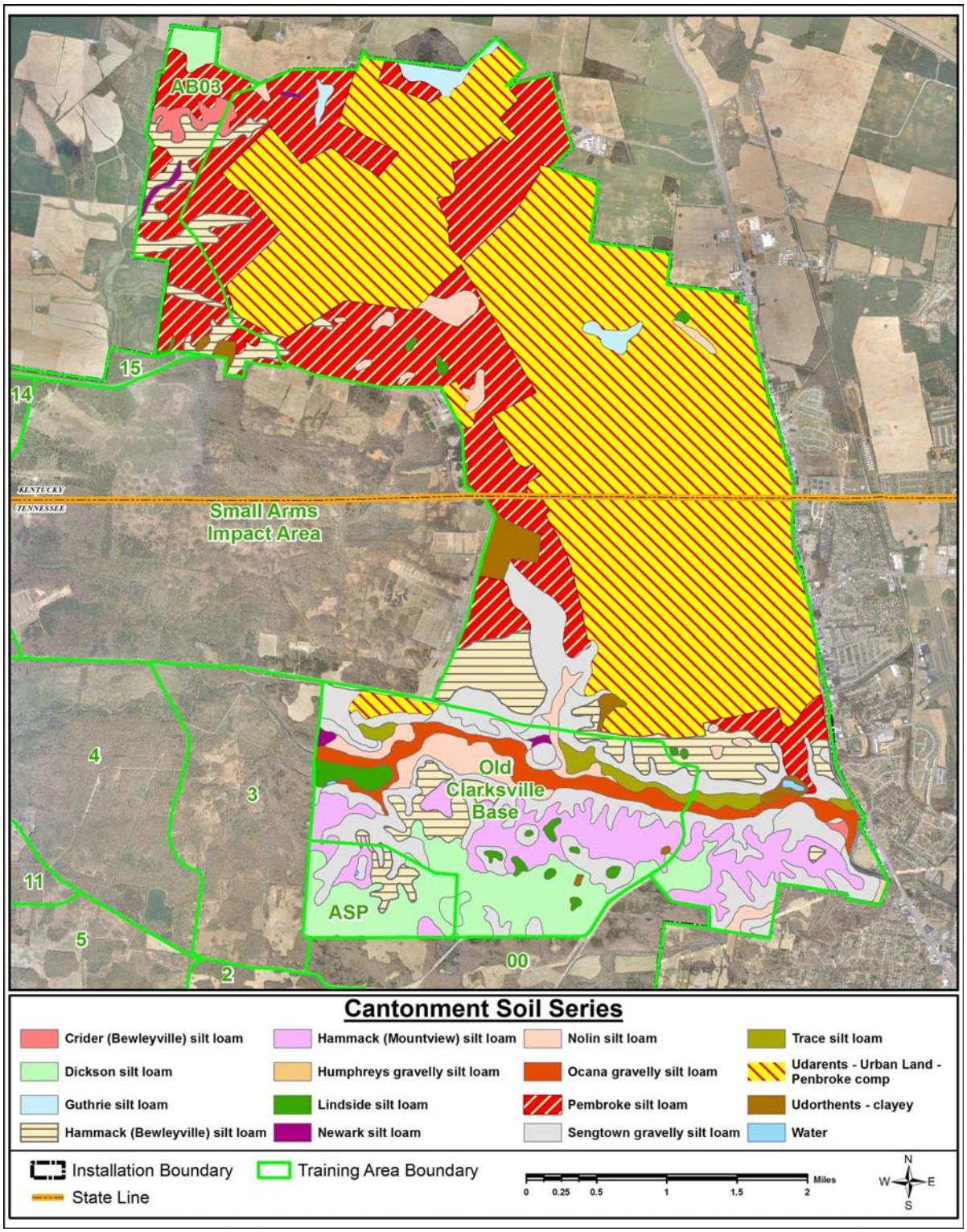

Figure 3. Cantonment Soils Map

3.4.3 Disturbed Urban Soils

Urban soils consist of areas that have been disturbed by the process of excavation or fill. Improved and semi-improved (and some unimproved grounds) are considered man-made because the land form has been changed to meet a designed purpose. After changes the soil can no longer be identified by a single soil series or a single soil name, and generally requires special treatment to establish and maintain vegetative cover. Human activity, by modification of the natural soilscape, is predominantly the active agent.

Disturbed landscapes and urbanized soils display the following characteristics:

Great vertical and spatial variability
Modified soil structure leading to compaction
Presence of a soil crust on bare soil, usually repelling water infiltration
Modified soil reaction, usually elevated pH
Restricted aeration and water drainage
Interrupted nutrient cycling and modified soil organism activity
Presence of man – created materials and other contaminants
Modified soil temperatures

3.4.4 Soil Structure

The natural processes that soils go through for structure formation are commonly lacking in urban soils. Most poor conditions present in urban areas tend to destroy structure and increase bulk density, due to soil compaction.

Disturbance or displacement of most urban soils partially destroys structure and reduces pore space, especially macropores. Macropores are the channels and spaces that help with the movement of air and water. Reduction of soil organism activity decreases the frequency of structure enhancing wet-dry or freeze-thaw processes. Urban soils are often subjected to surface traffic and other forces that, over a range of moisture conditions, contribute to soil compaction. Vegetation is subject to damage and reduction of cover, possibly leaving the surface bare and susceptible to crust formation, compaction, and erosion. All of the preceding conditions may detrimentally influence other soil properties such as water infiltration, permeability, water-holding capacity, aeration status and root penetration, especially in the upper soil layers where tree and shrub roots are concentrated.

3.4.5 Soil Horizons

Well developed, mature soils that have not been altered by construction and grading usually have well defined layers called horizons which differ in color, structure, and texture. From the surface down, the set of horizons (O, A, B, and C) is called the soil profile. The average depth to parent material on Fort Campbell is 65 inches.

At the surface is the organic layer or the O horizon. This layer is a couple of inches deep depending on the percentage of dead and decomposing matter it contains. On improved and semi

– improved grounds this layer is predominately grass and leaf debris. Current maintenance practices often remove dead and dying plant materials from this layer which limits nutrients in the A horizon.

The A horizon consists of the upper surface layer to an average depth of 12 inches of weathered soil. This horizon is subject to more change than the other horizons, due to the fact that the soil forming processes are most active at the surface layer.

The second layer, known as the B horizon, has less weathering and less root activity than the surface layer. It may possess less granular, more block - like structure. The B horizon depth ranges from an average of 12 inches to 40 inches where the average C horizon starts on Fort Campbell. The B horizon receives materials from the A horizon as a result of downward water movement. In humid climates, such as Fort Campbell's, the B horizon can be darker in color and more closely compacted due to a greater content of clay, iron, and aluminum compounds.

The last horizon is the C horizon. It has minor evidence of weathering and root residue. If the C horizon consists of impervious materials, internal drainage is seriously impeded. The principle value of this horizon is water storage. Tree and shrub roots are not often found this deep, however water found at this depth can help sustain trees and shrubs during periods of drought.

3.4.6 Soil Texture

Soil consists of mineral fragments varying in size from sand, 2.00 to 0.05mm (coarse particles), silt, 0.05 to 0.002 mm (fine particles), and clay, less than 0.002 mm (very fine particles). Classification of soil texture is based on the relative percentage of sand, silt and clay. Hydrological and mechanical analyses determine soil textural classification.

3.4.7 Water Holding Capacity

Water holding capacity is the available amount of water the soil holds between field capacity and the wilting point of plants. It is the pool from which growing plants obtain the water necessary for plant growth. Water holding capacity is measured in inches of water per inch of soil. Compaction decreases the water holding capacity and increases surface runoff.

3.4.8 Soil Fertility

Fertility of soil is dependent on the structure of the soil, the presence or absence of nutrients, and soil pH (degree of acidity or alkalinity). Soil pH, cation exchange capacity, and anion exchange capacity largely determine the capability of a soil to adsorb nutrients and relinquish these nutrients to plants.

3.4.9 Soil Nutrients

Nutrients are essential for healthy growth of plants. Nutrients are divided into two types, macronutrients and micronutrients. Macronutrients are those nutrients that are needed in large portions for the normal growth of plants. These include the following: nitrogen (N), phosphorus

(P), potassium (K), calcium (Ca), sulfur (S), and magnesium (Mg); nitrogen, phosphorus, and potassium are the most common macronutrients deficient in urban soils. The nutrients hydrogen (H), oxygen (O), and carbon (C) are obtained from air and water. Micronutrients are elements that are needed in minute amounts to help with plant metabolism and growth. The micronutrients in soils are manganese (Mn), zinc (Zn), boron (B), copper (Cu), iron (Fe), molybdenum (Mo), and chlorine (Cl). Urban soils may also be deficient in magnesium, calcium, and iron.

3.4.10 Soil pH

Soil pH is the measure of soil acidity, with neutral measuring 7 on a scale of 0 to 14. Levels measuring below 7 are considered acidic and levels above 7 are considered basic. In mineral soils most plants grow best with a pH between 6.0 and 7.0. Soil pH is important to the availability of nitrogen, potassium, phosphorus and specific amounts of microorganisms carried in the soil solution that plants need to grow, thrive, and fight off diseases. As pH changes, deficiencies in nutrients may develop allowing trees and shrubs to appear abnormal in color and be more susceptible to insect and disease attacks as well as biotic and abiotic disorders. The pH of urban landscapes tends to be higher than undisturbed soils. The most common reasons for higher pH in urban soils are likely due to: 1) large amounts of cement used during construction process, and 2) scraping and removal of top soil, exposing the more calcareous subsoil.

Soil tests should be conducted every 2 – 3 years unless there are special health problems evident; then soil tests should be done more frequently. Tests can be performed by the Christian County Cooperative Extension Service to determine soil deficiencies. The forestry section personnel can assist in the collection of soil extractions or the extension office could be contacted for soil sample collection procedures. Deficiencies can be corrected with soil amendments and proper fertilizer applications. Plantings in high visibility areas associated with buildings or landscaping around main entrances or thoroughfares should be fertilized as necessary.

4.0 Integrated Pest Management

Integrated pest management is the control of undesirable insects, diseases, plants and mammals through cultural, mechanical, biological and chemical means. The Fort Campbell Integrated Pest Management Plan (IPMP) describes management activities. The IPMP can be accessed on the Directorate of Public Works (DPW) San Server.

4.1 Insect and Weed Pest Control

Insects are part of the natural ecosystem but can be devastating to landscape plants if left un-checked. Control of problem insects can be accomplished through cultural, mechanical, biological and chemical treatments. Pest identification is important to planning proper treatment. Treatments can range from resistant plant selections, introduction of natural enemies, physical and mechanical controls and chemical pesticides. The control method typically used involves physically removing infected trees when they die before they become a safety hazard to people or property and/or to prevent the spread of a disease to other trees. Other methods include mechanical control with the use of insect traps and chemical control for the problem of bagworms in the trees and shrubs. Other insect pest problems are dealt with on a case-by-case

basis. Weed control is done for security and to maintain the aesthetic appearance of lawns and grasses. It also helps to prevent the spread of invasive plant species.

5.0 Emergency Storm Response Plan

Fort Campbell currently does not have an Emergency Storm Response Plan for cantonment trees. Having such a plan in place would provide guidance and assistance in an orderly and prepared manner for maximum safety at minimal cost. A typical plan should include organizational structure and storm responsibilities, resource preparedness and assistance, and operational procedures for major and minor storms.

6.0 Urban Forest Tree Inventory and Procedures

6.1 Urban Forest Tree Inventory

The urban forest is made up of trees, shrubs, turf, and flowers. Like any management strategy knowing what is in the forest is necessary to managing it properly: a comprehensive tree inventory is critical. Setting up maintenance programs, based upon inventory information, will help decrease maintenance costs over time. The Forestry Section, within DPW Environmental Division, Conservation Branch, conducted a comprehensive urban tree inventory from June 2005 to August 2006.

6.2 Inventory Procedure

Inventory of trees involved the identification and mapping of every individual tree in the designated cantonment area. In order to determine the present condition and the future management needs of the forest, each tree had a visual inspection and its location recorded using Global Positioning System equipment. The following information was collected: species, size (inches at 4.5 feet), condition, placement within the landscape, management unit, and maintenance needs, along with other information. The first four fields are used to determine the landscape value of the tree. Other information collected helped identify the tree's location and any physical or insect and disease problems. For purposes of the inventory, a tree is considered a perennial woody plant recognized as a tree species having a distinct trunk which is no less than four and a half (4.5) feet tall. A map showing the management units is at Figure 4.

Equipment used for the inventory included a field computer, GPS receiver, and Biltmore stick or diameter tape. Field computers used were the Trimble Recon and the Allegro CX. Both computers have Windows CE operating systems and data collection software, TerraSync, version 2.52. This software was also used to collect the GPS location points. Two different GPS receivers were used to collect location information. Recording individual points from the satellite to the receiver determined location. A minimum of 20 points was needed to calculate the coordinates. After the points were collected the average of all the points was determined in the Terrasync software and the coordinate set. The Trimble Pocket receiver was used between June 2005 and January 2006. It has a coordinate accuracy of 3 (9 ft.) to 9 meters (27 ft.). In February 2006 the Trimble XP Pro receiver was used until the end of the inventory in August 2006. The

accuracy of this new receiver is sub-meter (<3 ft.). The Biltmore stick and diameter tape are standard forestry instruments to measure a tree's diameter at 4.5 feet above the ground.

Tree data was collected for individual trees around buildings, on streets, parking lots, parks, playgrounds and green spaces. Along with GPS coordinates each tree record includes a building number or block number and street for identification purposes. The tree's arrangement related to the building face was recorded as front, side or rear. Every tree was then assigned a site number for each individual building or block number. This enables easy location of the tree in the field. Site numbers followed the forward direction of street traffic, right to left. Once the field observations were recorded, the tree data was entered. Information collected is used to determine total sum or average of data fields, as well as landscape value of individual trees. An example of the data collected is at Figure 5. Collected data was up loaded onto a personal computer where GPS points are corrected, establishing the tree's coordinates, and editing of data was done using TerraSync software.

The inventory is maintained and analyzed in Davey Resource Group's Treekeeper online database. The database is a D-base structured program that stores data and creates queries related to the data fields. From queries pre-set reports can be printed such as species frequency and tree value, or individual reports can be created. Treekeeper software is also designed to store work records and generate work orders. Data can be converted in to a GIS shape file for display in ArcMap 9.1. A shape file is currently available on the Directorate of Public Work GIS server. Database support is contracted with Davey Resources Group. The findings and analysis of the inventory are discussed in Section 7.

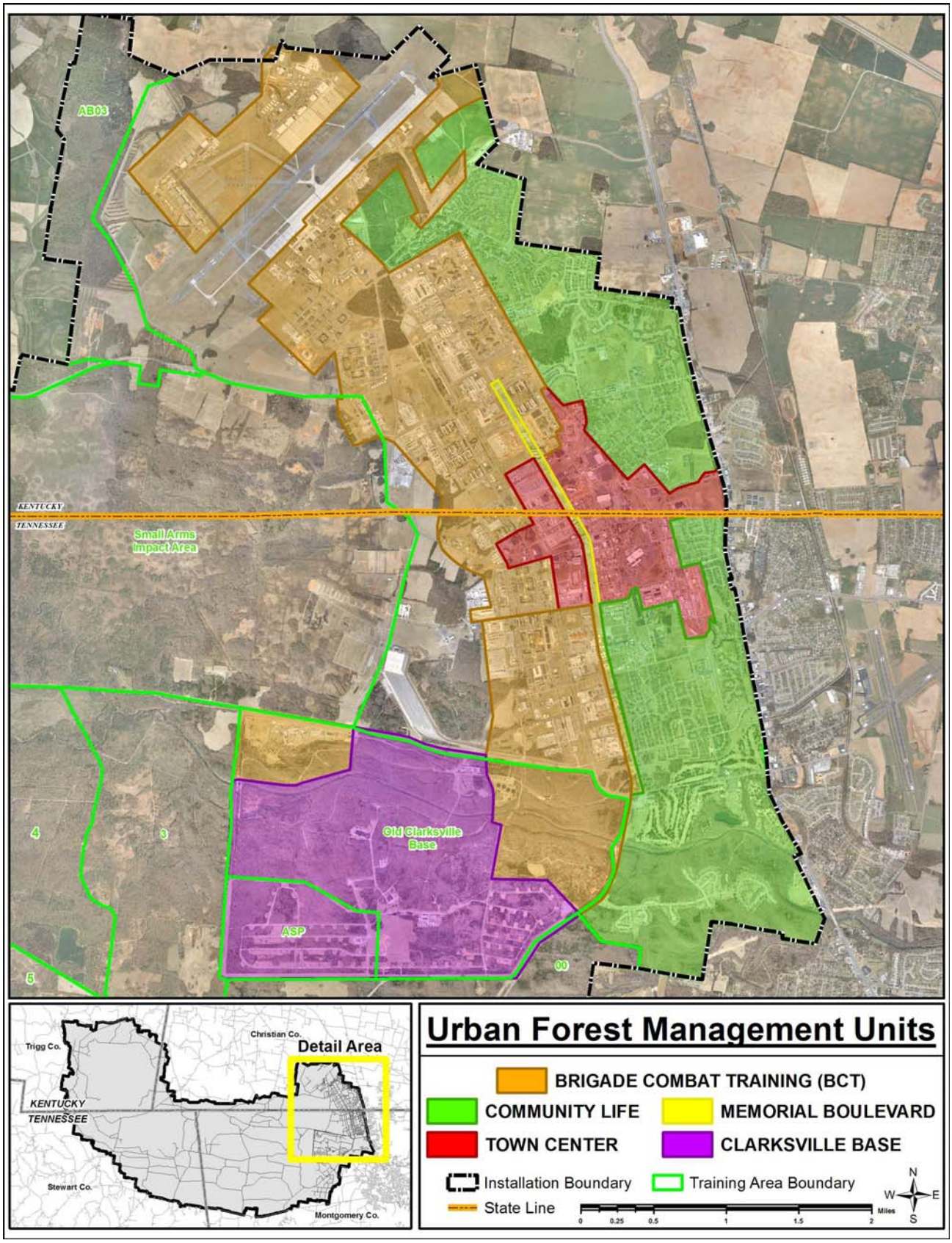

Figure 4. Urban Forest Management Units

Sample Urban Tree Inventory Data

Management Unit	Building or Block Number	Side	Site (1)	Species	Street	Location	DBH	Stems	Condition	Placement	Maintenance	Physical Observations	I & D Observations (2)	Clearance	Overhead Utilities	Grow Space	Space Size (ft)	Growth Stage	Further Inspection	Assigned (3)	Comments
Town Center	39	Rear	2	Yew ssp.	Screaming Eagle Blvd.	Building	5	3	Poor	Fair	Routine Prune – Small Tree	None	None	None	No	Planter	11	Structure	No	No	
Town Center	39	Rear	1	Yew ssp.	Screaming Eagle Blvd.	Building	5	4	Fair	Fair	Routine Prune – Small Tree	None	None	Signal / Sign	No	Planter	11	Structure	No	No	
Town Center	39	Front	4	Water Birch	Screaming Eagle Blvd.	Building	8	1	Dead	N/A	Removal Priority 3	None	None	None	No	Open	99	Replace	No	No	
Community Life – Residential	1541	Front	11	Tuliptree	Choctaw Loop	Residence	2	1	Good	Good	Training Prune	None	None	None	No	Open	99	Structure	No	No	
Community Life – Residential	1541	Front	13	Mockernut Hickory	Choctaw Loop	Residence	27	1	Good	Good	Routine Prune – Large Tree	Mechanical / Root Damage	None	None	No	Open	99	Structure	No	No	
Community Life – Recreation	540	Tot Lot	1	American Sycamore	Hooper Drive	Tot Lot	19	1	Fair	Very Good	Routine Prune – Large Tree	Mechanical / Root Damage	None	None	No	Open	99	Mature	No	No	
Community Life – Recreation	540	Tot Lot	2	American Holly	Hooper Drive	Tot Lot	2	4	Excellent	Good	Training Prune	Mechanical / Root Damage	None	None	No	Open	99	Mature	No	No	
Community Life – Recreation	540	Tot Lot	3	American Holly	Hooper Drive	Tot Lot	2	4	Excellent	Good	Training Prune	None	None	None	No	Open	99	Establish	No	No	
Community Life – Facilities	175	Greenspace	1	Oak Spp.	Forest Rd.	Park / Public Space	30	1	Critical	Excellent	Routine Prune – Large Tree	Broken Branches	None	None	No	Open	99	Over Mature	No	No	Wildlife Tree
Community Life – Facilities	175	Greenspace	2	Sassafras	Forest Rd.	Park / Public Space	45	1	Poor	Excellent	Routine Prune – Large Tree	Dead Branches	None	None	No	Open	99	Over Mature	No	No	
BCT Housing	3725	Front	1	Pin Oak	Tennessee Ave.	Greenspace	22	1	Poor	Excellent	Routine Prune – Large Tree	Mechanical / Root Damage	Trunk / Branch Rot	None	No	Open	99	Over Mature	Yes	No	
BCT Housing	3725	Front	2	Pin Oak	Tennessee Ave.	Greenspace	22	1	Poor	Very Good	Routine Prune – Large Tree	Poor Structure	None	None	No	Open	99	Mature	No	No	
BCT Facilities	127	Side	1	Lacebark Elm	Forrest Rd.	Building	15	3	Fair	Liability	Removal Priority 2	Poor Structure	None	None	Yes	Open	99	Mature	No	No	
BCT Facilities	127	Rear	5	Lacebark Elm	Forest Rd.	Building	10	4	Fair	Good	Training Prune	Mechanical / Root Damage	None	None	No	Open	99	Mature	No	Yes	
Memorial Boulevard	2000BLK	Greenspace	1	Eastern White Pine	Tennessee Ave.	Street	24	1	Fair	Very Good	Routine Prune – Large Tree	Mechanical / Root Damage	None	None	No	Open	99	Mature	No	Yes	
Memorial Boulevard	2000BLK	Greenspace	2	Eastern White Pine	Tennessee Ave.	Street	23	1	Good	Excellent	Routine Prune – Large Tree	None	None	None	No	Open	99	Structure	No	No	

1) Site – Individual trees space moving with the flow of traffic.
2) I & D Observations – Significant insect and disease observations.
3) Assigned – Indicates that the tree's block or building number was not visible and was interpreted to give a separate number.

Figure 5. Urban Tree Inventory Data Sheet

7.0 Urban Tree Inventory Results and Analysis

Figure 6. Commanding General's Residence

7.1 Tree Population Findings

The tree population was determined by the species recorded during the 2006 urban tree inventory. The tree inventory indicated a large, diverse population of trees in Fort Campbell's cantonment area. There are 31,143 trees with seventy-six (76) percent of the population considered healthy and vital. Twenty-two (22) percent of the tree population is in poor health and may need major maintenance or removal in the next three to five years. Two (2) percent of the trees are dead and need removing.

Trees in the cantonment area can be separated into one hundred and eighty-three (183) distinct species. The Installation Design Guidelines recommends that native species requiring less maintenance be used in plantings. Sixty-one (61) percent of the tree species found are considered native to the United States, and thirty-nine (39) percent are species that have been introduced from other regions of the world. An important note is that many of the introduced species have been around for centuries and have naturalized into the U.S. landscape.

The diversity of tree species on the installation is excellent. The region naturally supports a variety of native trees which has added to the available selection and sustainability of many of

the species. Continued use of native species would help provide low maintenance trees that are hardy enough to withstand the region's climatic conditions.

Figure 7 shows tree species present in the cantonment area by total number in descending order. The total species list is found in Appendix A. A guideline recommended by the International Society of Arboriculture is that no individual species should make up more than ten percent of the total population. This is in the event of an insect, disease or weather catastrophe that could devastate a large portion of the tree population. An example of this is Dutch Elm Disease (DED). Introduced in the U.S. in the 1930's, by 1970 the disease had killed 77 million American elms throughout North America, leaving many communities to remove large numbers of trees to prevent the spread of the infection. DED has been found in the cantonment area at Fort Campbell.

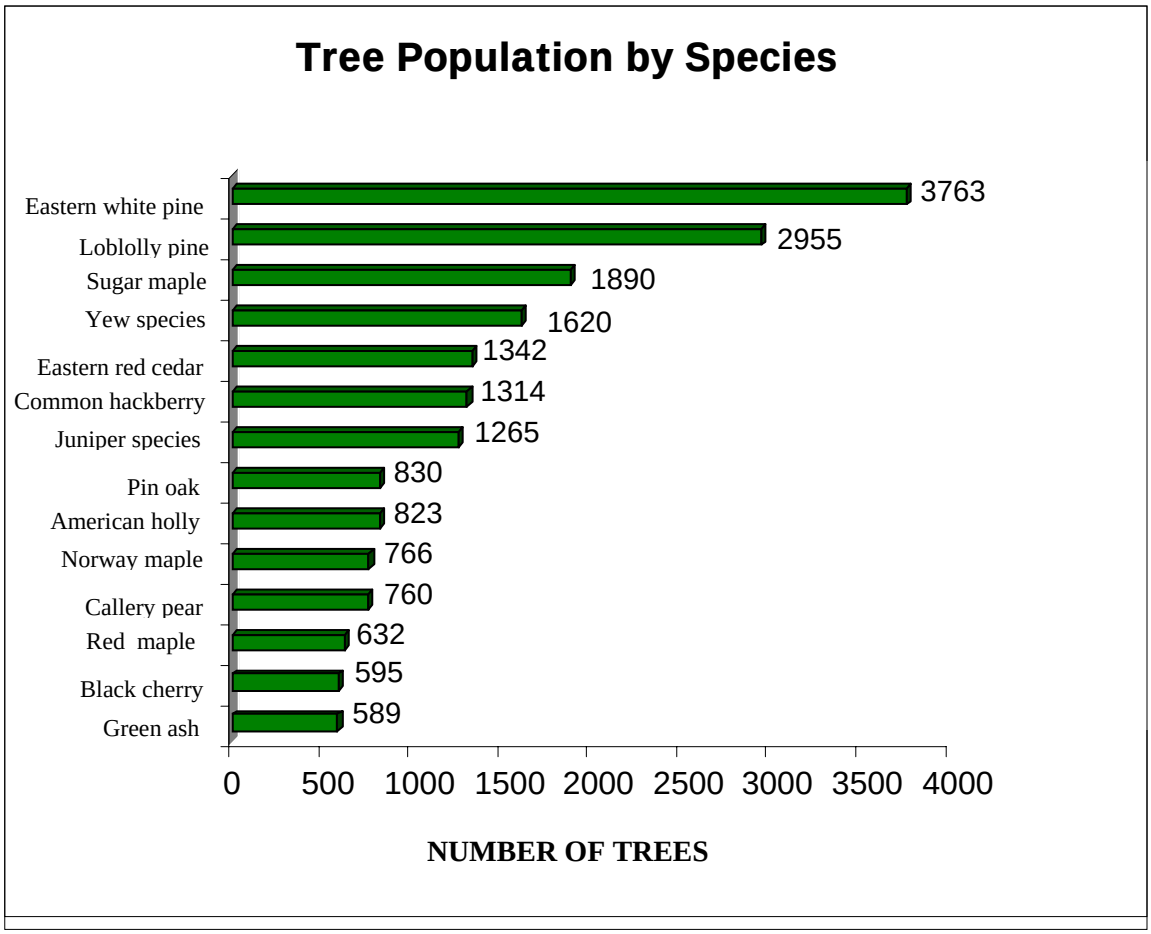

Figure 7. Population Numbers by Species

Eastern white pine currently makes up eleven (11) percent of the population with loblolly pine making up nine (9) percent. The two pines species present a large risk of removal should a traumatic, natural disaster or insect infestation occur. As the figures show, the remaining species' breakdown ranges from five (5) percent to one (1) percent. This is a more desirable density of species.

7.2 Size Distribution

Size classes are broken down in increments of 6 inches up to 36 inches. The distribution of sizes indicates that the majority of trees are relatively young according to the categories of trunk diameter (Figure 8). Although the ages of the tree population are fairly diverse, the middle age trees will probably have the greatest impact on the future maintenance procedures as well as budget requirements as those trees approach maturity.

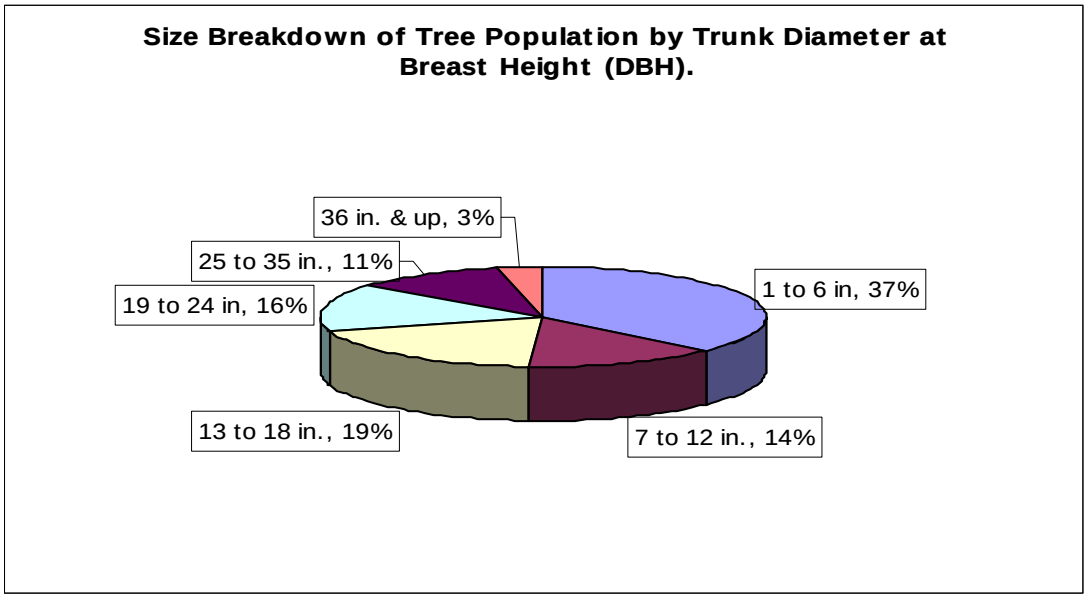

Figure 8. Distribution of Tree Population by Diameter .

Future management costs can be reduced for the younger trees (1 to 6 in.) by practicing routine maintenance. Structural problems and other defects that hinder the health and safety of mature trees can be reduced or eliminated with proper pruning. The long term cost is also reduced by requiring less time and equipment to complete the work.

7.3 Physical Damage

Physical damage is injury from external force to tree roots, trunks and branches. For each tree inventoried the dominant damage was recorded when damage was present. The urban forest had twenty-eight (28) percent of the trees with damaged roots or trunk due to lawnmower or weed eater use. Repeated injuries often create present and future maintenance problems such as weak trunks and decay in the roots and trunk turning safe healthy trees into unsafe and hazardous trees. Other physical problems recorded were caused by weather or animals. Weather damage may include ice, snow, wind and lightning. Weather damage is present in one percent of the trees. Less than one percent of the trees showed animal damage due to birds, wildlife or pets. There was no physical damage present in fifty (50) percent of the trees. Many of the causes of physical damage can be prevented with the use of safe cultural practices. A good cultural practice that will reduce physical damage is mulching, well placed and properly used around trees, to reduce lawnmower and weed eater damage.

7.4 Insect and Disease Problems

Insect and diseases are a part of the natural forest environment. Insects and diseases often infect trees at levels that can be controlled by the tree's defenses. It's when the disease and/or insect's population reaches a point where the defense mechanisms cannot control the infection source, tree health begins to decline.

7.4.1 Existing Insect Problems

The trees in the cantonment area show signs of many different insects. Most of them are in small populations and may impact the health of only a few trees but not pose a threat to the population of a single species. There are three (3) species of insects that are having an impact on the trees on Fort Campbell: horned oak wasp, bagworms, and Japanese leaf beetle.

Figure 9. Horned Oak Gall Wasp on Pin Oak.

Horned oak wasp (*Callirhytis cornigera)* infects many of the red oak species planted on post (Figure 9). Currently sixty-four (64) percent of the pin oaks have galls forming on branches. One gall can have as few as one or as many as one hundred and sixty (160) eggs. Galls have become so serious that aesthetic quality of the tree is reduced. As more galls are produced they will also cause die back on the branches and add stress to the tree. In time, as the galls increase in number the tree will die. Insecticide treatments are available but because of the cost and type of treatment they may be limited to important specimen trees. The other option for control is through cultural methods such as species selection and pruning out the galls when they first appear.

Another insect that is showing an impact is the common bagworm (*Thyridopteryx ephemeraeformis).* A bagworm is the larval/caterpillar stage of a moth. It lays its eggs most commonly on arborvitae, red cedar, pine, spruce and some deciduous trees. Six hundred and sixty-nine (669) trees had bagworms attached to branches. The majority of the infected trees are juniper and arborvitae. Damage is branch dieback caused by the stems being girdled. Bagworms can be hard to control because they often go unnoticed until mature. Currently bagworms are controlled by insecticide spray treatments by pest management in the Roads and Grounds Branch.

Japanese beetle (*Popillia japonica*) is developing into a health as well as a visual problem for the several species of trees in the cantonment area. Japanese Beetles are flying insects that move up to five miles from plant to plant to feed. The beetle feeds on a variety of tree and shrub species. Japanese flowering cherry has a high instance of beetle attack; it makes up sixty-six (66) percent

of the infested trees. Norway maples and lindens are the other trees infested. The adult beetles feed on the top portion of tree and shrub scaring the leaf surface which leaves it skeletonized.

Figure 10. Japanese Beetles in Pheromone Traps.

Damage occurs when large groups of beetles are attracted to the same plant and begin feeding from the top of the plant to the bottom. Pheromone beetle traps were set out in residential areas the summer of 2005 (Figure 10). Thousands of beetles were caught; however, the American lindens in the area still had heavy attacks.

Traps attract high numbers of beetles to the trap area increasing attacks on trees. Placement of traps is critical to the reduction of beetle attacks. The inventory showed that less than one percent of the trees showed Japanese beetles feeding on them. Continued attacks on the same trees will stress the trees and add to branch dieback and ultimately the death of the tree. There are a number of insecticides that are used to control Japanese Beetles. However, to get adequate control the grub/larval stage must also be treated. Treatment of Japanese Beetles is completed on a case by case basis through work order in accordance with the Fort Campbell IPMP guidelines.

7.4.2 Potential Insect Problems

There are three insects that have caused extensive damage to forests and urban forests in the United States. Two of them are exotic and one of them is a native insect. The two exotic insect pests are gypsy moth and emerald ash borer. Southern pine beetle is a native insect but is capable of extensive damage to loblolly and shortleaf pines. Monitoring is an important part of detecting and preventing serious resource damage.

7.4.2.1 Gypsy Moth

Figure 11. Male Gypsy Moth

Gypsy moth is an exotic moth that was introduced in 1869 in Massachusetts. By 1987, gypsy moth had established itself throughout the northeast. In recent years it has spread to Wisconsin and as far south as Tennessee. Gypsy moths have been caught by traps in the majority of the lower forty-eight states but have not established significant population outside the northeast. Since its introduction it has devastated approximately 74.5 million acres of federally owned forest lands. The larvae and adult

caterpillar are the life stages that inflict the most damage by eating the leaves of hardwood trees and shrubs.

Egg masses are laid in August and can be found on the underside of branches, tree trunks, fences, houses and other structures. They can also be attached and transported across state lines on vehicles, trailers, firewood, and mulch. Egg masses over-winter until April of the following spring when the eggs hatch. Larvae climb up nearby tree branches and feed on hardwood leaves while developing into adult caterpillars. In late June or early July they begin to pupate; one month later adult moths emerge from the cocoon. Pheromone traps are used for early detection. Traps should be placed in pre-determined sites in May and taken down in September. The trapping program is to continue until it is no longer needed.

In cooperation with the Southeast Region of the United States Department of Agriculture (USDA) Forest Service and the Tennessee Department of Agriculture Forestry Division, the Forestry Section has been placing survey pheromone traps for gypsy moths within the cantonment area since 1984. The last male moth caught on Fort Campbell was in 1995. The trapping program is designed to slow the spread of the gypsy moth by detection and follow up eradication. With continued success of the program the USDA Forest Service models show that by the year 2025 the gypsy moth should not have advanced to the Fort Campbell area.

7.4.2.2 Emerald Ash Borer

Figure 11. Adult Emerald Ash Borer

In the last five years the emerald ash borer (EAB) has made its presence known in the Great Lakes region of the upper mid-west. An invasive species from Asia, the borer feeds on the phloem of ash trees. Although the initial detection occurred in 2002, testing has shown that EAB has been in the United States for ten years. Predictions of the spread are not quantified but researchers have determined the ash borer can travel more than three miles per year (Poland and McCullough, 2006).

Currently populations have been detected in Indiana and southern Ohio. Presently state and federal regulatory agencies are establishing quarantines in counties where detection has occurred. The quarantines restrict the transportation and use of firewood and other ash products to prevent the spread of the insect.

The adults chew their way out of the tree leaving a D-shaped emergence hole. Emergence occurs in mid-May and peaks in late June to early July. Adults feed on ash foliage leaving only superficial aesthetic damage. Adults feed for 5-7 days before mating begins and females will feed for 5-7 more days before laying eggs. The adults will continue to feed and breed for 3-6 weeks. Eggs are laid in bark crevices and hatch within 2 weeks. Larvae feed on the phloem and cambium from July through autumn. Larvae create serpentine galleries that disrupt the translocation of food and water causing death to the tree in 1-3 years. Larvae pass through four

instars, or growth stages, with most larvae finishing feeding in October or November. Emerald ash borer pre pupate and over-winter in the sapwood or the outer bark. Some EABs over-winter as young larvae rather than pre pupae and need a second year to develop. Pupation begins in mid-April into May, with adult emergence lasting approximately 3 weeks. The need to develop over two years appears to be related to host quality, host resistance and weather.

Fort Campbell's ash trees make up a small portion (5 %) of the total tree population; however, this invasive pest could impact new family housing subdivisions where ash trees were planted as street trees. It is possible that 100% mortality could occur due to the limited knowledge of natural enemies and chemical insecticides. Detection is also difficult due to limited information on EAB. Visual surveys are difficult due to the small size of the emergence holes making large areas of survey samples labor intensive. The other current detection method is to do destructive sampling. This is done by identifying possible ash tree hosts and physically girdling and striping a small section of the bark causing the tree to become stressed which attracts the emerald ash borer and other wood borers. This survey type is also labor intensive and costly and destroys the tree resources. Chemical detection traps are currently under research but nothing has been approved for wide spread use.

7.4.2.3 Southern Pine Beetle

The loblolly and shortleaf pines in Fort Campbell's cantonment area are threatened by southern pine beetle (SPB), a native species of North and Central America. Native home range is the southeast and southwest United States, south through Central America to Honduras. The post is on the northern edge of the southern pine beetle's native range. Loblolly and short leaf pine growing on Fort Campbell are considered the preferred species for SPB. The chance of a major outbreak increases as the loblolly and short leaf pine stands become stressed. Pines are more susceptible to bark beetle attack when stressed by drought conditions or extreme changes in the weather.

Figure 13. Adult Southern Pine Beetle

Like the emerald ash borer, the SPB larvae feeds on the cambium layer of the underside of the bark. Attacks begin in early spring with a male and female pair chewing their way into inner bark and forming S-shaped galleries often crisscrossing other galleries and causing girdling of the tree and death. A fungus carried by the beetle cause blue stain and aids in the death of the tree by plugging up the water conducting structures.

After mating the female lays her eggs along the sides of the gallery creating niches for the eggs to hatch and develop. Newly hatched larvae feed in the soft inner bark and the older larvae move outward and feed on the corky bark. When fully grown the larvae enter the resting stage and begin to pupate. When the pupation is complete, about a month later, the newly formed adults

chew outward creating a small exit hole about the size of bird shot. This action takes place from April through September. Newly emerged adult beetles may attack nearby green trees or fly considerable distances to establish a new infestation. Brood emergence is often about the time the pine tree starts to show signs of the attack.

Detection is usually done by aerial survey looking for fading of green needle color or red needles. Every year the personnel from the Forestry Section participate in an aerial survey to look for signs of SPB in the rear training areas. Emphasis is on the over 10,000 acres of loblolly pine stands in the rear training areas. Due to scattered stands and individual trees in the cantonment area, detection would need to be a visual inspection on the ground. Inspection of loblolly and shortleaf pine trees would begin when trees begin to show signs of fading crowns or needles turn red. Other signs that would indicate the need for a closer inspection is a number of adult exit holes and pitch tubes at entrance holes. If all of these signs are present then removal of the outer bark would be done to identify the galleries and beetle(s) inside. The USDA Forest Service has recommendations for effective suppression techniques when multiple trees are infected. The techniques are designed to reduce the beetle populations to tolerable levels.

7.4.3 Existing Disease Problems

Disease organisms are another element in the health of the urban forest. Diseases like root rot, brown and white trunk rot, cankers, foliar diseases, rusts, and shoot blight affect the condition and vigor of the trees. Although all types of diseases were found, the three that are the most common are brown and white decay rot on the trunk and branches, cankers, and leaf blight.

7.4.3.1 Decay Rot

Figure 14. Decay Fungi Conks on Downed Oak.

Decay rot is caused by fungi that aid in breaking down dead wood cells. Trees often develop decay as larger branches die or are broken off and through mechanical injury. Decay weakens the wood's structure as it spreads and creates hollow cavities. Tree failure can increase as available holding wood decreases; a hazard is created when the tree could injure persons, pets or property when it fails.

One hundred and twenty (120) trees were identified as hazardous because of decay in branches or trunk. Over all, ten (10) percent of the trees have trunk and branch decay. Often, decaying branches can be pruned to prevent the spread of the disease. When the decay is present in the trunk it should be monitored and the tree should be removed when the tree becomes unsafe. The species that have the major presence of decay include common hackberry, sugar maple, eastern white and loblolly pines, oaks, and black cherry. These species would benefit the most from routine crown cleaning.

7.4.3.2 Canker

Cankers are also caused by fungi. Cankers are dead sections of bark on branches or the main trunk of trees. When the main trunk or branches are damaged by yard equipment or other means, canker fungi enter through an exposed wound. The canker spreads when the tree becomes

stressed and its defenses are weakened. If the canker enters the main trunk and encircles the whole trunk the tree will eventually die. Canker fungi are present on a number of species but most commonly viewed on sugar maple, black cherry, Norway maple, and thornless honeylocust. One way to prevent the spread of cankers is to put cultural practices into place to prevent injuries and keep the tree healthy and vigorous. If the canker is found in the tree, treatment includes routinely pruning out the dead and diseased branches, referred to as a crown cleaning. Fungicides are available to control cankers and treatment plans can be determined and put in place.

7.4.3.3 Leaf Blight

Leaf blight is caused by either bacteria or fungi depending on the leaf blight species. Symptoms of leaf blight include dead areas, blotches, black and brown scorched appearance and even death of the whole leaf that is shed prematurely; however on some trees the twigs, shoots, buds, and fruits will become infected. Most leaf blights are spread by wind, rain or mechanical methods. Repeated defoliation reduces or weakens the tree and increases it's susceptibility to attack from other pests or winter injury. Leaf blight infects many different tree species. A common leaf blight seen on post is anthracnose. Anthracnose infects a number of species in the region including American sycamore, Norway maple, white and red oaks, basswood, ashes, dogwoods and hickories. Numbers of trees having leaf blight are less than one (1) percent. Anthracnose was observed on post on sycamore, dogwood and Norway maple. The best way for reducing leaf blight in trees is to promote healthy and vigorous trees. Proper pruning practices and reduction of mechanical damage can help trees fight leaf infections.

8.0 Tree Care and Maintenance

Restrictions placed on trees in the urban forest make maintaining healthy trees a perpetual activity. Army Regulation 200-1, Chapter 4-5 (August, 2007) requires natural resources be sustained while supporting the army mission, and DoD's Urban Forestry Manual (August 1996) supports this regulation with the objective of protecting land and tree investments from depreciation. Growing space for vegetation is often limited and competes with roads, above and below ground utilities, sidewalks and buildings. This plan identifies the tree care needs of the cantonment trees as planting spaces, tree removals, pruning, and structural repairs. Industry standards set by the International Society of Arboriculture and American National Standards Institute (ANSI) Z – 133 Safety Standards and A300 Parts 1 – 6 Maintenance Standards, identify proven scientific methods for pruning, planting and establishment, cabling, bracing and guying supports, fertilization, lighting protection systems, and management of trees during site planning, development and construction. These standards were established to provide safe and sustainable healthy woody vegetation.

8.1 Inventory Removals

Tree removal is part of any urban landscape. Trees are removed for a variety of reasons: hazard to people or property, dead or infected with a disease or insect, planted in an inappropriate site. Tree removals are prioritized by three different categories: priority one removals are hazard trees; priority two removals are non-hazard trees that are diseased, dead and/or have a strong chance of becoming a hazard or are planted or growing in a place that creates a liability. Priority

three removals are declining or dead trees in low hazard areas that can be removed when time and money are available. Note that if priority three trees are left too long they may become hazardous. These three categorizes are based on Davey Resource Group's standard inventory definitions.

8.1.1 Hazard trees – Priority One

A tree becomes a hazard when placed in an area that in the event of failure, it causes injury to a person or damages property. Street trees next to buildings often become hazards. An example occurred in March of 2006, in the Cole Park residential area when an oak tree's root system failed, and the large tree fell into the nearby house. Fortunately no one was home at the time and no injuries occurred. (Figure 15)

Figure 15. Failed Oak Tree in Cole Park.

In urban forestry, public safety is the first priority of any management program. The cantonment area has a number of priority one hazard trees. Much of this is due to the lack of routine care and mechanical damage. Many of the older trees have broken branches and cankers that have not healed allowing decay to enter. The inventory identifies two hundred seventy-eight (278) trees as being hazardous, and recommendations have been made for their removal.

A yearly follow up hazard tree inspection should be conducted for areas where pedestrian and vehicle activity are high (residential areas, business areas, schools, etc.). Medium and low use areas should be inspected at increments of three and five years, respectively. This will ensure that all trees are evaluated during a set period (Pokorny and others, 2003).Tree evaluation should follow a systematic process of assessing the tree or tree parts (Matheny and Clark, 1994). A numeric system is used to determine risk. When corrective recommendations are implemented trees with the highest scores should be dealt with first as they have the greatest chance of failing. Both the International Society of Arboriculture and the U.S. Forest Service have evaluation systems available for reference to set up a hazard tree inspection program. When designing and caring for plant material in the urban forest, public safety should be of highest importance.

8.1.2 Dead, Diseased and Liability Trees – Priority Two

Priority two removals are those trees that are in medium hazard areas (areas where people and vehicle traffic use is intermittent), placement is considered a liability or the tree is dead or badly infected with a disease or insect and may die within the next two years. The inventory identifies eight hundred forty-nine (849) priority two removals. This includes two hundred sixty-nine (269) trees where placement has been identified as a liability. A tree becomes a liability when the placement is such that it could cause an accident or damage a structure. The majority of those identified as a liability are volunteer trees growing in sites too small for a fully mature tree. Examples of this are trees growing next to building foundations or growing in fences or into air conditioners. Two hundred and seventeen (217) of the identified liability trees are six inches or

less in diameter and can be removed with hand tools. The others are either dead or in poor or critical condition. There are five hundred and eighty (580) trees in this condition that need to be removed in the near future (2 to 5 years). Although none of these trees are hazardous at this point in time, if left in place they could become hazardous.

8.1.3 Dead or Declining Trees -Priority Three

Priority three removals are trees that are in a low hazard area (areas of low use, no structures and no vehicles), dead or in a state of decline and will probably die within five years, or growing in a poor planting site that will not support a mature healthy tree.

Fort Campbell's tree population has numerous trees in poor, critical or dead conditions. Six (6) percent, or two thousand and eleven (2011) trees have been identified as priority three removals. This will influence the maintenance budget over the next five to ten years. Size distribution of the largest portion of this category is 1 in. to 6 in. dbh or forty-six (46) percent of all priority three removals. Table 1 shows these numbers.

The majority of these trees can be removed as time and money are available. Those trees that are competing for growing space should be removed as soon as possible. This will reduce the competition for nutrients and water and improve the health of neighboring trees.

DBH SIZE CLASSES	NUMBER OF REMOVALS
One to Six inches	936
Seven to Twelve inches	365
Thirteen to Eighteen inches	302
Nineteen to Twenty four inches	195
Twenty five to Thirty five inches	149
Thirty six + inches	64

Table 1. Size Classes for Priority Three Tree Removals.

8.1.2 Tree Pruning

Pruning is done to remove dead branches, improve structure, remove closely parallel branches and crossed or broken limbs and superfluous growth at the base of the main branches. Pruning should be timed for most species when the tree or shrub is dormant. Pruning practices should follow ANSI A300 (Part 1) Standard Practices (Pruning), and industry standards described in the companion publication published by International Society of Arboriculture, "Tree Pruning" and "Utility Pruning of Trees". One observation made during the inventory was the use of incorrect pruning practices during installation ground maintenance activities. The incorrect practices observed include incorrect placement of pruning cut and pruning technique. Three percent of the urban forest had been pruned poorly at some point in time, as evidenced by cuts beyond the branch collar and pruning wounds that never healed. Poor pruning practices were observed in the housing areas, on Brigade Combat Team areas, and in other barracks and building areas. Most of the poor pruning is probably due to the lack of education or training in proper pruning practices.

Many of these trees now have reduced landscape value and are more susceptible to insects and disease.

In the tree inventory, pruning needs were recorded as follows:

Priority one prunes – Hazard branches four inches or greater to be removed
Priority two prunes – Hazard branches two inches to four inches to be removed
Priority three prunes – Branches needing removal because of interference with an object
Routine prune large – Rotation pruning of large and medium mature trees
Routine prune small – Rotation pruning of small mature trees
Training pruning – Pruning of young trees to develop desired future structure

8.2.1 Hazard Prunes – Priority One and Two Prunes

Hazard prunes are regarded as similar to hazard removals; it is a matter of public safety. Trees that are identified as priority one and two prunes have dead or injured branches that may harm people or damage property when they fail. The inventory identified one hundred forty (140) priority one hazard prune trees. In addition to the priority one numbers, there are one hundred thirty-seven (137) priority two prune trees. Action to trim these trees should be taken as soon as possible.

8.2.2 Clearance Prunes – Priority Three Prunes

Branches that interfere with streetlights, signs or are limiting head clearance over streets or sidewalks can be dangerous to pedestrians and vehicles. Tree limbs growing into buildings can become a hazard if left uncorrected. Low growing branches in parks and green spaces can be dangerous to maintenance personnel and park visitors. Identified were three hundred and fourteen (314) trees needing clearance prunes. The majority of the priority three prunes are in Fort Campbell Family Housing areas: two hundred and seventeen (217) trees were identified. Part of the problem has been in the original landscape design; most likely, the mature tree height and spread size were not anticipated when the landscaping was planned. Trees with large mature size were planted too close to streetlights and houses. The lack of routine maintenance over time has allowed the trees to fill in over sidewalks, driveways and under roof overhangs. These problems are often easy to correct by raising the crown and removing the problem branch(es).

8.2.3 Routine Pruning – Large and Small trees

Standards

Routine pruning involves pruning on a regular cycle. An ideal cycle would be a regular 5 or 7 year rotation, depending on growth stage (mature or over mature) ensuring every tree is evaluated and healthy branches are maintained or problems corrected. This category is assigned to those trees that are in fair, good or excellent condition, and do not have serious pruning needs. Routine pruning involves one of three types of pruning practices. The first and most common is a crown cleaning. This involves the removal of dead, broken, structurally weak or diseased branches to prevent the spread or introduction of disease. This will also allow damaged branches

to heal. The other two practices, crown reduction and crown raising are not used as often but can be used if needed. Crown reduction is a technique used to reduce the windsail effect of a tree's crown, decreasing the weight of heavy limbs and increasing light penetration and air movement throughout the tree. Crown rising, or lifting, is the selective removal of branches to provide vertical clearance for trees interfering with buildings, signs, vehicles, or pedestrians.

Observations

Trees have often been left unpruned for fifteen to twenty years. In that time branches die, become broken due to storm damage, or become infected with primary and secondary insects and/or diseases. Larger dead branches may become hazardous and/or cause the decline of the tree's health. Routine pruning practices were not observed on post. The inventory identified the following numbers of trees needing routine prunes: small trees (mature height 25 – 30 feet) 8030 trees; medium trees (mature height 35 to 40 feet) and large trees (50 feet and taller) together total 15839 trees.

Recommendations

Pruning maintenance was discussed in the "External Review of United States Army Forest Resources 2006" report prepared for the Assisted Chief of Staff for Installation Management, Army Headquarters. It pointed out the scientific justification and benefits of regular pruning on urban trees. Accomplishing routine prunes on post, in an efficient manner, could be by blocks. Selecting a block or blocks and continuing until the whole cantonment area is complete would set up pruning rotation. If it takes five years to complete the whole cantonment area then there would be a five year rotation, with maintenance pruning beginning over with the first blocks selected. Involving routine pruning in the tree maintenance program would benefit tree health and help maintain or increase the landscape value of trees. Improvements would also include educating and training contract management personnel and monitoring tree contractors to insure industry standards are met.

8.2.4 Training Prunes

Training prunes, or structure pruning, is the best way to insure strong and safe mature trees. By training trees from the time they are young, a qualified professional can select the branches that will be the scaffolding, or support branches, for the mature tree. Removing branches that are poorly attached, co-dominant leaders, or are dead or diseased keeps the tree healthy and prevents the tree from becoming a hazard when mature. The first pruning should occur five years after the tree is planted. Pruning should then continue every four to five years until the tree reaches maturity. There are several advantages to training trees when young: cost of pruning is reduced; it is easier and safer to prune with hand tools and a ladder; and less time and money are needed to make corrections. Also, smaller wounds from early pruning take less time to heal as long as correct pruning methods are used. The result is a structurally safer tree with less pruning required when the tree reaches maturity. Over the life of the tree, benefits are increased (landscape value, energy savings, pollution absorption, and aesthetics) and maintenance costs decreased. There are three thousand three hundred and seventy-two (3372) trees that would benefit from

training/structure pruning. Being proactive on early tree pruning will decrease the cost of maintenance over the life of the tree.

8.3 Bracing and Cabling

Standards

Many trees have poor structure due to natural growth forms. Many problems can be eliminated when the tree is young. However, correction of structural problems with mechanical methods is possible to prevent branch or tree failure and preserve the standing tree. The practice is called cabling or bracing. Cabling uses steel wire, steel strand or synthetic-fiber and specialized hardware put into the wood to limit movement and provide supplemental support. Bracing uses lag-thread screws or threaded-steel rods in limbs, leaders, or trunks to provide additional support. Cabling and bracing are specialized skills that should only be performed by a certified arborist with experience in tree stabilization. All work to cable or brace should meet the industry standards set in ANSI A300 (Part 3) – Tree Care Operations Maintenance Standards, Support Systems (Cabling, Bracing, and Guying).

Observations

The inventory documented 18 trees that would benefit from cabling or bracing. Trees represent both conifer and deciduous species, ranging in sizes from 7 in. dbh to 32 in. dbh.

Recommendations

This option may not be appropriate for all identified trees. If determined not to be appropriate because of cost or other factors the other options would be do nothing and wait until the tree fails and then remove the tree, correct the structure problem with pruning, or change the management need to priority tree removal.

8.4 New Tree Planting

Natural forests reproduce trees naturally, producing seeds that are worked into the soil and grow randomly as conditions permit. Urban areas are influenced by man's presence and planned to produce a desired environment. Planned environments are more appealing comfortable and ordered when trees and plants are included in the landscape. Trees have a limited life span, so to continue the presence of the forest canopy new trees need to be planted on a regular basis.

Standards

Urban forest management not only includes tree maintenance but also new tree planting. New trees planted in the cantonment area should meet industry standards set by the American National Standards Institutes. These standards include ANSI Z60.1 American Standards for Nursery Stock and the ANSI A300 Tree Care Operations: Part 6 (Transplanting). Table 2 shows the number of vacant spaces available in the management units.

MANAGEMENT UNIT	VACANT PLANTING SPACES
Community Life Residential	1264
Brigade Combat Team Facilities	229
Town Center	65
Memorial Boulevard	34
Community Life Facilities	29
Brigade Combat Team Housing	25
Community Life Recreation	21

Table 2. Number of Available Planting Spaces in Each Management Unit.

Observations

Tree planting sites were recorded in areas that have existing trees or could sustain trees to maturity. Areas suitable for planting include among buildings, houses, along streets and sidewalks. Greenspaces and park planting spots were not recorded because of multiple sites available that could support a mature tree. Tree spaces were recorded as one of three different tree sizes, large, medium, and small. Each site indicates the maximum mature size tree that would grow in that vacant site.

The inventory shows are1646 vacant tree spaces available to plant new trees. Table 3 shows the available sizes and numbers:

TREE SPACE SIZE	NUMBER OF SPACES
Large vacant sites	567
Medium vacant sites	546
Small vacant sites	533

Table 3. Number of Available Planting Spaces by Mature Tree Size.

Trees grow best when there is adequate room for root and crown development. The following tree sizes are recommended spacing between trees to allow for mature tree sizes. Three sizes of trees spaces are as follows: small tree – 30 to 35 feet; medium tree – 40 to 45 feet; large tree – 50 feet and greater, mature height.

Recommendations

Tree planting is a positive activity for Fort Campbell that can include participation from the RCI communities, soldiers, civic groups, schools and employees. To increase the number of trees in the Fort Campbell urban area, and to sustain the urban forest, a minimum of 100 total replacement and new trees in planting sites should be planted each year. In areas such as parks and

Figure 16. Tree planting at Fisher House.

greenspaces an inventory to identify available planting sites (in areas not collected in the 2006 inventory) would identify additional areas needing new trees.

9.0 Value of the Urban Trees

The value of urban trees is determined using the trunk formula method found in the ninth edition of the "Guide for Plant Appraisal" prepared by the Council of Tree and Landscape Appraisers. The formula is used on an individual tree and calculates the landscape value. The formula is: [installed plant cost * (species %) * (condition %) * (placement %)].

- The installation cost is the purchase price of the replacement tree plus the cost of materials and labor to install it.

- Species rating (species %), given as a percentage, is the desired value of a particular species. These ratings run from 5% to 100% and vary depending on the region within the United States. The Southern Chapter of the International Society of Arboriculture Tree Species Rating Guide was used to determine this percentage. An example rating is tree-of- heaven is listed as 45 % where southern red oak is rated as 80% (Southern Chapter ISA, 2005). Southern red oaks are more desirable in the landscape than tree-of-heaven.

- Condition (condition %)is based on the health and structure of the tree. Condition percentages are given in the range of 50% for critical condition, very poor = 60%, poor = 70%, fair = 80%, good = 90% and 100% for excellent tree condition.

- Placement (placement %) is a determination of how effective the tree is in providing its function and aesthetic attributes. One element looked at could be whether the site is large enough to maintain the tree's mature size.

The landscape value is the worth a tree has in the location in which it is planted. At the end of the urban tree inventory in 2006 the value of the trees in Fort Campbell's cantonment area was approximately $58.5 million. The value calculation was determined using the Davey Resource Group's Treekeeper software.

This value does not include the other benefits that trees provide such as energy savings, pollution absorption, storm water interception, and carbon dioxide storage. A dollar value can be determined for these benefits also. By knowing the costs of planting, after care and other costs to maintain and administer an urban forestry program and the value of the benefits, a cost benefit analysis, dollar value can be calculated. A cost benefit analysis was completed using the program STRATUM (Street Tree Resources Analysis Tool for Urban Forest Managers). However, STRATUM software only analyzes street tree data, so only street tree records were entered for this calculation. Fort Campbell's street trees represent six percent of the total tree population (number of street trees divided by total tree population). These records were entered to calculate a benefit value. Another limitation of the software is the reference data used within the software. It is from a city in the upper mid-west of the United States. Currently there is no reference data for the south central region in which Fort Campbell is located. Because trees grow differently in the different regions of the U.S., (ex. greater rainfall, longer growing season, and warmer

temperatures) the growth rates are under estimated for the data entered for Fort Campbell's trees and therefore the cost benefit analysis is low.

STRATUM calculated the benefits of energy savings, atmospheric reduction of carbon dioxide, air quality improvement, reduction of stormwater runoff, and aesthetics (from only the street trees at Fort Campbell) of $205,859. The benefit per tree is $107.27; being that this is only a small portion of the total tree population benefit dollar amount, actual dollar amounts would be larger for the whole population. To determine the total population benefits would require a fixed plot survey throughout the cantonment area. The 2006 inventory did not contain all the required data, therefore total population benefits are not available. The landscape trees planted in the cantonment area help increase the land value and the residents and personnel receive the environmental benefits. With the improvement of maintenance and management practices the values associated with better tree condition will increase total landscape values.

10.0 Improved and Semi - improved Tree Summary

The improved and semi-improved urban forest is healthy in 76% of the tree population. Portions of the tree population show mechanical damage and poor pruning practices. Observations during this inventory indicate that lack of knowledge on proper care continues to be the cause of the damage. Improper care has a tendency to stress trees and attract secondary insects and diseases, threatening the health of the tree. Diseases such as decay rot and cankers on branches or the trunk are not treated or pruned out until the tree's health is fading or the tree is dead. Crown cleaning of trees (removal of dead and diseased branches) on a regular cycle would help reduce the spread of disease to other trees and keep trees healthy. Newly planted trees would benefit from improved after-care. After-care practices such as correct mulching, along with watering newly planted trees when natural rain fall is lacking (drought conditions), would help ensure an increase in survival rates. Correct mulching, as outlined in the Installation Design Guidelines, prevents mechanical damage from lawnmowers and weed trimmers. New plantings seem to be limited to new construction and special projects, often planted on a limited basis. Proper care for new trees and shrubs is even more important with limited resources available for new landscape design.

As discussed in the "External Review of Army Forest Resources" the current urban forestry management practices used on Fort Campbell, and many other installations, will not sustain the urban forest resource. Removal of poor and dead trees and limited replacing of trees with poor after-care will reduce the population of trees and the benefits of mature trees. A proactive approach to tree care management would help achieve a sustainable urban forest resource.

11.0 Unimproved Forest Stands

Within the cantonment area there are several fragments of unimproved forest land. These forest stands are remnants of original forests or are planted non-native loblolly and Eastern white pine stands. Some stands are in sink holes and may not be suitable for development. All of the stands are unmanaged with many of them having been identified for future development. Some stands may be used for troop training, storm water interception and wildlife habitat. A list of wildlife and bird species can be found in Appendix B. Collectively, the mapped stands make up 393.6

acres; of these acres, 12.5 acres were either inaccessible or they were less than one acre and not inventoried for statistical reasons. The remaining 381.1 acres were inventoried using a standard timber inventory method.

Additionally, three of the stands were not inventoried because one had been identified for a new building project and two were under quarantine for *Histoplasmosis* and did not fit into the scope of work for the project (Figure 17).

11.1 Inventory Procedure

The inventory was completed between August 2006 and October 2006. The stands were named based on the management units set in the urban tree inventory. A point sampling method was used to collect information on the stand. The points were determined using a four chain by four chain (1 chain = 66 ft) grid layer over the 2004 aerial photos in ArcGIS 9.1 software. The longitude and latitude for each point falling within the stand was input and located in the field with a Magellan Medium Platinum GPS unit. The plot center was established when GPS showed location within five feet of the coordinates entered. The accuracy of the Magellan Medium Platinum is approximately 15 feet.

Once the sampling point was located, a 26.3 foot (1/20 acre) radius was identified to determine vegetation canopy closure for three levels: understory, mid-story, and overstory. The understory area is from the ground to ten feet in height. Plant forms in this zone are forbs, sedges, grasses, seedling trees, small and medium shrubs, and sapling trees. The midstory is the area space that is 10 feet to 30 feet in height. Plant forms in this zone are large shrubs and intermediate and suppressed trees. The overstory trees are above 30 feet in height and are co-dominant and dominant trees.

After canopy closure was determined a ten basal area prism was used to determine plot trees for the overstory tree observations. The information collected included species, tree diameter (measured at 4.5 feet), living status (alive or dead), timber quality (saw log or pulpwood), height of timber product, percent defective wood, crown class and crown condition. The information was used to evaluate the health of the forest stands and estimate the volume of merchantable timber within the stands. The information was collected with an Allegro field personal computer, utilizing NEDDC software developed by the United States Forest Service. The stand data was analyzed using NED2 -Ecosystem Management Decision Support software also developed by the United States Forest Service.

11.2 Forest Stand Information

The stands ranged from less than one acre to 156 acres. Stands are divided into management units: Brigade Combat Training (BCT) and the Community Life (COM). Management units are the same as the urban forest inventory management units. BCT management unit has 17 forest stands with 8 of the stands large enough to inventory. Two stands that were greater than one acre were not inventoried for security reasons. (Figure 17)

The cantonment area forest stands are made up of a variety of forest cover types.

Table 4 shows the forest cover types and their acreages as determined by the NED-2 software. The forest canopy is dominated by the species group “other hardwoods”. These are tree species that are not identified in broader groups such as oaks or southern bottomland hardwoods.

Forest Cover Type	**Sum of Acres**
Other hardwoods (hackberry/American elm/ ash)	339.2
Southern bottomland hardwoods	14.9
Oak – yellow poplar	13.7
Loblolly pine – shortleaf pine	11.2
Cherry	2.1
Total	381.1

Table 4. Forest Cover Type Acres

Canopy closure influences tree species make up and associated shrub and groundcover layers. The average canopy closure was calculated from data collected and input into NED-2. Canopy closure is the degree and depth of closeness of branches and leaves of individual crowns to other crowns and is an indicator of the amount of light reaching the ground. As canopy closure increases tree species that are shade tolerant have a better chance of reaching maturity. Those species that are intolerant of shade will struggle to survive unless the canopy is opened. Shade tolerance of tree species is listed in Appendix C. Table 5 shows the percent of canopy closure for the five cover types.

Cover Type	**% of Canopy Closure**
Other hardwood	50
Southern bottomland hardwoods	65
Loblolly – shortleaf pine	53
Oak – yellow poplar	60
Cherry	25

Table 5. Percent Canopy Closure for Unimproved Forest Stands

Canopy closure can also influence the introduction of invasive species. In a minimum of three stands, canopy closure has decreased, allowing more sunlight to reach the forest floor. The invasive grass species Japanese siltgrass *(Mirostegium vimineum)* has established and is continuing to move across the ground choking out native vegetation and tree seedlings. Japanese siltgrass has the potential to affect native species of insects that lay eggs on ground vegetation. The full effects of population changes have not been researched enough to predict future impact (Swearingen and Sheherezade, 2007). Currently there is no known biological control for the grass. Chemical herbicides have been effectively used for control; pre-emergent herbicide would be the best option as other herbicides used are non-selective and would kill all herbaceous plants. The use of mechanical or manual control methods are not realistic options due to terrain and manpower constraints. Control is possible but with the extent of the spread of the grass it would be costly. Invasive tree species, tree-of -heaven and Bradford pear, were found in stands; however their occurrence is not of enough concern at present. Tree species considered invasive in Kentucky and Tennessee are listed in Appendix C.

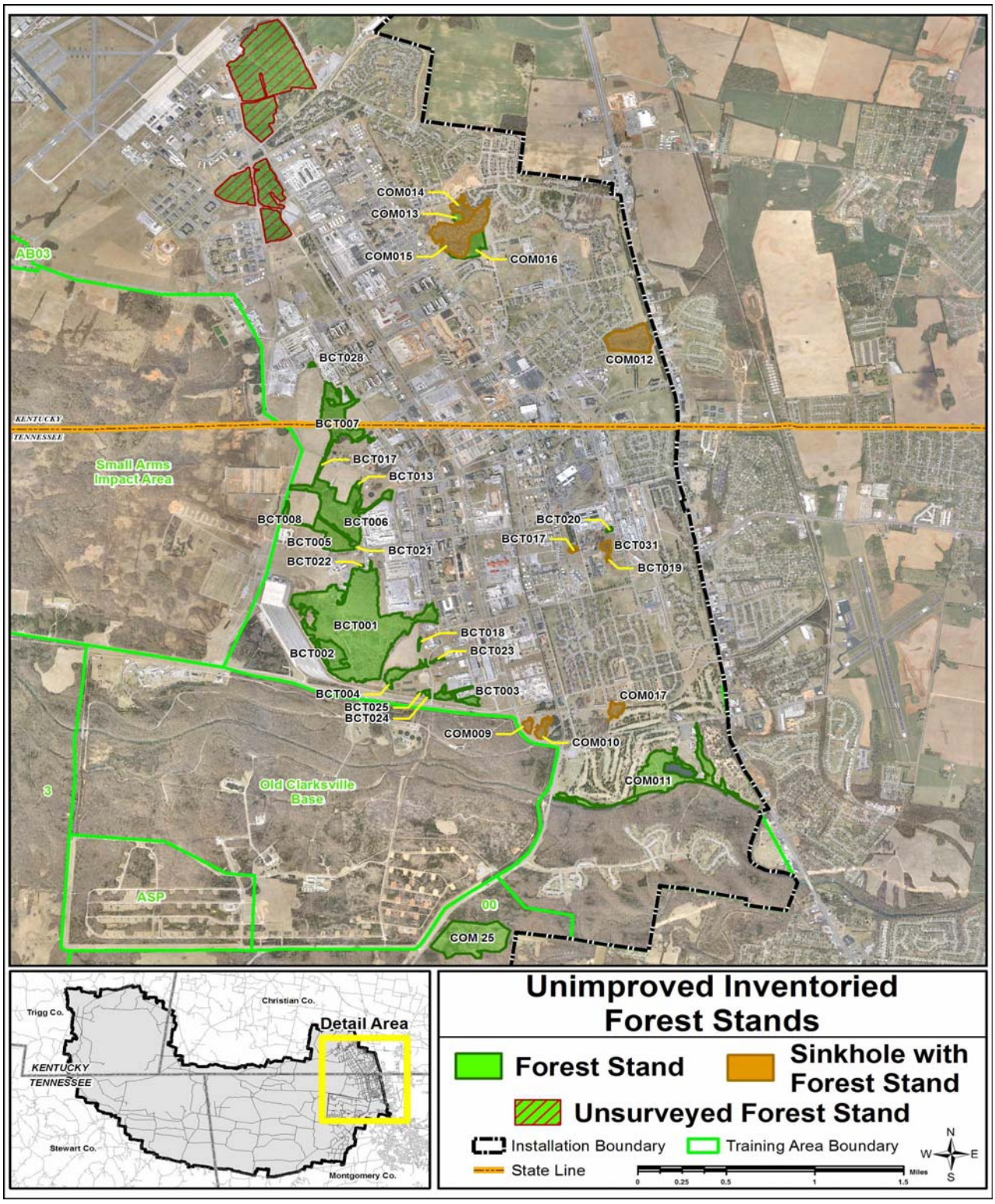

Figure 17. Unimproved Forest Stands

Canopy closure is related to the density of trees and their size. The acre is the standard area of measurement used in forestry to evaluate numbers and volume of trees. Stems per acre, or trees per acre, represents the amount of trees in the specified area. The information has been broken down by size class (< 6 in., < 12 in., ≥ 12 in.). This information shows which species have the highest density and occurrence in the stand. With silvicultural and timber management practices the desired species mix can be cultivated for wildlife or timber production. Pine species numbers are typically small in low diameter numbers, because they were planted and not established from seed. Table 6 below shows the stems per acre of the forest cover types.

Stems per Acre by Species

Forest Cover Type	**< 6 “**	**< 12 “**	**> 12 “**
Pine Species			
Loblolly pine	29	68	122
Shortleaf pine	0	7	29
Other Softwoods			
Eastern redcedar	124	128	12
Oak Species			
Southern red oak	2	4	19
Northern red oak	4	1	4
Pin oak	0	21	5
Cherrybark oak	0	18	9
Chinkapin oak	0	0	0
Post oak	1	2	1
Black oak	1	9	12
Scarlet oak	0	0	0
Chestnut oak	0	0	0
Shingle oak	6	6	4
White oak	10	8	3
Maples			
Red maple	0	2	1
Silver maple	0	1	2
Sugar maple	218	43	4
Cherry/Ash Yellow Poplar			
Black cherry	186	146	46
Ash (green, white)	416	129	62
Yellow poplar	27	9	33
Other Hardwoods			
Pecan	0	0	0
Eastern cottonwood	0	3	35
Common hackberry	336	355	98
Common persimmon	20	20	1
Sweetgum	0	0	0
Sycamore	1	1	21
Mockernut hickory	9	7	4
Pignut hickory	0	1	1

Stems per Acre by Species (cont'd)

Forest Cover Type	**< 6 "**	**< 12 "**	**> 12 "**
Other Hardwoods, cont't			
Shagbark hickory	0	0	2
American elm	247	69	23
Slippery elm	0	0	0
Winged elm	1	0	0
American beech	0	0	0
Black walnut	11	30	20
Black locust	1	24	7
Blackgum	0	0	4
Sassafras	106	39	12
Honey locust	52	48	4
Red mulberry	36	9	1
Non-Commercial Species			
Osage-orange	0	1	0
Sourwood	0	1	0
Flowering dogwood	335	9	6
Tree-of-Heaven	2	0	0
Eastern redbud	31	3	0
Boxelder	92	157	32
Hophornbeam	38	0	0
Total Stems per Acre	**2,070**	**1,397**	**640**

Table 6- Stems per Acre in Unimproved Forest Stands

Table 6 shows large numbers for trees less than 6 in. Ash, common hackberry, American elm, and flowering dogwood have the largest numbers in this small size class. As the trees grow, weather, disease, insects, animals and competition will reduce the trees numbers, leaving trees that are hardy enough to survive to maturity. Pine species planted by hand show little or no regeneration for future stands. Pines stands will eventually convert into hardwood stands as trees die or are harvested (Edwards 1987).

In accordance with Army Regulations, 200-1 and 405 – 90, Disposal of Real Property (May 1985), timber products are sold and associated monies are deposited into the proper account(s). Merchantable volume is determined by size (diameter at breast height) and height. Product prices are based on quality of wood product, which influences current market value. Cruise data volumes are estimates, actual volumes are determined when harvest is planned. Species volumes determined for board foot, cubic foot and ton per acre are listed below.

Volumes per Acre by Species

Forest Cover Type	Board Feet	Cubic Feet	Tons
Pine Species			
Loblolly pine	23,452	7,820	78
Shortleaf pine	7283	1,662	49
Other Softwoods			
Eastern redcedar	0	1,241	40
Oak Species			
Southern red oak	2,842	1,057	31
Northern red oak	1,092	285	9
Pin oak	650	382	11
Cherrybark oak	762	430	13
Chinkapin oak	23	6	0
Post oak	517	202	6
Black oak	5,317	1,453	44
Scarlet oak	32	11	0
Chestnut oak	154	6	0
Shingle oak	509	203	6
White oak	10	8	15
Maples			
Red maple	27	34	1
Silver maple	345	113	2
Sugar maple	811	548	16
Cherry/Ash Yellow Poplar			
Black cherry	5,959	3,631	108
Ash (green, white)	4,712	2,638	78
Yellow poplar	10,759	2,625	78
Other Hardwoods			
Pecan	56	23	1
Eastern cottonwood	13,873	3,616	108
Common hackberry	8,161	4,910	146
Common persimmon	98	125	4
Sweetgum	6	7	1
Sycamore	2,894	2,894	32
Mockernut hickory	1,025	337	10
Pignut hickory	92	33	1

Volumes per Acre by Species (cont'd)

Forest Cover Type	Board Feet	Cubic Feet	Tons
Other Hardwoods, cont't			
Shagbark hickory	85	62	2
American elm	1,832	1,057	31
Slippery elm	0	2	0
Winged elm	0	2	0
American beech	134	52	2
Black walnut	553	887	26
Black locust	354	24	7
Blackgum	617	321	8
Honey locust	628	635	19
Sassafras	908	805	24
Red mulberry	15	63	2
Non-Commercial Species			
Osage-orange	0	0	0
Sourwood	0	9	0
Flowering dogwood	0	64	2
Tree-of-Heaven	0	1	0
Eastern redbud	0	10	0
Boxelder	200	1,607	48
Hophornbeam	0	0	0
Total Volume per Acre	**96,787**	**4,921**	**1,059**

Table 7. Volume per Acre in Unimproved Forest Stands

11.3 Regulations

Policies and procedures govern the budgeting, accounting and reporting obligations associated with the production and sale of forest products at Army installations. (Title 10, United States Code (U.S.C.), Section 2665, Sale of Certain Interests in Land; Logs, and Army Regulation (AR) 200-1, Environmental Protection and Enhancement, 28 August 2007.) Chapter 4, Section 4-3 of the AR, Land Resources, regulates the sale of forest products and stipulates where fees received for the sales are deposited. It also stipulates that forest products may not be given away, abandoned carelessly, destroyed, used to off set the cost of construction, or traded for any type of supplies or services. Commercial harvests are administered by the Army Corp of Engineers with assistance of the Forestry Section of the Environmental Division. Non-commercial disposal of forest products requires that fair market value will be used to determine payment. Commercial

harvests shall be completed before construction begins to limit impact to forest resources. CAM Regulation 385-5, Sustainable Range Program, Safety and Integrated Training Area Management (14 September 2007), Chapter 21, Section 21-3, Training Area Stewardship, prohibits the cutting and removal of hardwood trees for use in training without permission of the post forester. This regulation also allows the use of scrub limb foliage (eastern redcedar, sumac foliage and pine) for use as camouflage. These regulations are intended to sustain the forest resource and support mission training and are applied to forest products in the cantonment area. Other pertinent regulations may also apply to protect water supplies, endangered species and cultural and/or historic resources.

11.4 Endangered Species

The Indiana bat and the gray bat are listed on the federal endangered species list and have been surveyed by trapping on post. Only the gray bat has been identified in the cantonment area. Forest stands near streams and riparian areas within the cantonment area can be suitable forage and roosting habitat for the bats. The Fort Campbell's Endangered Species Management Plan (February 2007) addresses the activities that can be detrimental to the conservation of foraging and roosting habitat (ESMP section 4.2). The Fort Campbell Endangered Species Coordinator should be consulted prior to forestry activities to determine if planned activities will degrade bat habitat.

11.5 Unimproved Forest Stand Summary

Unimproved forest stands are a small component of the cantonment area, but are important for wildlife habitat as well as other environmental benefits. They are largely mixed species in uneven-aged stands, currently unmanaged and allowed to grow with only natural, environmental conditions to affect changes to the forest structure. Stands in the northern portion of the area have been quarantined because of Histoplasmosis or identified for future construction projects (Figure 17). Most of the unimproved stands are classified as hackberry, American elm, and ash (green or white), one of the five cover types identified. The volume of merchantable trees for all the stands is 96,787 board feet per acre. Forest product sales in the undeveloped urban forests are sometime difficult based upon available volume and product for sale in traditional timber markets. New markets should be explored to best utilize the resources. In the largest stand much of the species make up is loblolly and shortleaf pine. Loblolly pine will continue to expand in open areas and abandoned roads. However, as the canopy opens up there is a chance of invasive species entering. In three stands the invasive Japanese stiltgrass has entered and is spreading across the forest floor preventing tree seedlings and other native vegetation from growing. This could develop into a serious problem in the future.

Over time the undeveloped forest stands will change as they reach over maturity. Quality of merchantable wood product will decline. Dying trees and increased ground vegetation will build up fuels loads and increase the chance of wildfires. The use of management practices employed in the rear training areas that keep stands healthy and the fire fuels in check would also improve stand structure and forest health. It is unrealistic to use prescribed fire in the cantonment area to control vegetative fuels; however a common saying among natural resource professionals is "It is not a matter of if a fire will happen as when the fire will happen." Fuel reduction with

mechanical measures, thinning tree densities to an acceptable level, could be used instead to reduce potential for wildland-urban interface fire.

12.0 Wildland-Urban Interface

Unimproved forest stands are part of the urban forest and do have benefits such as providing locations for troop training, storm water retention, and wildlife habitat. There is also potential danger from wildland fire. Although rare in the cantonment area, wildfire is always a risk to resources, people and property. However, with knowledge and planning the risk can be reduced.

Fire is a natural part of the forest ecosystem, and it is not unrealistic to expect a wildfire in any of the undeveloped stands. There are two fire hazard seasons in Kentucky, February 15 - April 30 and October 1 - December 15. These periods were set by Kentucky State Bill 164, Chapter 47, Section 1 KRS. 149.400 (amended 2003). These periods can be influenced by above normal moisture or drought conditions. Fort Campbell Fire Department is responsible for suppression of fires within the cantonment area. However, the department is not equipped with wildland fire equipment. When a wildfire occurs the fire department may request the Forestry Section assist with equipment and personnel to suppress the fire.

Many of the undeveloped forest stands in the cantonment area are near homes or buildings, putting these structures at risk in the event of a wildfire. Wildland – urban interface is defined as the fringe area where home and businesses intermingle with forests or wild lands. With buildings being at risk it's important that Directorate of Emergency Services personnel and RCI Partners, Fort Campbell Family Housing and Actus-Lend lease, understand the potential threats to residents and property. Housing areas like Cole Park and Gardner Hills and future development of The Woodlands are considered Wildland – Urban interface because of proximity to undeveloped forest stands. (Figure 21, page 46)

According to the Tennessee Division of Forestry the following factors are important in assessing risk: access, vegetation, building construction, special hazards, additional factors and defensible space.

12.1 Access: The ability of emergency vehicles to enter and exit an area is critical to saving people and structures. There should be more than one road in and out of all areas, so if for some reason the entrance or exit is blocked, emergency vehicles can still enter via another entrance. Currently Cole Park and Gardner Hill's developments each have only one road in and out.

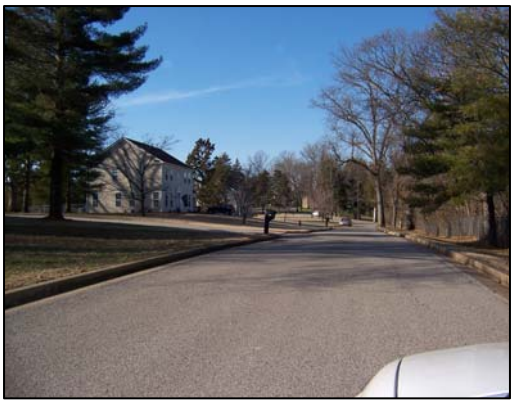

Figure 18. Roadway in Cole Park

Another factor of importance is road width. A narrow road with no shoulders limits emergency vehicles entry and maneuverability. The entrance at Gardner Hills is 21 ft. with 5 ft. shoulders; the rest of the roads are 30 ft. with no shoulders. The entrance at Cole Park is 18 ft. wide and the majority of the remaining roads are 21 ft. wide with little or no shoulder.

The National Fire Prevention Code 1141 states "Road width should be a minimum of 12 feet clearance for each lane of travel" (NFPA, 2003). Provisions in width should be made for drainage, snow removal, parking, and utilities.

12.2. Vegetation: Vegetation will feed the fire around adjacent lands and buildings. In unimproved forest stands vegetation has been allowed to grow with little or no management. This has left dead trees, standing and fallen, ladder fuels, shrubs, saplings and pole trees and build-up leaf litter from trees and shrubs. In some stands the loss of overhead canopy has allowed Japanese stiltgrass, and other weeds to establish, replacing native vegetation and adding to the litter layer. Heavy fuels cause more intense fires which are harder to control. The type of vegetation around buildings is just as important to the possibility of the building burning. Un-maintained evergreen trees and shrubs are more likely to burn than deciduous trees and shrubs, and, when located near buildings, flames can easily spread to the structure.

12.3 Building Construction: Materials used in home construction can also influence the ignition of the structure. Most common building materials will burn. Selecting flame resistant glass, siding and shingles will reduce or prevent the start of a fire and keep it from entering the interior of the structure.

The roof is the largest surface area of a building and the most vulnerable part of the structure. It can easily catch fire from wind blown embers. Asphalt shingles used in the interface area on older homes and newly constructed homes are recommended to prevent structures from catching fire.

Siding and wall construction are best when fire–restrictive or non – combustible construction materials are used. Using a minimum Class III, flame-spread rated siding material such as stone, brick, and/or stucco is best. Walls should be constructed of fire restrictive materials from the ground to the roof overhang. Newly constructed homes in Cole Park and the Woodlands subdivisions are constructed with wood and vinyl siding. Homes in Gardner Hills are constructed with two different materials: Becker Loop houses are constructed with brick from the ground to the roof while the homes along McAuliffe Ave. and other streets are constructed with brick fronts from the ground to the ceiling and vinyl siding on the other three sides from the ground to the roof. Homes in the area are vulnerable to heat and fire damage when wildland fire is in or near these.

The heat of a wildfire may be enough to ignite furnishings inside the home through the windows. Multi – paned glass provides insulation from trapped air and gives more protection from radiant heat than single – paned glass. It also reduces breakage potential from wind-blown debris.

12.4 Special Hazards: There are other elements that can affect the ability of fire fighters to access and save homes. Overhead utilities, such as powerlines, can prevent firefighters from entering an area. The heat from a wildland fire can cause lines to stretch, arc, or break damaging equipment and injuring personnel. Well-marked underground utilities are the safest. Currently overhead electrical and cable lines service the 70 homes on Barker Circle in Gardner Hills.

Underground lines power Cole Park, the Woodlands and homes on McAuliffe Way as well as Dexter, Snell and Hines Avenues in Gardner Hills.

Figure 19. Power Lines in Gardner Hills.

12.5 Additional Factors

The housing areas near forest stands, like Gardner Hills, have additional hazards such as the nearness of adjacent homes and the proximity of unmanaged forestlands. As discussed in the Section 12.3 of the Plan, these forest areas have dead vegetation and leaf litter that can cause a more intense wildfire and complicate its suppression. A more intense fire could increase the amount of hot embers hitting homes and igniting the structure. The proximity of homes to each other also adds to the potential of fire spread.

Figure 20. Homes near undeveloped forest stands.

12.6 Defensible Space

Defensible space is the area around a structure that reduces the fuels and fire flame lengths to an easily suppressible height thus preventing the flames from getting to the structure and causing major damage. The standard defensible space is 30 ft around buildings. This distance increases as slopes increase greater than 20 percent. Most of the housing areas on the installation have adequate space with turf grass from the forest edge leading to the structure.

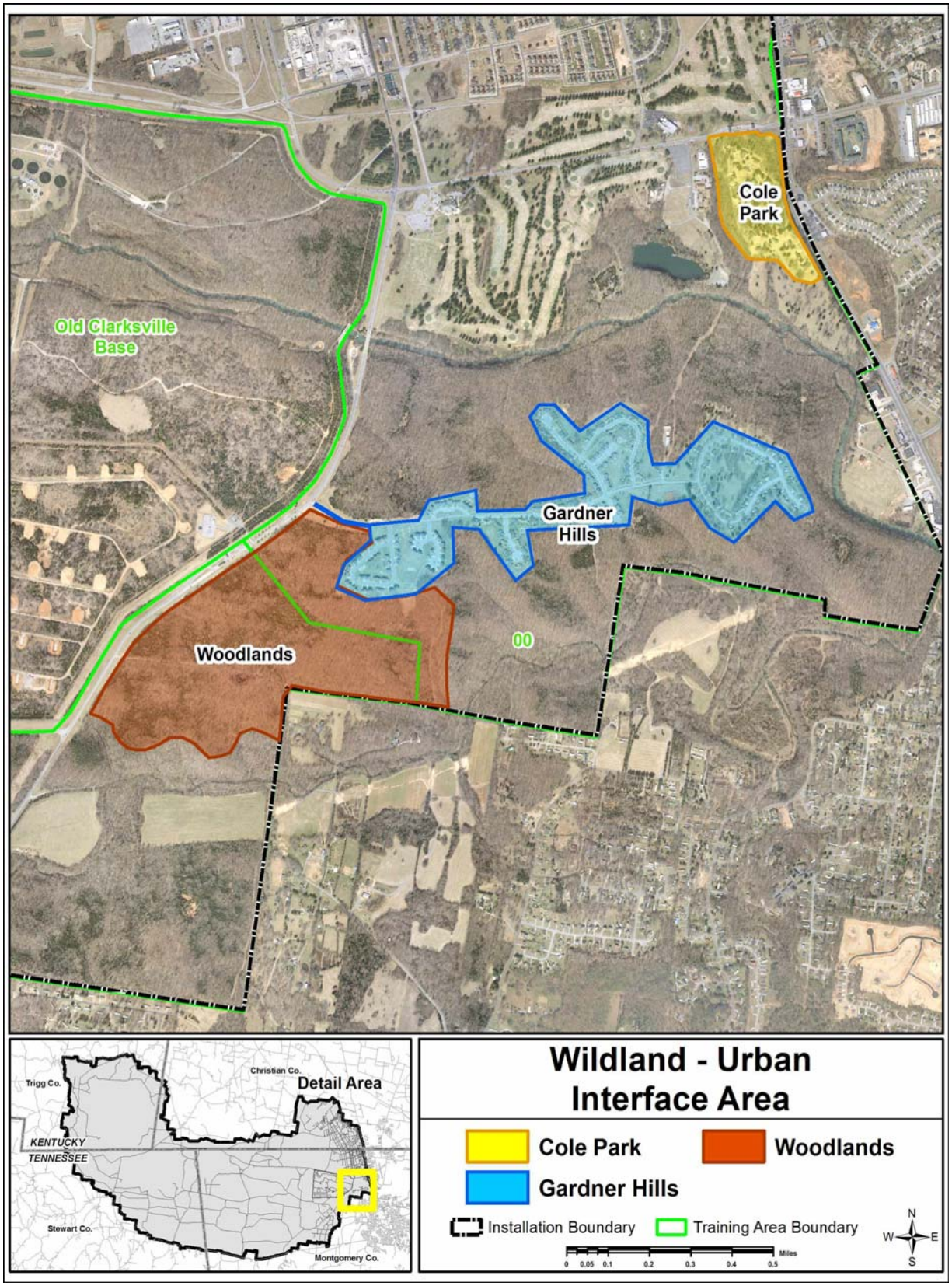

Figure 21. Wildland – Urban Interface Areas

13.0 Management Strategy

13.1 Staffing and Supervision

Management of urban forest trees and forests requires special knowledge and technical skills. Staffing with trained profession forestry personnel to supervise the various program elements will ensure specialized guidance is available to implement DoD policy for the management of urban forests. The number of installation personnel and their necessary technical skills should be dependent on the scope of the Urban Forestry Management program and the size and current condition of the urban forest complex. The use of contractors to accomplish desired goals, coordination and proper scheduling becomes important, and communication between personnel will be the key to success.

13.2 Command Tree Policy Directive/Tree Ordinance

Development of a Command Tree Policy Directive and/or a Tree Ordinance is recommended in Army Regulation 200 - 1. The policy or ordinance should identify and state specific requirements, authorizations and approvals for excavation permits, tree removals, and liabilities for unauthorized tree removal and damage, as well as for failure to use tree protection fencing. State law requires that all underground utilities be located before digging begins. This is accomplished with a dig permit from Directorate of Public Works.

13.3 Technical Assistance

To obtain technical assistance, Fort Campbell personnel may coordinate with forestry personnel at Army Environmental Center, Department of the Army. Also available is the U.S. Forest Service, state forestry, and county extension personnel. Guidance includes policies, standards, procedures, and periodic on-site advice to resolve technical problems and to establish goals to implement Urban Forestry Management Plans. Periodic consultation with specialists in related disciplines is essential to resolve specific problems. This assistance is commonly available through memoranda of understanding and cooperative agreements in applicable directives from the Department of the Army. Fort Campbell has entered into a Cooperative Fire Protection Agreement with the USDA Forest Service at Land Between the Lakes National Recreation Area. This agreement is in effect until 2010 unless renewed. Department of Defense has a Memorandum of Understanding with the United States Department of Agriculture related to food and agricultural sciences, pest management, nutrition, and other areas of mutual interest (e.g. forestry and wildlife). The document was signed in 1992. In the event of a national disaster the Department of Homeland Security’s National Response Plan (December 2004) is in place to provide direction and assistance.

13.4 Directorate of Public Works Contract Management Branch

Personnel involved with contract management of the urban forestry program should have the necessary training to understand the basics of proper tree and shrub care and urban forest management. Personnel should also understand industry standards and practices, as required by Department of Defense, to ensure that hired contractors meet those standards and practices. Contractors involved with urban forest activities should have qualified, certified supervisors. Certification may be in the form of federal, state, or industry endorsed programs. Certification is needed for tree care, pesticide technicians, and landscape technicians. Some responsibility for tree and shrub care is passed on to unit personnel and housing residents for vegetation around buildings and homes. These people can be educated on proper watering, pruning and fertilizing practices. Conditions beyond the scope of urban forestry personnel should be referred through command for corrective action.

13.5 Equipment and Supplies

Urban forestry equipment should be maintained in good working order. Monthly inspections and prompt repair of any deficiency should be performed, and equipment should be serviced when needed. New technologies and equipment should be evaluated for use as needed. Equipment used for pruning or cutting trees should be cleaned with alcohol between trees and prior to re-use to eliminate transmission of pathogens.

Requirements for replacement trees and shrubs to maintain a forest canopy, should be evaluated annually and included in the yearly landscape maintenance financial and budget requests.

14.0 Preventive Maintenance for the Urban Forest

Urban forest work must be accomplished when the stage of plant growth is favorable and when soil and climatic conditions permit. Many operations, such as timing of planting and pruning are best accomplished when the plant is dormant or when the plant will have little or no stress. Otherwise plants are more susceptible to insect attacks or disease infections that can cause a decline in health. Well-managed ground maintenance programs should have a comfortable margin of reserve funds for emergencies. The need for these funds can be reduced when a preventative maintenance program is practiced. Preventative maintenance anticipates needs and requirements and accomplishes maintenance activities when they are most efficient and effective.

14.1 Tree Database and Inventory

The tree database created while completing the urban forest inventory is a working management tool. Management needs recorded in the database will provide guidance in maintenance actions. It can also be used to estimate a budget for annual maintenance. The database is most cost effective when used to reflect the changes to the forest and maintenance needs of the trees. The GIS data layer should also be corrected as changes are completed on the ground. An updated inventory should be conducted a minimum of every ten years. However, the urban forest changes frequently and the ideal period of continuous inventory would be five to seven years.

14.2 Wildland-Urban Interface Fire Risk

Wildland fire is always a possibility when undeveloped forest stands are near urban areas. In order to determine the potential risk an evaluation of housing areas should be conducted. This would identify present conditions and corrections that may need to be addressed either with land management or future community renovations.

14.3 Industry Standards and Safe Working Practices

Maintenance of trees and shrubs should be done in accordance with standard practices developed by leading professional organizations. Such standards include, but are not limited to, ANSI A300 for Tree Care Operations - Tree, Shrub, and Other Woody Plants Maintenance. Specific parts include: Pruning (Part 1), Fertilization (Part 2), Support Systems - Cabling, Bracing, and Guying (Part 3), Lightning Protection Systems (Part 4), Management of Trees and Shrubs During Site Planning, Site Development, and Construction (Part 5), and Tree Planting (Part 6). Companion books published by the International Society of Arboriculture for each part (1 – 6) are available describing Best Management Practices for tree care. The Departments of the Army and Defense accept these industry standards.

Post personnel and contractors involved with urban forest maintenance activities should use safe work practices as recognized by Occupational Safety and Health Administration and professional organizations (e.g. Tree Care Industry Association, International Society of Arboriculture). Industry practices are documented in the ANSI Z 133.1 – Pruning, Trimming, Repairing, Maintaining, and Removing Trees, and Cutting Brush – Safety Requirements.

14.4 Tree Removals

Hazard trees should receive first priority for removal, as public safety is a basic principle of urban forest management. Removals would include badly decayed trees and dead branches, especially those that threaten people, structures, powerlines, roadways, walkways, or rail lines. Those plants infected with insect and disease problems that cannot be treated should be removed and disposed of in a sanitary way as to not spread the problem, if contagious, to other plants. Volunteer trees that germinate and grow in unwanted areas should be removed. Stumps should be ground to the required depth and prepared for grass seeding. Trees in undeveloped open areas that are dead and pose no threat to structures or life may be left standing as they help enhance wildlife habitat within the cantonment area.

14.5 Hazard Tree Survey

Trees should be surveyed annually to determine potential risk in high use areas around buildings, residence, and campgrounds, etc. Inspections to determine these trees should be conducted in the fall and should follow the guidelines set in the publication “Urban Tree Risk Management: A Community Guide to Program Design and Implementation” (Pokorny and others 2003). Areas within the cantonment area should be identified as high, medium, or low risk areas. Based on this

assignment the trees should be inspected on a regular cycle (e.g., annually, bi-annually, every five years) to ensure that trees are observed and conditions evaluated on a regular basis.

14.6 Tree Pruning

The following are recommendations for pruning:

- Remove dead, decayed and diseased branches when branch could damage structures or harm people.
- Prune shade trees to reduce damage from wind and ice according to the guidelines established by industry standards.
- Prune trees that are planted too close to buildings to prevent damage to structures.
- Branches interfering with safety structures such as signs, streetlights and stop signs should be pruned and hazard branch(es) removed.
- Pruning should be completed when the cuts will not attract insects or provide access for disease. November to March is the ideal time.
- Pruning scheduling should be timed when wildlife nests are not occupied and active. The dormant season between November and March is the best time to prevent disturbance in these trees.

Pruning cycles help strengthen the sustainability of the urban forests. Plants managed under a routine pruning cycle remain healthy, live longer, and are safer than those rarely pruned. Over the life of the plant, maintenance costs are reduced and landscape value increases.

15.0 Tree Planting

Planting is important to maintaining a sustainable urban forest. Making sure that trees and shrubs are planted in the right place is important to the health of the plant and could reduce maintenance costs for the life of the tree or shrub. Determining the right site and species (or the right tree in the right space) takes planning and understanding of the landscape characteristics and soil properties. Best Management Practices developed by the International Society of Arboriculture will insure proper mechanics of tree planting and an increased survival of plants.

15.1 Site and Species Selection

Selecting a planting site depends on many factors: sunlight, soil properties, available water and the available room for growth. Soils information is part of the NRCS Service soil survey. Interpretation of soil survey data for the site plan will give basic soil properties, information important in the comprehensive plant site selection. Planting sites should be selected that will support a mature plant height and crown spread of the desired species. Minimum distances from buildings, street signs, streetlights, and other facilities should be observed as listed in the Fort Campbell Installation Design Guide. Trees planted under powerlines should be a height, at maturity that will not interfere with the operation and maintenance of the powerline.

Having a healthy plant material is the best start to having a healthy forest. Stock should be the appropriate form and character of the species desired. The plant should be healthy, undamaged and free of disease and insect problems. The foliage should be full, resilient, and moist to the

touch, rejecting overage materials; plants with poorly balanced branching, weak-stemmed plants and other material not well proportioned or fully branched. Commercial nursery stock suitable for use should meet industry standards set in the American Standards for Nursery Stock ANZI Z60.1 by the American Nursery and Landscape Association.

Native plants are best suited, and desired, for use in the landscape. They easily adapt to the region's environmental conditions and most often do not require special maintenance to survive. Those species acceptable for planting on Fort Campbell are listed in the Fort Campbell Installation Design Guide**.** Species not listed in the Design Guide must be approved by forestry section and master planning before planting. Native plants are those plants that will survive within the 6b hardiness zone (0 to -5 degrees Fahrenheit) set by the U.S. Department of Agriculture.

15.2 Tilling, Grading, and Drainage

Tilling and grading are important procedures for preparing soil for the establishment of planting and in preventing erosion. Following construction, soil and subsoil materials are often in poor condition for planting. Debris remaining after construction operations should be removed before further preparation continues. Break-up any stone or gravel layers with appropriate tools then mix and pulverize the upper 5 to 10 inches of soil. A rotary tiller is also helpful, but may be effective to only to a depth of 2 or 3 inches.

Make sure rain runoff does not accumulate on the planted area against structures that have prominent ridges, depressions, and unnecessarily steep grades. Contractors involved with installation of landscaping should meet all federal and state requirements and laws pertaining to the control of stormwater and sedimentation of on-site disturbances. Problems that would hinder the economical maintenance of the planted area should be eliminated.

15.3 Subsoil Improvements

Wherever topsoil is not available but the subsoil is deep enough to be worked, it is possible to institute an improvement program. With the treatment described below, most subsoil will support plant species.

Scarify as deeply as possible (recommended to a depth of 12 to 18 inches, depending upon the terrain, type of soil, and site location). Then incorporate composted organic matter such as leaves, manure, etc. After the additives have been thoroughly worked into the soil, prepare a smooth planting site and adjust the pH following recommendations determined by a soil test. Revegetate with appropriately selected plant material.

15.4 Mulching

Mulching, when done correctly, provides the following benefits: conserves moisture and prevents sharp temperature fluctuations in the soil, improves soil structure and aeration, prevents wind and water erosion, controls or reduces weed growth, decreases maintenance costs and prevents the need for mechanical weeding around the trunk. Mulch is an after planting step to

help the tree survive the root establishment period (1 to 5 years). Mulches should be attractive, resistant to fire, and relatively inexpensive.

Mulches may be classified as follows:

1. Organic
   Organic mulches are usually debris or byproducts of plants. Plant organic matter decomposes on the surface and decomposition products (i.e., humus and other compounds) slowly work down through the soil aggregates. A soil structure with increased porosity develops greater air and water holding capacity. Therefore, organic mulches are a definite benefit to the soil. Many of the commonly used organic mulches are tree bark, wood chippings, pine needles, straw, hay, and sphagnum peat. Each has characteristics to make it more or less suitable for specific situations.

2. Inorganic

   Inorganic mulches are natural and manmade substances which provide long-term protection. Some commonly used inorganic mulches include rock or gravel, sand, plastic roll (weed barrier), and fiberglass. Again, each type of mulch has characteristics that make it more or less suitable for specific situations.

Mulch should be applied to a depth of 2 to 3 inches. Organic and inorganic mulch should never be placed next to the woody stem to prevent mold and fungus from growing on the stem. Mulch should start three inches from the stem and continue out to the plant's dripline.

15.5 Aftercare Maintenance

Aftercare of a newly planted trees or shrubs is important to plant survival. Often without the proper aftercare to relieve the stresses of transplanting, newly planted trees and shrubs succumb to environmental causes of death. The following practices should be used in a landscape maintenance program:

- Newly planted trees should be watered with at least 5 gallons to help the soil settle and remove air pockets in the planting site.
- Newly planted trees should have mulch placed properly at time of planting. Protective tubing placed around the trunk of trees will protect the bark and trunk from mechanical damage (weed trimmer, mower).
- During drought conditions when natural rainfall is behind normal levels, plants should be supplemented with 1 in. of water per week for the first year.
- Trees that are staked should have stakes removed after one growing year (Best Management Practices - International Society of Arboriculture).
- Mulch should be replaced on a yearly basis.
- Structure pruning for newly planted trees should start three to five years after the tree has been planted and continued on a regular cycle until the tree is mature.

16.0 Urban Forest Management Operation Plan

16.1 Long Range Goals

Goal 1: Improve the quality of Fort Campbell's urban forest resource.

Objective: Tree quality will be improved by contracting those companies that show they have the required knowledge to provide quality pruning and removal care that meet industry standards. Army Regulation 200-1 which …"incorporates policy and related requirements from AR 200-3, AR 200-4, AR 200-5 (Chapters 4, 5, and 6)", requires that personnel and contractors involved with tree care and landscaping operations should be certified by a state or professional organization such as the International Society of Arboriculture. Work crews should be supervised by at least one certified arborist or a certified landscape technician when at the work site. Verification of certifications should be completed during the bidding process.

Objective: Implement aftercare practices which promote healthy plants.
Such programs should include mulching and shields to protect tree trunks from mechanical and weed eater damage. Construction specifications should be written to identify these practices on all new plantings. Develop pruning schedules that train young trees for mature structural branch growth. Track pruning schedule in tree inventory or other database. Supplement watering for newly planted trees when significant deficit in moisture availability occurs due to lower than normal rainfall conditions.

Objective: Develop a hazard tree rating system and inspect trees during a time of year when defects can be observed. Document hazard tree inspections with prepared forms and arrange for corrective action when needed. Suitable periods would be annually for areas with high hazard species in high use areas (around permanent structures, concentrations of people, and stopped or parked vehicles). Medium risk areas should be inspected every three years for medium risk species (areas in which people and moving vehicles use is intermittent). Low risk areas should be inspected every five years this includes areas (with low people use, no structures and no vehicles). This should ensure all areas in the cantonment are evaluated.

Objective: Monitor potential insect and disease problems through USDA agency web-sites and trade literature. If the presence of an undesirable insect or disease that could have devastating effects on the urban forest and/or the surrounding area is found then sampling method(s) should be identified and implemented to locate the location of the pest(s). Treatment of the pest should be the most economical and safest method available. Make on post observations and identify pest present on trees, treating them as needed. Record insect and disease calls and other significant problems, when observed, in a database or spreadsheet.

Objective: Prepare procedures to respond to natural resource clean up from natural disaster emergencies. Develop an emergency tree response plan that identifies critical personnel and transportation circulation paths in the event of a natural disaster. Document pre-existing conditions and post event conditions to document changes.

Goal 2: Develop a tree replacement plan.

Objective: Replace and increase numbers of trees with the use of the urban forest inventory results and direct field observations. Priority areas would be determined based on current canopy coverage and available room for mature tree sizes as well as need for replacement of dead trees. Plantings should be designed and installed as funds permit. In some cases, existing, poor quality trees or poorly designed plantings should be removed to make way for new plantings. A tree coverage plan could give guidance and recommendations about tree placement. Species selection should follow Installation Design Guidelines. Document replacement trees by adding them to the existing tree inventory. Review all construction plans by 65 % for landscape plans or tree removal requirements. Record projects reviewed in a spread sheet or data base.

Goal 3: Maintain National Arbor Day Tree City, U.S.A award

Objective: Plan and hold an annual Arbor Day celebration and renew the Arbor Day proclamation. Promote proper tree care through education and best management practices within the Directorate of Public Works.

Goal 4: Increase the involvement of post residents and employees in urban forest planning and implementation.

Objective: Directorate of Public Works acknowledges that Fort Campbell's urban forests are managed and maintained (in part) for the people who live and work on post and those who visit. These people are not only affected by the urban forest resources on post, they also have major impacts on the resources and their long term sustainability. Residents and employees should be involved through annual educational and outreach programs, through tree-planting and care programs, and by direct assessments (survey) of their attitudes and desires involving urban forests. The survey should be conducted once during a five year period.

Post residents and employees will also need to be educated or trained since they establish, partially maintain, and significantly affect the health of a significant portion of the trees and shrubs on post. Training will be done through workshops, Earth Day and Arbor Day events, brochures/fact sheets, newspaper articles, newsletters, and other means. Numbers of attendees at educational programs will be recorded, and number of tree care documents produced would be inserted on a spread sheet for records.

17.0 Annual Work Plans

Segments of the long range goals and objectives need to be performed yearly. Projects to be undertaken will be set forth in the annual urban forestry work plan. Examples of these include: special projects, such as Arbor Day celebrations, and high priority items outlined in the long range plan, all recurring work and revisions necessitated by operational change of the installation, and required rehabilitation of reforestation caused by extreme weather, wildfire or other factors. The annual work plans are prepared in advance of the fiscal year in which the work is scheduled to assure adequate supplies, materials, equipment, man-power, and funds. The annual work plans would be coordinated with the installation Master Plan Division. The annual urban forestry work plan would be prepared using DoD Urban Forest manual guidelines and Department of the Army guidelines.

17.1 Recommended Project Descriptions

17.1.1 Tree Hazard Survey:

Survey of housing areas, parks and high traffic areas within the Cantonment area will be performed by a professional on the forestry staff trained in identifying hazard trees. A list of trees needing removal or corrective action will be developed during the survey and submitted to the appropriate maintenance partner (Fort Campbell Family Housing or DPW Contract Management).

17.1.2 Tree Replacement Program:

Periodic tree replacement is necessary to ensure a sustainable urban forest. Replacement plants will be purchased from accepted nursery stock and planted by contract, Fort Campbell Family Housing or special projects. Location of replacements will be determined from observation, tree inventory or tree replacement plan. Replacements will meet nursery and industry standards and follow the Fort Campbell Installation Design Guidelines.

17.1.3 Prepare Tree Cover Plan:

Develop a tree coverage plan that shows existing tree areas. Areas would then be prioritized based on planting sites available for full mature trees and replacement needs.
Tree planting needs shall be determined based on the planting sites inventory and field observations. Update the plan on a bi-annual basis to provide guidance for new and replacement plantings.

17.1.4 Tree Trimming and Removal:

Requests for tree trimming and removals are received via the service/work order desk.
Upon request forestry personnel can respond to requests for inspection and provide a recommendation of work that needs to be done. Other tree trimming work and removals will be developed from the Urban Forest tree inventory. No trimming or removal will be done without approval from DPW Contract Management, Fort Campbell Family Housing and DPW Forestry.

17.1.5 Renew Arbor Day Proclamation and Tree City USA Application:

Summit the annual application each year to the Kentucky Division of Forestry by the end of the current year. Arbor Day proclamation will be read at Arbor Day celebration. Historically the application has been signed by the Garrison Commander.

17.1.6 Natural Resource Management Plan and Forest Management Plan:

Ensure Integrated Natural Resource Management Plan and Forest Management Plan includes an Urban Forestry section and are compatible with this document and annual operational components of this plan. This document will be included as an appendix in the Forest Management Plan to meet this requirement.

17.1.7 Update Urban Forest Inventory:

Maintain the tree inventory database by removing and editing tree records as work is completed; including the urban tree layer in the GIS data base. Continue to add tree records as new trees are planted. Arrange to do a complete re-inventory of the cantonment area trees at year five of the established plan (2013).

17.1.8 Insect/ Disease Survey and Control:

Fort Campbell cooperates with the Tennessee Division of Forestry and the United States Department of Agriculture, Forest Service to detect the presence of exotic pest gypsy moth. Traps are placed in the cantonment area and the back training areas where they are monitored once every month through out the summer. Detection of Dutch elm disease will be done with visual inspections and sampling of suspected trees. Prior to removal of trees, when possible, a forestry staff member will inspect dead or dying trees to determine if insect or disease were a causal agent and if any treatment control needs to be implemented. An annual fly-over is scheduled in early spring, when possible, to detect indicators of Southern Pine Beetle. DoD Forest Pest Suppression projects may be funded following annual submission of project proposals when deemed necessary by installation personnel. Proposals must be validated following a biological evaluation of the problem and suggested controls.

17.1.9 Review all Construction Plans by 65% design for landscape specification or tree removal requirements:

Forestry staff should have the opportunity to review designs as soon as possible in the design process to ensure that trees and shrubs are suited for the area and that existing vegetation is utilized appropriately. Construction projects can be very detrimental to existing vegetation if not properly protected during construction.

18.0 Cost of Maintenance

Maintenance costs are a commitment to achieving a safe and healthy urban forest. Planting, pruning, and removals are only a small portion of the care required for the urban forest. Most of

the time they are the most expensive items needed. To date, most of the hazard trees have been pruned or removed, or have been scheduled for maintenance and the money has been budgeted. With identified hazards being dealt with, the other priorities can be managed as stand improvement. The total cost of pruning and removals of the remaining trees is estimated to be approximately $ 3,182, 165.00, based on 2006 DPW work contract prices. The cost should be included as part of the budgets of DPW and Fort Campbell Family Housing. The table below shows requirement costs.

Priority 2 Removals	$212,615.00
Priority 3 Removals	$464,510.00
Clearance Prunes	$56,420.00
Structure Training Prunes	$135,240.00
Routine Prunes - Large	$1,690,050.00
Routine Prunes - Small	$623,330.00
Total	**$3,182,165.00**

Table 8. Costs of Tree Care and Maintenance.

Increasing trees in the cantonment area planting spaces identified in the inventory is estimated to cost $383,860.00, as estimated from the 2006 Contract Management replacement tree price.

Work can be determined based on funds available for the current year. It is expected that it will take several years to complete routine pruning work. The first time routine pruning is done will cost more due to the fact that many of the trees have never been pruned. After the first scheduled routine pruning, additional future pruning can be scheduled on a set cycle. For example the trees between Tennessee and Kentucky can be pruned once every six years, removing dead and diseased branches. Other costs associated with tree care are establishment, insect and disease control, fertilizing, and supplemental watering.

These goals and objectives are developed to improve the health and safety of the Fort Campbell urban forest. With the dedication of the Directorate of Public Works and Fort Campbell Family Housing, the post can have a beautiful urban forest while supporting the mission of the Department of Defense and providing for the safety, health and education of the community.

Glossary

Best Management Practices:	Best-available industry recognized course of action, in consideration of the benefits and limitations, based on scientific research and current knowledge.
Branch Collar:	Area where a branch joins another branch or trunk that is created by the overlapping vascular tissues from the branch and the trunk. The base of the branch is typically enlarged.
Callus:	Differentiated tissue formed by the cambium, usually as the result of wounding.
Cambium Layer:	A thin layer of living, meristematic cells between the wood that gives rise (inward) to the xylem and (outward) to the phloem of a tree.
Closure:	Refers to the roll of the callus growth around the wound area.
Crown Cleaning:	Crown Cleaning is the selective removal of dead, diseased, detached, and broken branches. This type of pruning is done to reduce the risk of branches falling from the tree and to reduce the movement of decay, insects, and disease from dead or dying branches to the rest of the tree.
Crown Length:	On a standing tree the vertical distance from the leader to the base of the crown, measured to the lowest live branch excluding any epicormics branches.
Crown Raising/ Lifting:	Crown raising or lifting is the selective removal of lower branches to provide vertical clearance. Shortens or removes branches of a tree to provide clearance for buildings, signs, vehicles, pedestrians and vistas. Live crown ratio should be no less than 66 percent when raising/lifting is completed. Structural pruning should be considered when raising the canopy.
Crown Thinning:	Crown thinning is the selective removal of small live branches to reduce crown density. Because majority of the branches are at the outside edge of the crown, thinning is focused in that area. Proper thinning retains the crowns shape and should provide an even distribution of foliage throughout the crown. Thinning increases sunlight penetration and air movement through the crown. Thinning can also remove suckers from the base of the tree and some watersprouts on the interior.
Cultural Practices:	Refers to those maintenance practices that evolve use of plant selection, proper planting, placement, and pruning.

(The) Cut:	The exposed wood area that remains after the branch has been removed.
Cut Back:	Specified reduction of the overall size of the tree or individual branches, but may include the overall reduction of the sides as well as the top of the tree.
Declining Tree:	A tree in a poor state of health due to many combinations of problems. Problems may include old age, poor growing conditions, insect infestation, decay, root rot, mechanical damage, vandalism, drought or cultural practices.
Diameter at Breast (DBH):	Measurement standard for trees taken at four and a half feet (4 ½') height from finish grade.
Dormancy:	Period of naturally reduced physiological activity in the organs of a plant with the potential for reactivation of growth.
Drought Conditions:	A significant deficit in moisture availability due to lower than normal rainfall.
Field Capacity:	Soil water content resulting after the free water has been allowed to drain from a saturated soil for 1-2 days; expressed as a percentage on a dry-weight basis.
Free Water:	Water which moves into, through, or out of soil pores.
Geographic Information System:	An organized collection of computer hardware, software, geographic, and descriptive data, personnel, knowledge, and procedures designed to efficiently capture, store, update, manipulate, analyze, report, and display the forms of geographically referenced information and descriptive information.
Girdling roots:	Located above or below finished grade, whose circular growth around the base of the trunk or over the individual roots applies pressure to the bark area, there by choking or restricting the flow of sap.
Global Positioning:	A commonly hand held, satellite-based navigational device that records x, y, z coordinates and other data allowing users to determine their location on the surface coordinates and other data allowing users to determine their location on the surface of the earth.
Hardscape:	Paved area surrounding a tree and/or adjacent to a tree such as a sidewalk, street, curb, gutter, driveway, planter wall, retaining wall, walkway etc.

Hazard Assessment:	Identifying the risks associated with the trees involving the following: 1) a tree with a potential to fail, 2) an environment that may contribute to the failure, and 3) a target that may be damaged (i.e., person or property), recorded on a form for corrective action and priority determination.
Hazard Tree:	A tree (or part of a tree) that has a high potential for failure and hitting a nearby target because of dead or dying foliage, branches, roots or trunk.
Improved grounds:	Grounds on which intensive maintenance activates must be planned and preformed annually. Activities include mowing, irrigation, aeration, spraying, pruning, trimming, weeding, erosion control, drainage, and planting for landscape effects.
Live Crown Ratio:	The ratio of crown length to total tree height.
Landscape Value:	The calculated appraised value of a tree based on the cost of replacing the tree in the landscape. The Trunk Formula Method used to calculate the value can be found in the book Guide for Plant Appraisal, 9th Edition, published by the International Society of Arboriculture, Champaign, Illinois.
Lion Tailing:	The removal of all inner foliage from a particular branch displacing the weight to the end of the branch giving the appearance of a lion's tail.
Lifting:	The removal of lower branches for under-clearance.
Nuisance Tree:	A tree with the characteristics that include but are not limited to: a. Capability of damaging surrounding hardscapes to the point the costs associated with maintaining the tree exceeds its value. b. Produces excessive litter and creates an annoyance to pedestrian traffic. c. Reproduces itself excessively thus be coming weed like.
Parent Stem:	The main trunk system of the tree.
Precut/Precutting:	The removal of the branch at least 6" beyond the finished cut, to prevent splitting into the stem or branch.
Pruning:	The removal of dead, dying, disease, live interfering, objectionable and weak branches in a scientific manner.
Pruning Standards:	Pruning Standards which have been developed by American National Standards Institutes and have been adopted by the International Society of Arboriculture (ISA) and/or the Tree Care Industry Association (TCIA).

Tree Risk Zone:	An area occupied by mature trees that is defined by the amount of pedestrian traffic, permanent structures, and tree species resistance to decay. Referred to as defective tree risk zone.
Sap Flow:	The definite course assumed by sap in its movement through a tree.
Saprophyte:	An organism that obtains its nutrition from dead organic matter.
Scars and Injuries:	Natural or man made lesions of the bark in which wood is exposed.
Semi-improved Grounds:	Areas with periodic recurring grounds maintenance is preformed but to a lesser degree than on improved grounds. Practices normally include such cyclic variables as soil sterilization, weed, and brush control, drainage maintenance, mowing for fire protection and major land repair/restoration/rehabilitation as a result of mission activities.
Soil Bulk Density:	The mass of oven dried soil per unit bulk volume including the air space. The bulk volume is determined before drying to a constant weight at 105 degrees Celsius.
Street Trees:	Trees planted or to be planted in various parkways, along City streets, roads, boulevards.
Suckers:	Abnormal growth of small branches usually not following the (epicormic growth) general pattern of the tree.
Thinning Out:	The removal of live branches to reduce wind resistance and to create more space within the crown.
Topping:	Same as cut back.
Tracing:	Careful cutting of the bark along the lines of sap flow to encourage closure and to block the outline of the wound area.
Tree or Trees:	Trees, plants, or shrubs, shall mean woody perennial plants which usually have (but not limited to) a single dominate trunk and a mature height of fifteen (15) feet or more, or a trunk diameter of four (4) inches or more measured at twenty four (24) inches above grade.
Tree Space:	A growing spot with enough room to allow mature root growth and normal crown growth.
Trimming:	Same as pruning.

Unimproved Grounds:	Acreages not classified as improved or semi-improved grounds. Practices and intervals of attention are generally unpredictable such as evolve from flood, fire, insects, or disease epidemics.
Volunteer Tree:	A tree that is growing in a site that it was not intended. Most volunteer trees are products of wind, wildlife, or bird dispersal.
Wildland – Urban Interface:	The fringe area where homes and businesses intermingle with forests or wild lands.
Wilting Point:	The minimum soil moisture at which a plant wilts and can no longer recover its turgidity when placed in a saturated atmosphere for 12 hours.

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Appendix A

Improved and Semi-improved Area Tree List
Unimproved Area Tree List
Unimproved Areas Tree Shade Tolerance List

Improved and Semi – improved areas
Tree List

Common Name	Scientific Species	Common Name	Scientific Name
Balsam Fir	*Abies balsamea*	Flowering Dogwood	*Cornus florida*
White Fir	*Abies concolor*	Kousa Dogwood	*Cornus kousa*
Fraser Fir	*Abies fraseri*	Corneliancherry Dogwwood	*Cornus mas*
Amur Maple	*Acer ginnela*	European Filbert	*Corylus avellana*
Boxelder	*Acer negundo*	Common Smoketree	*Cotinus coggygria*
Black Maple	*Acer nigra*	Cockspur Hawthorn	*Crataegus crusgalli*
Japanese Maple	*Acer palmatum*	Washington Hawthorn	*Crataegus phaenopyrum*
Norway Maple	*Acer plantanodies*	Japanese Cedar	*Cryptomeria japonica*
Sycamore Maple	*Acer pseudoplantanus*	Leyland Cypress	*Cupressocyparis leylandii*
Red Maple	*Acer rubrum*	Common Persimmon	*Diospyros virginiana*
Silver Maple	*Acer saccharinum*	Euonymus ssp.	*Euonymus ssp.*
Sugar Maple	*Acer saccharum*	American Beech	*Fagus grandifolia*
Yellow Buckeye	*Aesculus flava*	European Beech	*Fagus sylvatica*
Tree – of - Heaven	*Ailanthus altissima*	White Ash	*Fraxinus americana*
Mimosa	*Albizia julibrissin*	European Ash	*Fraxinus excelsior*
Common Alder	*Alnus glutinosa*	Green Ash	*Fraxinus pennsylvanica*
Serviceberry ssp.	*Amelanchier ssp.*	Ginkgo	*Ginkgo biloba*
Common Pawpaw	*Asimina triloba*	Honeylocust	*Gleditsia triacanthos*
Sweet Birch	*Betula lenta*	Thornless Honeylocust	*Gleditsia triacanthos inermis*
River Birch	*Betula nigra*	Kentucky Coffeetree	*Gymnocladus dioicus*
Paper Birch	*Betula papyrifera*	English Holly	*Ilex aquifolium*
European White Birch	*Betula pendula*	Foster's Holly	*Ilex attenuata fosteri*
Gray Birch	*Betula populifolia*	Chinese Holly	*Ilex cornuta*
Bog Birch	*Betula pumila*	American Holly	*Ilex opaca*
Paper Mulberry	*Broussonetia papyrifera*	Black Walnut	*Juglans nigra*
American Hornbeam	*Carpinus caroliniana*	Western Juniper	*Juniperus occidentalis*
Bitternut Hickory	*Caraya cordiformis*	Rocky Mountain Juniper	*Juniperus scopulorum*
Pignut Hickory	*Caraya glabra*	Eastern Redcedar	*Juniperus virginiana*
Shellbark Hickory	*Carya liciniosa*	Goldenraintree	*Koelreuteria paniculata*
Shagbark Hickory	*Craya ovate*	Common Crapemyrtle	*Lagerstroemia indica*
Mockernut Hickory	*Carya tomentosa*	American Sweetgum	*Liquidambar styraciflua*
Pecan	*Carya illinoinensis*	Tuliptree	*Liriodendron tulipifera*
Chinese Chestnut	*Castanea mollissima*	Osage-orange	*Maclura pomifera*
Northern Catalpa	*Catalpa speciosa*	Southern Magnolia	*Magnolia garndifolia*
Atlas Cedar	*Cedrus atlantica*	Lily Magnolia	*Magnolia liliiflora*
Deoder Cedar	*Cedrus deodara*	Star Magnolia	*Magnolia stellata*
Common Hackberry	*Celtis occidentalis*	Sweetbay Magnolia	*Magnolia virginiana*
Katsuratree	*Cercidiphyllum japonicum*	Saucer Magnolia	*Magnolia x soulangiana*
Eastern Redbud	*Cercis Canadensis*	Common Apple	*Malus pumila*
Sawara Falsecypress	*Chamaecyparis pisifera*	Flowering Crabapple	*Malus spp.*

Improved and Semi – improved areas
Tree List

(Species list continued)

Common Name	Scientific Name	Common Name	Scientific Name
White Mulberry	*Morus alba*	Southern Red Oak	*Quercus falcata*
Red Mulberry	*Morus rubra*	Laurel Oak	*Quercus hemisphaerica*
Black Tupelo / Blackgum	*Nyssa sylvatica*	Shingle Oak	*Quercus imbricaria*
American Hophornbeam	*Ostrya virginiana*	Bur Oak	*Quercus macrocarpa*
Sourwood	*Oxydendrum arboreum*	Chinkapin Oak	*Quercus muehlenbergii*
Royal Paulownia	*Paulownia tomentosa*	Water Oak	*Quercus nigra*
Amur Corktree	*Phellodendron amurense*	Cherrybark Oak	*Quercus pagoda*
Norway Spruce	*Picea abies*	Pin Oak	*Quercus palustris*
White Spruce	*Picea glauca*	Chestnut Oak	*Quercus prinus*
Serbian Spruce	*Picea omorika*	Willow Oak	*Quercus phellos*
Oriental Spruce	*Picea orientalis*	English Oak	*Quercus robor*
Colorado Spruce	*Picea pungens*	Northern Red Oak	*Quercus rubra*
Bristlecone Pine	*Pinus aristata*	Shumard Oak	*Quercus shumardii*
Austrian Pine	*Pinus nigra*	Post Oak	*Quercus stellata*
Scotch Pine	*Pinus sylvestris*	Black Oak	*Quercus velutina*
Eastern White pine	*Pinus strobes*	Carolina Buckthorn	*Rhamnus caroliniana*
Loblolly Pine	*Pinus taeda*	Common Buckthorn	*Rhqmnus cathartica*
Virginia Pine	*Pinus virginiana*	Smooth Sumac	*Rhus glabra*
American Sycamore	*Platanus occidentalis*	Black Locust	*Robinia pseudoacacia*
White Poplar	*Populus alba*	Weeping Willow	*Salix alba 'Tristis'*
Eastern Cottonwood	*Populus deltoides*	Hankow Willow	*Salix matsudana*
Black Cottonwood	*Populus nigra*	Black Willow	*Salix nigra*
American Plum	*Prunus americana*	Sassafras	*Sassafras albidum*
Sweet Cherry	*Prunus avium*	Japanese Pagodatree	*Sophora japonica*
Cherry Plum	*Prunus cerasifiera*	Common Baldcypress	*Taxodium distichum*
Pin Cherry	*Prunus pensylvanica*	Japanese Yew	*Taxus cuspidata*
Common Peach	*Prunus persica*	Eastern Arborvitae	*Thuja occidentalis*
Black Cherry	*Prunus serotina*	Oriental Arborvitae	*Thuja orientalis*
Japanese Flowering Cherry	*Prunus serrulata*	Western Arborvitae	*Thuja plicata*
Higan Cherry	*Prunus subhirtella*	American Linden	*Tilia americana*
Yoshino Cherry	*Prunus x yedoensis*	Littleleaf Linden	*Tilia cordata*
Douglas-fir	*Pseudotsuga menziesii*	Silver Linden	*Tillia tomentosa*
Callery Pear	*Pyrus calleryana*	Eastern Hemlock	*Tsuga canadensis*
Common Pear	*Pyrus communis*	Western Hemlock	*Tsuga caroliniana*
Sawtooth Oak	*Quercus acutissima*	Winged Elm	*Ulmus alata*
White Oak	*Quercus alba*	American Elm	*Ulmus americana*
Swamp White Oak	*Quercus bicolor*	Lacebark Elm	*Ulmus parvifloia*
Scarlet Oak	*Quercus coccinea*	Siberian Elm	*Ulmus pumila*
		Slippery Elm	*Ulmus rubra*

Unimproved Area Tree List

Common Name	Scientific Name	Common Name	Scientific Name
Red Maple	*Acer rubrum*	Blackgum	*Nyssa sylvatica*
Boxelder	*Acer negundo*	Hophornbeam	*Ostrya virginiana*
Silver maple	*Acer saccharinum*	Sourwood	*Oxydendrum arboreum*
Sugar maple	*Acer saccharum*	Shortleaf pine	*Pinus echinata*
Tree-of-heaven	*Ailanthus altissima*	Loblolly pine	*Pinus taeda*
Mockernut hickory	*Carya tomentosa*	Sycamore spp.	*Platanus spp.*
Pignut hickory	*Carya glabra*	Eastern Cottonwood	*Populus deltoides*
Pecan	*Carya illinoinensis*	Black cherry	*Prunus serotina*
Common Hackberry	*Celtis occidentalis*	White Oak	*Quercus alba*
Eastern Red Bud	*Cercis canadensis*	Scarlet Oak	*Quercus coccinea*
Flowering dogwood	*Cornus floidia*	Southern Red Oak	*Quercus falcata*
Common persimmon	*Diospyros virginiana*	Cherrybark Oak	*Quercus pagoda*
American Beach	*Fagus grandifolia*	Pin Oak	*Quercus palustris*
Ash	*Fraxinus spp.*	Chestnut Oak	*Quercus prinus*
Honeylocust	*Gleditsia triacanthos*	Post Oak	*Quercus stellata*
Black walnut	*Juglans nigra*	Northern Red Oak	*Quercus rubra*
Eastern Redceadar	*Juniperus virgianiana*	Black Oak	*Quercus velutina*
Sweetgum	*Liquidambar styraciflua*	Black Locust	*Robinia pseudoacacia*
Tuliptree	*Liriodendron tulipifera*	Sassafras	*Sassafras albidum*
Osage orange	*Maclura pomifera*	American Elm	*Ulmus americana*
Red mulberry	*Morus rubra*	Slippery Elm	*Ulmus rubra*

Unimproved Areas Tree Shade Tolerance List

Common Name	Scientific Name	Shade Tolerance	Common Name	Scientific Name	Shade Tolerance
Red Maple	*Acer Rubrum*	intermediate	Hophornbeam	*Ostrya virginiana*	tolerant
Boxelder	*Acer negundo*	intolerant	Sourwood	*Oxydendrum arboretum*	intermediate
Sugar maple	*Acer saccharum*	tolerant	Shortleaf pine	*Pinus echinata*	intermediate
Silver maple	*Acer saccharinum*	intermediate	Loblolly pine	*Pinus taeda*	tolerant
Tree-of-heaven	*Ailanthus altissima*	intermediate	Sycamore spp.	*Platanus spp.*	tolerant
Mockernut hickory	*Carya tomentosa*	intermediate	Eastern Cottonwood	*Populus deltoides*	intermediate
Pignut hickory	*Carya glabra*	very intolerant	Black cherry	*Prunus serotina*	tolerant
Pecan	*Carya illinoinensis*	intolerant	White Oak	*Quercus alba*	intermediate
Common Hackberry	*Celtis occidentalis*	intermediate	Scarlet Oak	*Quercus coccinea*	intolerant
Eastern Red Bud	*Cercis canadensis*	tolerant	Southern Red Oak	*Quercus falcata*	intermediate
Flowering dogwood	*Cornus florida*	tolerant	Shingle Oak	*Quercus imbricaria*	intolerant
Common persimmon	*Diospyros virginiana*	intermediate	Chinkapin Oak	*Quercus muehlenbergii*	intolerant
American Beach	*Fagus grandifolia*	tolerant	Cherrybark Oak	*Quercus pagoda*	tolerant
Ash	*Fraxinus spp.*	intermediate	Pin Oak	*Quercus palustris*	intolerant
Honeylocust	*Gleditsia triacanthos*	intolerant	Chestnut Oak	*Quercus prinus*	intermediate
Black walnut	*Juglans nigra*	intermediate	Northern Red Oak	*Quercus rubra*	intermediate
Eastern Redceadar	*Juniperus virginiana*	intermediate	Post Oak	*Quercus stellata*	intermediate
Sweetgum	*Liquidambar styraciflua*	intolerant	Black Oak	*Quercus velutina*	intermediate
Tuliptree	*Liriodendron tulipiferia*	intolerant	Black Locust	*Robinia pseudoacacia*	intolerant
Osage orange	*Maclura pomifera*	tolerant	Sassafras	*Sassafras albidum*	intermediate
Red mulberry	*Morus rubra*	intermediate	American Elm	*Ulmus americana*	intermediate
Blackgum	*Nyssa sylvatica*	tolerant	Slippery Elm	*Ulmus rubra*	tolerant

Shade Tolerance Definitions

Shade tolerance – The relative capacity of a plant to become established and grow in the shade of over topping vegetation. The terms below are used to express the relative shade tolerance.

Shade tolerant – Trees in this category require 3 to 10% full light or a closed canopy with some gaps in order to survive.

Intermediate tolerant – Trees in this category require 10 to 30% of full sun. Woodland edge trees are often in this category.

Shade intolerant – These trees require 30 to 60% of full sun to develop properly. Pioneer invader trees are often in this category.

Very shade intolerant – Very intolerant trees require at least 60% of full sun to survive and grow.

Appendix B

Bird and Mammal Species Found in the Cantonment Area

Bird Species Identified in Fort Campbell's Cantonment Area

Family	**Common Name**	**Scientific Name**
Blackbirds, Orioles, and Grackles, etc.	Red-winged blackbird	*Agelaius phoeniceus*
Cardinals, Grosbeaks, and Allies	Northern cardinals	*Cardinalis cardinalis*
Cranes	Sandhill crane	*Grus canadensis*
American Crow	American crows	*Corvus brachyrhynchos*
Ducks, Geese and Swans	Wood duck	*Aix sponsa*
Ducks, Geese and Swans	Canada goose	*Branta canadensis*
Falcons and Caracaras	American kestrel	*Falsco sparverius*
Finches, Siskins, and Crossbills	American goldfinch	*Carduelis tristis*
Finches, Siskins, and Crossbills	Pine siskin	*Carduelis pinus*
Grebes	Pied-billed grebe	*Podilymbus podiceps*
Hawks, Eagles, and Kites	Northern harrier	*Circus cyaneus*
Hawks, Eagles and Kites	Red – tailed hawk	*Bueto jamaicensis*
Hawks, Eagles and Kites	Copper's hawk	*Accipiter cooperii*
Hawks, Eagles and Kites	Red – shouldered hawk	*Buteo lineatus*
Hawks, Eagles and Kites	Bald eagle	*Haliaeetus leucocephalus*
Herons, Egrets, and bitterns	Great blue heron	*Ardea herodias*
Herons, Egrets, and bitterns	Green heron	*Butorides virescens*
Herons, Egrets, and bitterns	Cattle egret	*Bubulcus ibis*
Larks	Horned lark	*Eremophila alpestris*
Loons	Common loon	*Gavia immer*
Mockingbirds and Thrashers	Northern Mockingbird	*Mimus polyglottos*
New World Vultures	Turkey vulture	*Cathartes aura*
Nuthatches	Red – breasted Nuthatch	*Sitta canadensis*
Owls	Great horned owl	*Bubo virginianus*
Pigeons and Doves	Rock dove	*Columba livia*
Pigeons and Doves	Morning dove	*Zenaida macroura*
Plovers and Lapwings	Killerdeer	*Charadrius vociferus*
Rails, Gallinules, and Coots	American coot	*Fulica americana*
Sandpipers and Phalaropes	Common snipe	*Gallinago gallinago*
Sparrows, Towhees, and Juncos	Chipping sparrow	*Spizella arborea*
Starling	European Starling	*Strunus vulgaris*
Swallows	Northern rough – winged swallow	*Stelgidopteryx serripennis*
Swallows	Purple martin	*Progne subis*
Swifts	Chimney swift	*Chaetura pelagica*
Thrushes	Eastern bluebird	*Sialia sialis*

Bird Species Identified in Fort Campbell's Cantonment Area

Species list continued

Family	Common Name	Scientific Name
Thrushes	American robin	*Turdus migratorius*
Turkeys	Eastern wild turkey	*Meleagris gallopavo*
Tyrant Flycatchers	Eastern kingbird	*Tyrannus tyrannus*
Vireo	Warbling vireo	*Vireo gilvus*
Wood Warbler	Pine warbler	*Dendroica pinus*
Woodpeckers	Red – headed woodpecker	*Melanerpes erythrocephalus*
Wrens	House wren	*Troglodytes aedon*

Mammal Species Identified in Fort Campbell's Cantonment Area

Scientific Name	Common Name
CANIDAE	**DOGS and Allies**
Canis latrans	coyote
Urocyon cinereoargenteus	gray fox
Vulpes vulpes	red fox
CASTORIDAE	**BEAVERS**
Castor canadensis	beaver
CERVDAE	**DEER, ELK AND MOOSE**
Odocoileus virginianus	white-tailed deer
DIDELPHIDAE	**OPOSSUMS**
Didelphis marsupialis	opossum
FELIDAE	**CATS**
Lynx rufus	bobcats
LEPORIDAE	**RABBITS AND HARES**
Sylvilagus floridanus	eastern cottontail rabbit
MEPHITIDAE	**SKUNKS**
Mephitis mephitis	striped skunk
MURIDAE	**RATS AND MICE**
Peromyscus maniculatus	deer mouse
Reithrodontomys humulis	eastern harvest mouse
Orchrotomys nuttalli	golden mouse
Mus musculus	house mouse
Zapus hudsonius	meadow jumping mouse
Ondatra zibethicus	muskrat
Microtus pinetorum	pine vole
Oryzomys palustris	rice rat
Synaptomys cooperi	southern bog lemming
Peromyscus leucopus	white-footed mouse
MUSTELIDAE	**WEASLES AND ALLIES**
Lutra canadensis	river otter
PROCAYONIDAE	**RACCOONS**
Procyon lotor	raccoon
SCIURIDAE	**SQUIRRELS**
Tamias striatus	eastern chipmunk
Sciurus niger	fox squirrel
Sciurus carolinensis	gray squirrel
Marmota monax	groundhog
Glaucomys volans	southern flying squirrel

Mammal Species Identified in Fort Campbell's Cantonment Area

Species list continued

Common Name	Scientific Name
SORICIADAE	**SHEWS**
Sorex cinereus	masked shrew
Sorex hoyi	pygmy shrew
Blarina brevicauda	short-tail shrew
Sorex longirostris	southeastern shrew
TALPIDAE	**MOLES**
Scalopus aquaticus	eastern mole
VESPERTILIONIDAE	**MOUSE-EARED BATS**
Eptesicus fuscus	big brown bat
Pipistellus subflavus	eastern pipistrelle bat
Nycticeius humeralis	evening bat
Myotis grisescens	gray bat
Lasiurus cinereus	hoary bat
Myotis sodalis	Indiana bat
Myotis lucifugus	little brown bat
Lasiurus borealis	red bat
Lasiurus seminolus	seminole bat
Lasionycteris noctivagans	silver-haired bat

Appendix C

Invasive Tree Species of Kentucky and Tennessee

Common Name	Scientific Name
Tree-of -heaven	Ailanthus altissima
White mulberry	Morus alba
Mimosa	Albizia julibrissin
Princess tree	Paulownia tomentosa
Paper mulberry	Broussonetia papyrifera
Chinaberry tree	Melia azedarach
Bradford pear *	Pyrus calleryana ‘Bradford’
Chinese tallowtree *	Sapium sebiferum

KENTUCKY – TENNESSEE INVASIVE TREES SPECIES

Appendix D

Photographs of the Urban Forest - Care and Concerns

Planting, Placement and Establishment

Good Planting Practices

Correct mulching is important to tree health and establishment.

Proper staking method and “water bags” help to stabilize and provide needed water to the roots.

Poor Planting Practices

Wire baskets, burlap, and twine left on the root ball can cause roots to be stunted or girdled, causing the death to the root(s) and tree.

Tree Placement

Proper Placement

Tree lined streets of Milcon Sub-division

Poor Placement

Poor placement of trees creates future maintenance problems. Large trees grow into power lines and block out street lights and stop signs. Spacing and mature tree height should be considered to prevent future damage or create liabilities

Arbor Day Plantings

2005

2006

2007

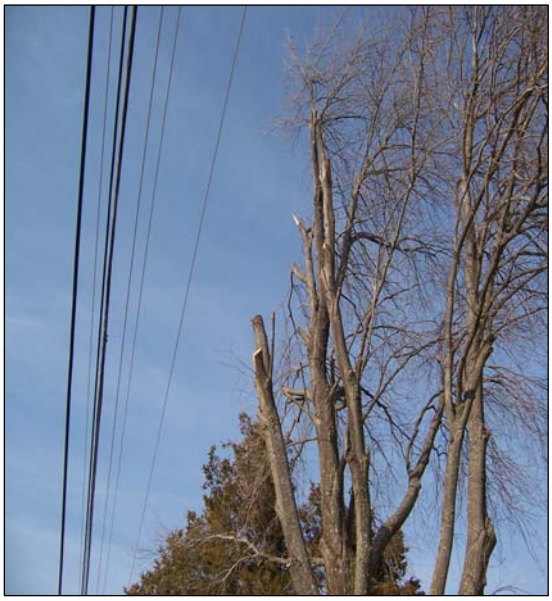
2008

Pruning and Maintenance

Proper pruning cuts allow pruning wounds to heal without scaring.

Flush cuts prevent the trees defenses from healing properly and may allow insects and diseases into the tree.

Leaving poorly pruned branches can introduce decay and weaken the tree's structure.



Improperly pruned branches near power lines make the tree look ugly
and create future management problems.

Applying best management practices would help trees and utilities co-exist.

Topping trees causes ……

1.…tree stress. 2.…new wounds allowing decay to form.
3....sunburn of tissue below the bark.
4.…branch growth to double, creating hazardous branches in storms.
5.…reduction in home and land value. 6.…the tree to look ugly!

Mechanical damage from lawn mowers and weed trimmers shorten the tree's life by girdling the trunk and allowing decay to enter the heartwood.

Storm Damage

Golf course after ice storm - Christmas 2004
Emergency Storm Response Plan will help organize clean up efforts making them cost efficient.

Barkley Elementary School after Thunderstorm
Identification and removal of hazard trees is important to preventing incidences like this.

Cole Park Elm Tree

Estimated landscape value: $13,575 before 1/23/08

Estimated landscape value: $5, 732 after storm of 1/30/08

Positive Images of Urban Forests

BCT Area

Cole Park Housing Area

Fall at Milcon Park

Gander Memorial Grove

Bastogne Avenue near Werner Park

Tree City, USA - presented Arbor Day 2006