Lake Houston Wilderness Park

August 2008

Forest and Wildlife Management Plan

EXECUTIVE SUMMARY

The Lake Houston Wilderness Park (Park) is a fascinating, unique parcel of mixed pine and hardwood forests that has been heavily influenced by human activities in the past. This forest was examined and analyzed by Advanced Ecology, Ltd (AEL) in terms of plants, soils, topography and hydrology in order to formulate a Sustainable Forest and Wildlife Management strategy that recognizes the full scope of values offered by the forest from both the ecological and human context.

The primary goal of this Plan is to improve environmental conditions in the Park that are important for public recreation and education. The strategies guiding this Plan involve the preparation of a sustainable schedule for modification of forest wildlife habitat. These activities will utilize ecologically-based management methods for selective harvesting, natural forest regeneration, and the establishment of irregularly-shaped forest openings.

This approach to habitat management is intended to emulate pre-settlement fluctuations from disruptions to periods of stability, and, thus, to encourage the natural biodiversity inherent to the Park. These habitat management activities are designed to:

- conserve the natural resources and preserve the natural aspects of the Park;
- enhance the wildlife habitat and wildlife viewing opportunities;
- increase ecosystem diversity;
- improve tree health and lessen insect and disease risks;
- assist in wildfire hazard mitigation;
- provide for forest regeneration to insure the long-term viability of the forest; and
- generate positive income streams for development and maintenance costs of the Park.

The appropriateness of this proposition to increase-diversity in the Park is based on knowledge about historical aspects of plants, animals, and the associated causes of changes in their populations and/or distributions. We are aware that since the end of the last glacial period some 10,000 years ago a

number of events, both natural and human-induced (by native people), brought episodes that prevented stagnation in plant communities and animal populations. These events, as well as the recovery from them, brought prime conditions for many habitats and many niches for a wide range of organisms.

We urge understanding that the results of natural events as well as the actions of pre-Columbian civilizations existed through time in a wide variety of situations on the land. These situations ranged from stark, denuded landscapes to the rich natural environments now envisioned as desirable. Fortunately, we now understand that, by design, we can avoid the undesirable conditions, and, through management prescriptions, can achieve the conditions envisioned as desirable in natural settings valued today by our society.

By organizing and controlling the patterns of influential events for the Park, the qualities that we value are sustained (thus, the outcome is "sustainability"). This management plan is a guide for scheduling these activities. Adaptive management is used to make adjustments and corrections as operations are conducted. Taken together, the entire process becomes a management scheme that develops and holds the qualities of the landscape characteristics that we envision as desirable and valuable.

Certainly, the management actions bring changes, but these changes occur within limits prescribed by the management plan. That is, the management plan serves as a filter that prevents the "downside" conditions while still allowing the dynamics that the land needs. This outcome, then, is why a natural resource management program is necessary. Put another way, the management plan is the road map to the where the land is progressing in the future.

AEL approaches this task with great humility. We recognize that while we have vast amounts of data and experience in managing forests, we are still human and are unable to forecast with absolute certainty the responses of dynamic ecosystems over the span of a century. It is important to formulate goals and plans to achieve them, and to start the process of moving forward. A key element will be the monitoring and modification of these plans as time and the ecosystem dictate.

While much of the information in this report contains details about specific matters, this Plan is to be considered in a strategic context. Consequently, from this Plan, periodic operational plans containing quantifiable, time-bound objectives addressing specific targets for wildlife populations or habitats can be developed for the largely forested cover types in the Park. Therefore, these operational plans should represent sequential, incremental progress toward the strategic goals for forest conditions and the wildlife habitat qualities of these conditions.

Considering that this document is a part of the Master Plan for the Park and is intended generally for the public at large, and more specifically for those with an abiding interest in this exceptional tract of land, the flora and fauna discussed will be referred to by common names only.

It is our earnest desire that the reader shall enjoy reading this document, and, perhaps, learn something new about the wonders of the natural world and the Park.

SPECIFIC RECOMMENDEND ACTIVITIES

1. Initiate Uneven-Aged forest management to enhance wildlife habitat, diversity and forest regeneration
2. Sustainable forest thinnings to improve forest health and provide Park funding
3. Establish streamside management and habitat corridor areas to provide unique habitats
4. Create undisturbed Retention Areas for educational purposes and judging habitat enhancement success
5. Thinnings to provide diverse bird habitats to enhance bird watching and neotropical migration staging
6. Target habitat enhancement thinnings to limit invasive species establishment and spread
7. Conduct vegetation management actions to control invasives and promote forest regeneration
8. Enhancement of Baldcypress Swamp habitat by additional baldcypress plantings
9. Establish educational program of signage, field tours, nature guides and viewing areas for Park visitors
10. Enhance wildfire mitigation, suppression and establish evacuation routes

FOREST ANALYSIS

FIELD DATA COLLECTION

In order to learn about the flora and fauna in the Park, it was necessary for AEL to gather information from in-the-field assessments and publicly-available reference data. AEL collected the basic information about the types of plant and animal communities, their frequency and distribution across the Park through our field visits. The man-made features of the Park such as roads, powerlines and pipelines were also observed and mapped using geographic positioning system (GPS) technology during the field data collection process. In addition, AEL researched information from various local, county, state and federal agency sources on subjects such as soils, aerial photos, topographic maps, and water feature data.

The field data was gathered on the forests of the Park during May and June, 2008. A grid pattern of 2,310 sample points were mapped across approximately 4,970 acres of forestland, so that one sample point was taken on every two acres. AEL foresters and biologists traversed the entire Park on foot, stopping at the GPS-indicated sample point locations to gather the forest data. The trees and plants that were representative on each of the two-acre sampling areas were tallied into handheld computer/ GPS devices. Once this data was assembled using computer software, we mapped out exactly where the sample points were taken in the Park, and the major plants found in each of the two-acre sample areas.

At each of the sample points the forest was evaluated at three levels: the overstory, midstory and understory. The understory is defined as the plants growing from ground level up to twelve feet in height. The midstory class represents those plants and trees that are between twelve and twenty-five feet above ground level. The overstory is the tallest trees and plants that are over twenty-five feet tall that constitute the forest canopy. Additional information regarding the presence of wildlife species and habitat was collected. Such information included physical presence, tracks, and/or vocalizations.

In each of the forest canopy classes, AEL took a representative look at the three most commonly-occurring plant species in the two-acre sampling area. The Primary species would be the tree or plant that is the most numerous in that area. If there was a second plant species that was worthy of mention, it was tallied in the Secondary class. If there were three separate plant species constituting that canopy class, then the least numerous one would be listed as Tertiary.

As an example, a common description of one of the two-acre sampling areas found on the Park was as follows:

- Overstory: Primary – Loblolly Pine , Secondary – Water Oak, Tertiary – Laurel Oak
- Midstory: Primary – Swamp Chestnut Oak , Secondary – Red Oak, Tertiary – Yaupon
- Understory: Primary - Yaupon, Secondary – American Beautyberry, Tertiary – Palmetto

Many of the areas had classifications that only listed one or two species in each canopy class. A good example of this would be the areas of almost pure loblolly pine – these have an Overstory description listing only 'Loblolly Pine' as the Primary, with no Secondary or Tertiary species being noted. Likewise, there are many areas where the midstory is so dominated by yaupon that there are no other species listed in the midstory class.

The landform of each of the two-acre sampling areas was also noted at each sample plot location. Landforms are defined by the surface characteristics of the land and their place in the landscape. They are described by physical traits such as elevation, slope and soil type. On the Park, this generally works out as being a description of the land in terms of soil drainage as it affects the makeup of the forest. AEL distinguished six different landform types on the Park:

- Flatwoods – flat to concave forested areas that have standing water during the wetter months of the year. About thirty percent of the Park is classed as being Flatwoods.
- Bottomlands – areas along streams that are subject to flooding events and have primarily hardwood (oak, elm, sweetgum) species generally associated with these floodplain areas. Only slightly more than three percent of the Park is bottomland.
- Uplands – the higher elevation, generally better-drained areas that do not commonly have standing water on them except during times of excessive rainfall. A majority of the Park, about fifty-eight percent of the total area, is upland.
- Clay Flats – areas that hold water virtually year-round to the point that no trees will grow there, forming small, round-shaped wetland prairies. Although less than one percent of the Park's acreage is Clay Flats, these spots offer unique plant ecosystems.
- Stream Terraces – the sandy ridges of old stream banks that parallel the two major stream courses. These areas, with their varied plant species, constitute around eight percent of the Park's acreage.

- Baldcypress Swamps – forested areas in low-lying sloughs, creeks and lake edges that have a significant component of baldcypress trees. As with the Clay Flats, these ecotypes offer some unique plant communities on a small percentage of the total Park property.

The two-acre sampling area was also evaluated as to its forest timber type stratum. This attribute describes the forest from the standpoint of the general composition of the dominant trees in the forest overstory. This description of the forest is important, both as a general portrayal of the type of forest, and in assisting with the inventory of merchantable forest products.

The classifications used in evaluating the forest stratum in the Park were:

- Pine – being over 75% pine
- Pine Hardwood – being at least 60% pine
- Hardwood Pine – being at least 60% hardwood
- Hardwood – being over 75% hardwood
- Bottomland Hardwood – being hardwood forest with riverine bottomland species
- Baldcypress – forests with over 60% baldcypress

Additionally, at each sampling point, AEL collected very detailed tree data on a much smaller sampling area. This data included the diameter and heights of the trees over five inches in diameter at breast height (measured four and one-half feet above ground level and commonly referred to as "DBH"). The density of the forest in terms of the area of their trunks that occupy the space in the forest was also measured. This data was collected for the purpose of formulating the long-term forest management for the Park.

AEL also gathered data on other land features such as old roads and logging railroad beds, large and/or unique trees, trails, old camphouses, heads of creeks, fences, property corners, etc.

GEOGRAPHIC DATA SOURCES

To assist in affording a more complete understanding of the forest on the Park, additional data was collected and combined with the field-derived data. These datasets were acquired primarily through governmental agencies such as the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS), the U.S. Geological Survey (USGS), the U.S. Fish and Wildlife Service, (USFWS), the Harris County Flood Control District (HCFC), the Texas Natural Resource Information System (TNRIS), and the Houston-Galveston Area Council (HGC).

These datasets included information on:

- Soils mapping – showing the various soil types across the Park (NRCS)
- General wetlands mapping (USFWS National Wetlands Inventory)
- Topographic Mapping (maps showing the elevations of the land, USGS)
- Aerial Photographs taken at various times from 2006 back to 1995 (TNRIS, HGC)
- Hydrological data – creeks, streams, lakes, ponds (USGS)
- Line feature data – roads, powerlines, pipelines (TNRIS)
- Flood Plain Mapping (HCFC)

COMPUTERIZED DATA ANALYSIS

The next step involved utilizing the industry-standard program, *T-Cruise*, to analyze the information on the forest that AEL observed at each of the sample points. This gave AEL information as to the plant species, their relative abundance, the size and heights of the trees, and their location on the Park lands.

This data was converted into a database format, and then integrated with the geographic data using the GIS program *Arcmap 9.3*. This allows us to map out the combined data to symbolize the various attributes of the forest on paper and electronic-format maps.

SUMMARY TABLES OF FOREST DATA

The following tables detail the basic findings of the forest data gathering and analysis. These classifications of the Park's forests will be discussed in detail and shown in map form throughout the remainder of this report. Note: the GIS-calculated acres vary from the preliminary boundary information from the surveying team by three-tenths of one percent.

Figure 1 – Landform & Soil Drainage Classifications Summary

Landform	Acres	% Of Park
Upland	2,830.5	57.0%
Flatwoods	1,483.5	29.8%
Bottomland	165.9	3.3%
Stream Terrace	381.3	7.7%
Baldcypress	20.8	0.4%
Clay Flat	11.7	0.2%
Utility Right-of-Ways	76.2	1.5%
Total	4,969.9	100.0%

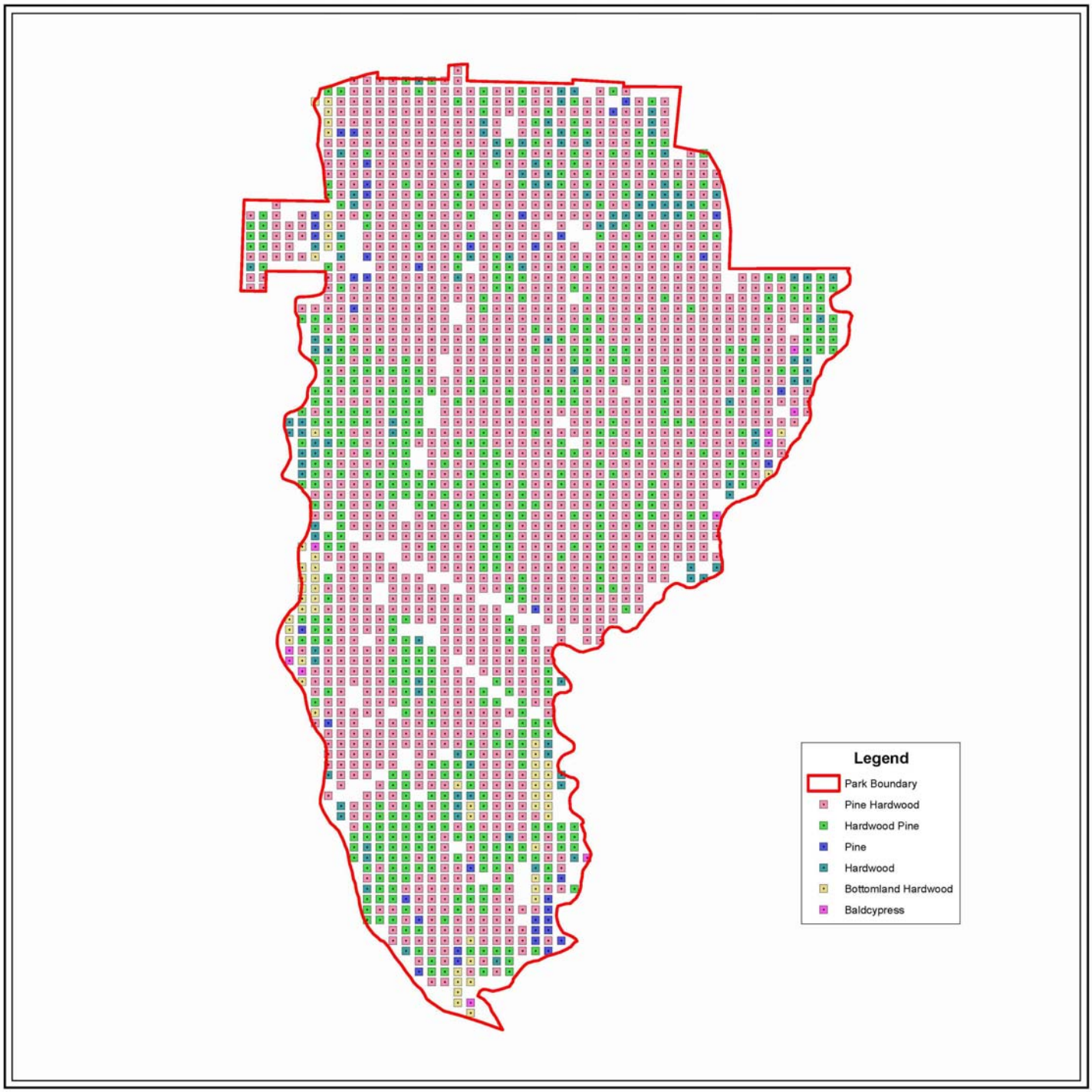
Soil Drainage Classification	Acres	% Of Park
Poorly-Drained	2,463.6	49.6%
Somewhat Poorly-Drained	1,457.6	29.3%
Well-Drained	595.1	12.0%
Stream Terrace	440.5	8.9%
Open Water	13.1	0.3%
Total	4,969.9	100.0%

FOREST DATA MAPPING

The maps in this section illustrate some of the forest data that was gathered during the field inventory work, and then combined with geospatial data in the GIS system. These maps serve to help illustrate the locations of

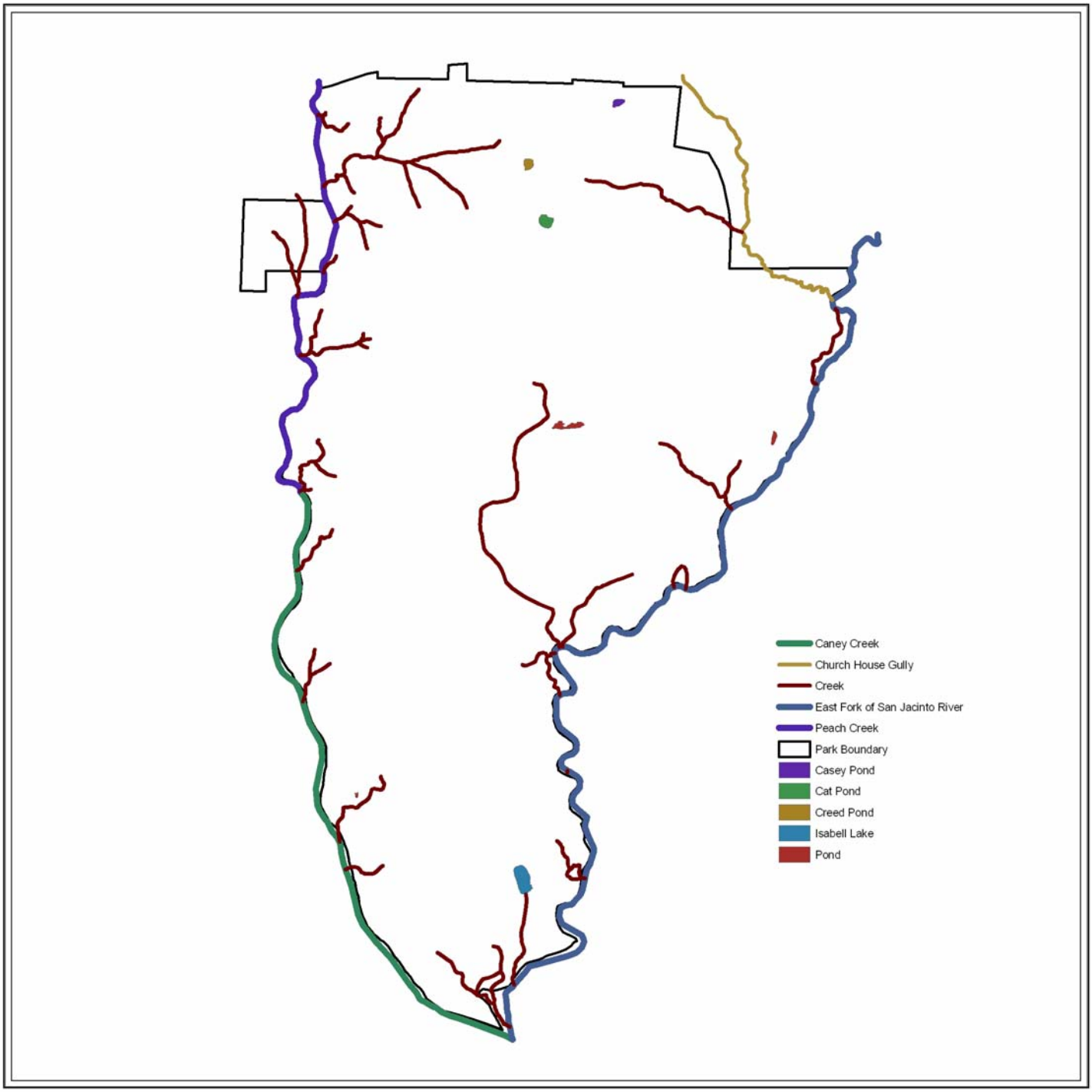
Forest Timber Type Strata Mapping

The following map shows the forest timber type at each sampling point that was measured in the field, and the corresponding stratum determined for the two-acre sampling area around that point.



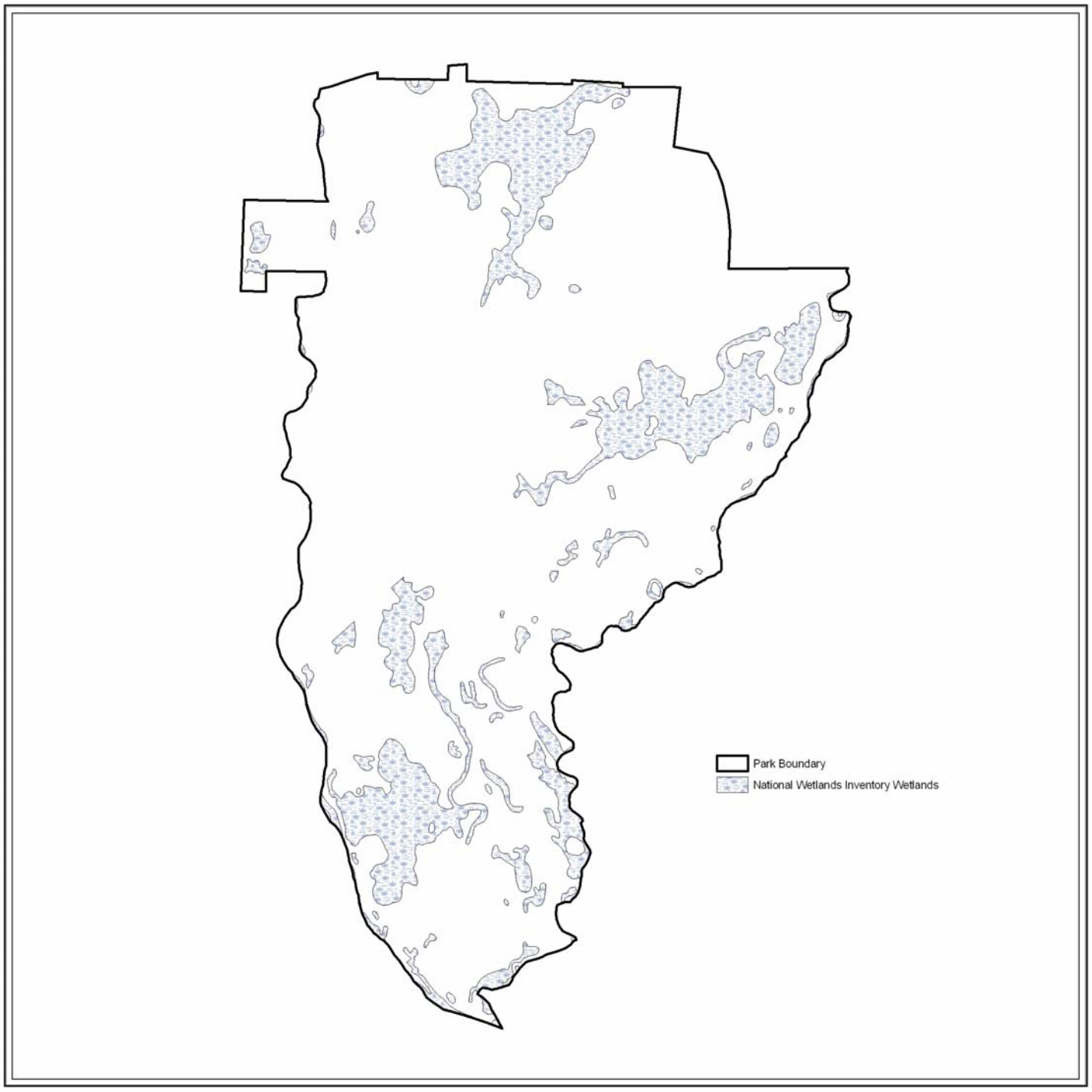
Water Features Mapping

This illustration uses both field-derived data and USGS topographic map data to show the major hydrological elements on the Park. The two major features are the East Fork of the San Jacinto River on the east boundary and the combined Peach Creek / Caney Creek system on the west boundary. The ponds and small lakes, as well as the intermediate streams, are also shown.



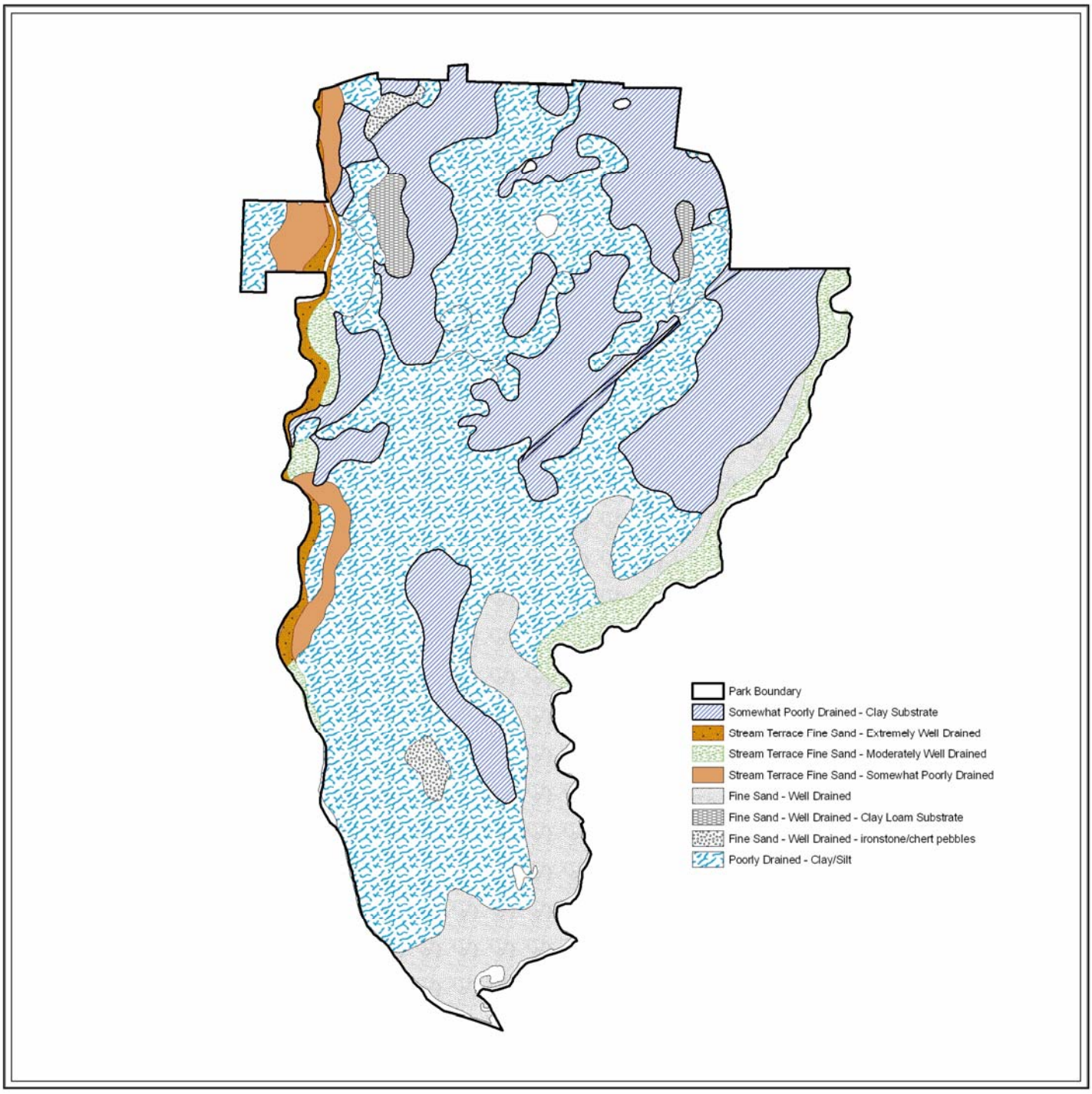
National Wetlands Inventory Mapping

This map shows areas of the Park that have generally wet forested soils, these are not necessarily jurisdictional wetlands; this mapping was used to assist in determining the poorer-drained areas of the Park, such as the Flatwoods classification.



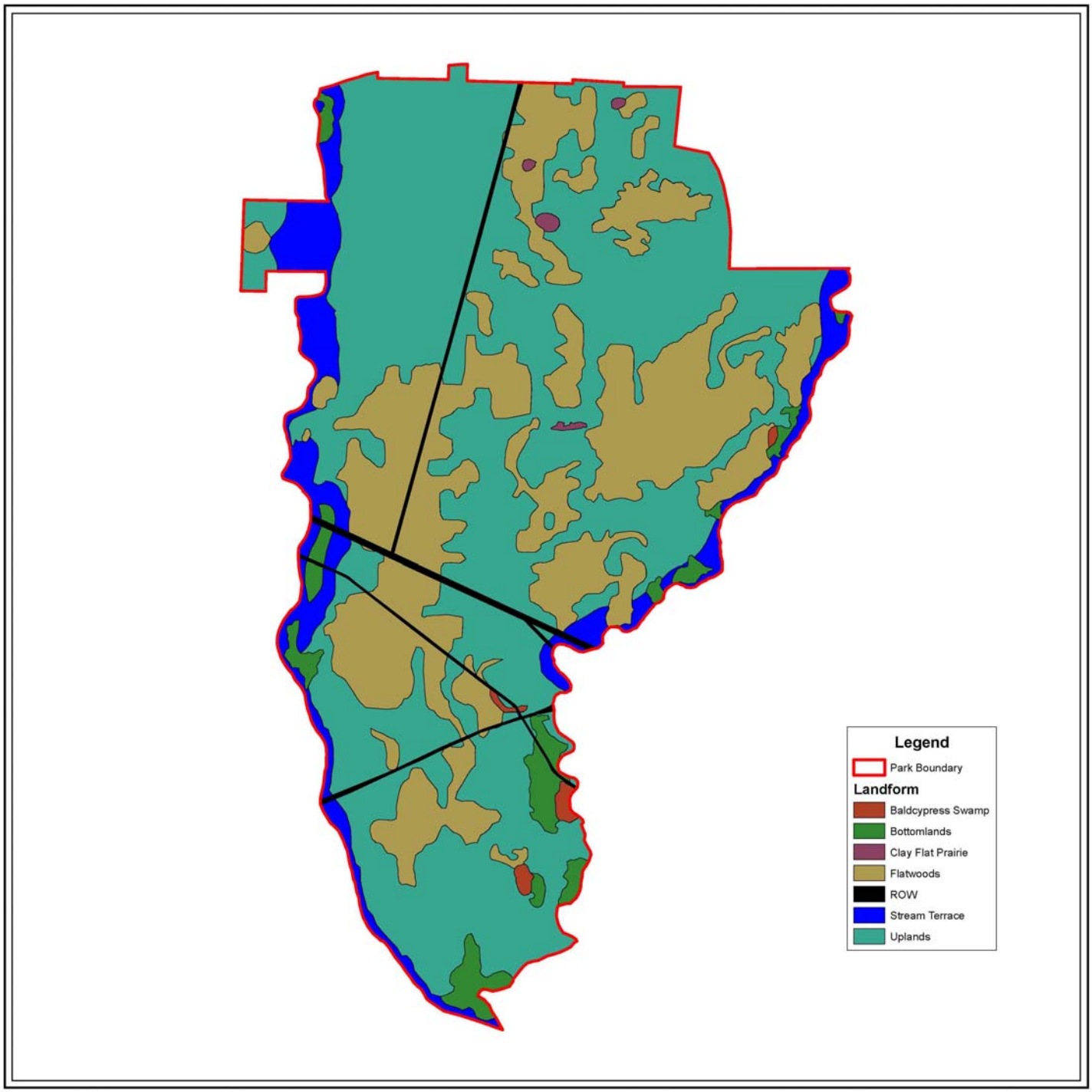
Soils Mapping

The information shown on this map was derived from the NRCS Soil Surveys for Montgomery and Harris County, Texas. AEL analyzed this data to combine areas of varying drainage and soil texture classifications. Much of the Park is made up of poorly-drained to somewhat poorly-drained soils. A complete NRCS Custom soils report has been provided in Appendix "C".



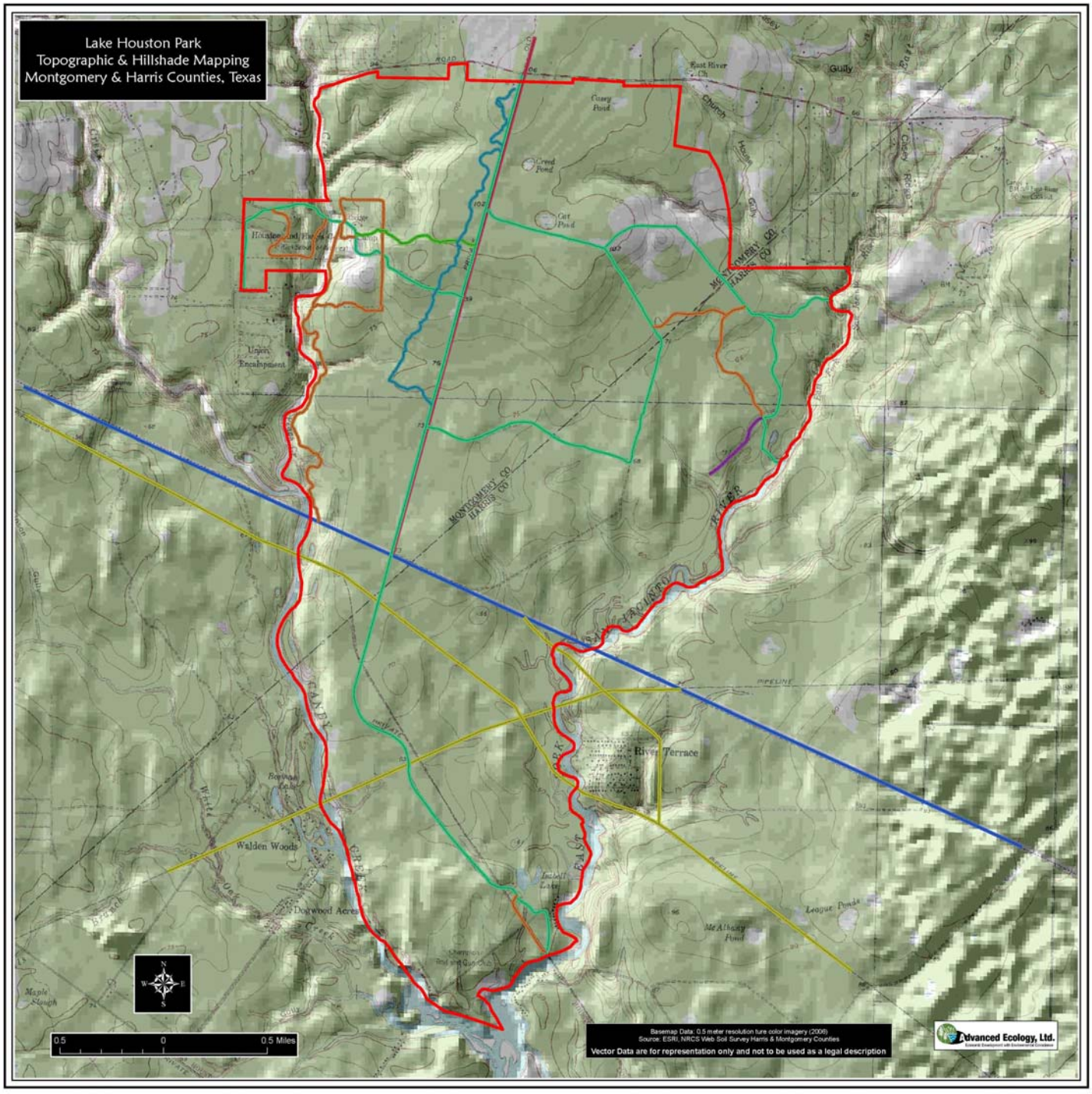
Landform Mapping

This map shows the landform that AEL described for each of the two-acre sampling areas. Note that the vast majority of the Park is Upland or Flatwoods – there are only relatively small sections of Stream Terraces and Bottomlands along the two major stream courses on each side of the Park.



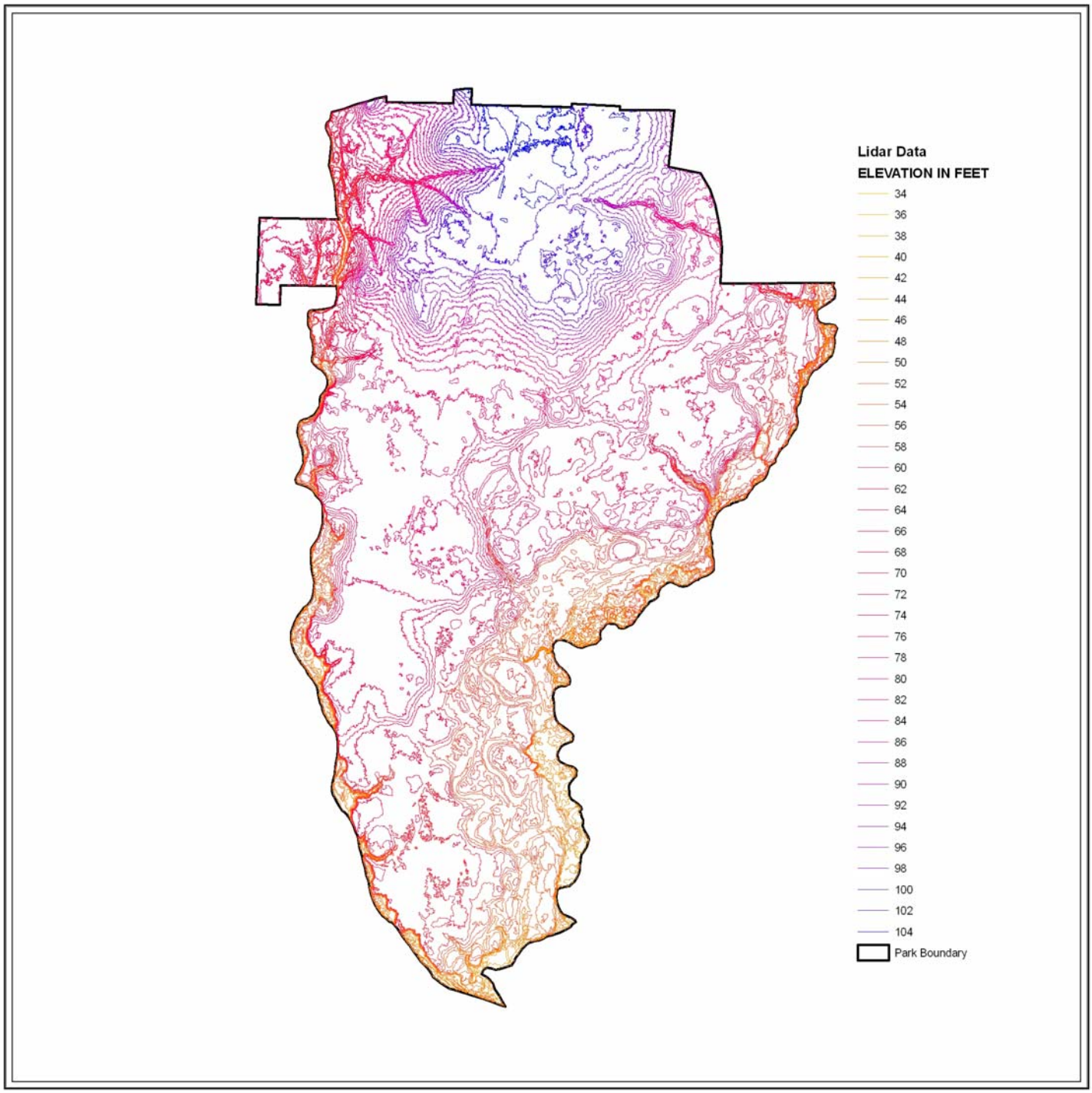
Topographic & Hillshade Mapping

The general topography of the Park is illustrated by this map, which is a combination of digital elevation model hillside-shading data and the USGS topographic maps. The Park is basically a flat ridge lying between the Peach/Caney Creek system and the East Fork of the San Jacinto River.



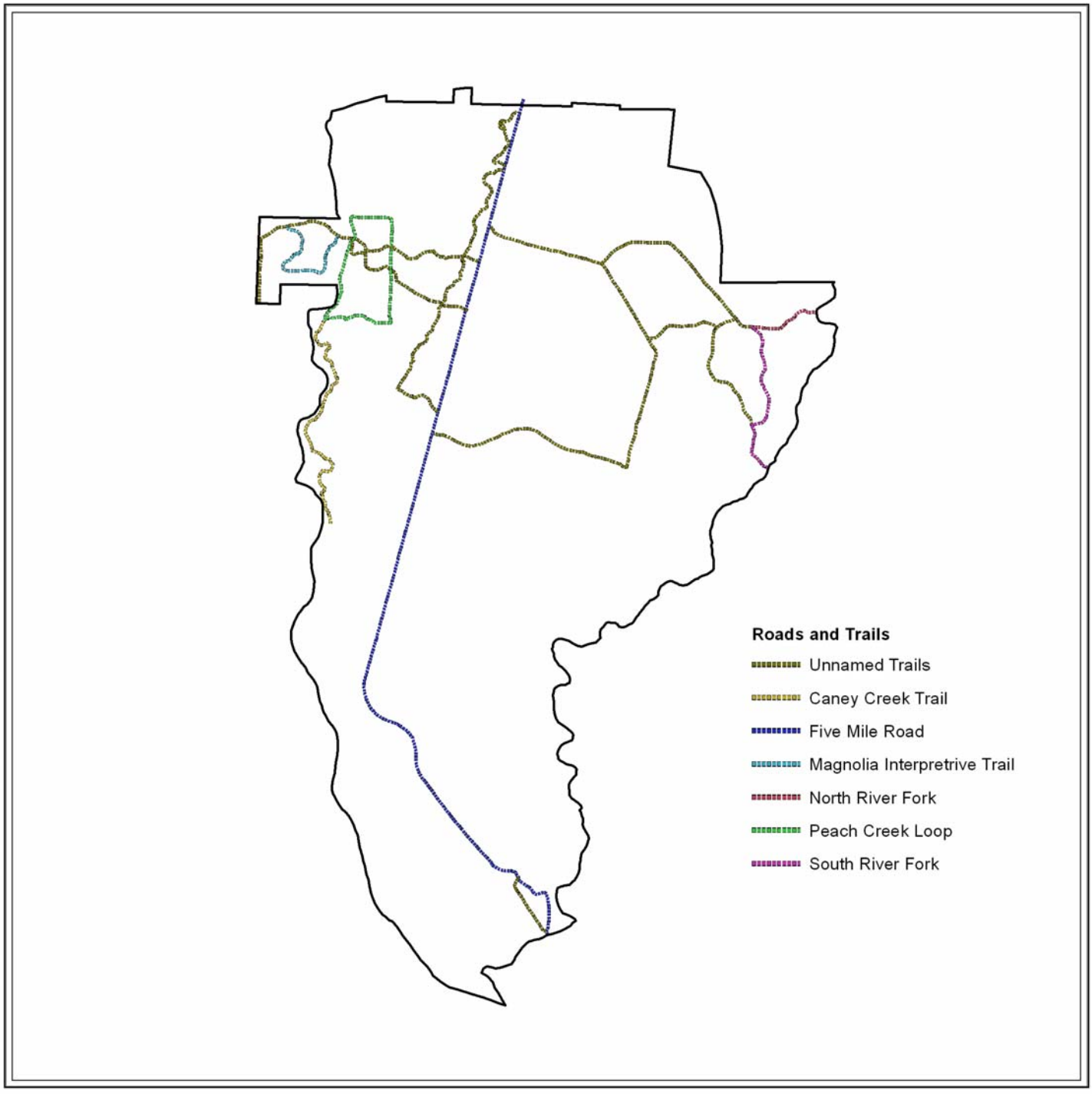
Lidar Mapping

More current topographic information was made available through lidar (Light Detection and Ranging) data. Lidar is similar to radar, but uses laser light to make determinations about land elevations. It is much more accurate than the older existing topographic data.



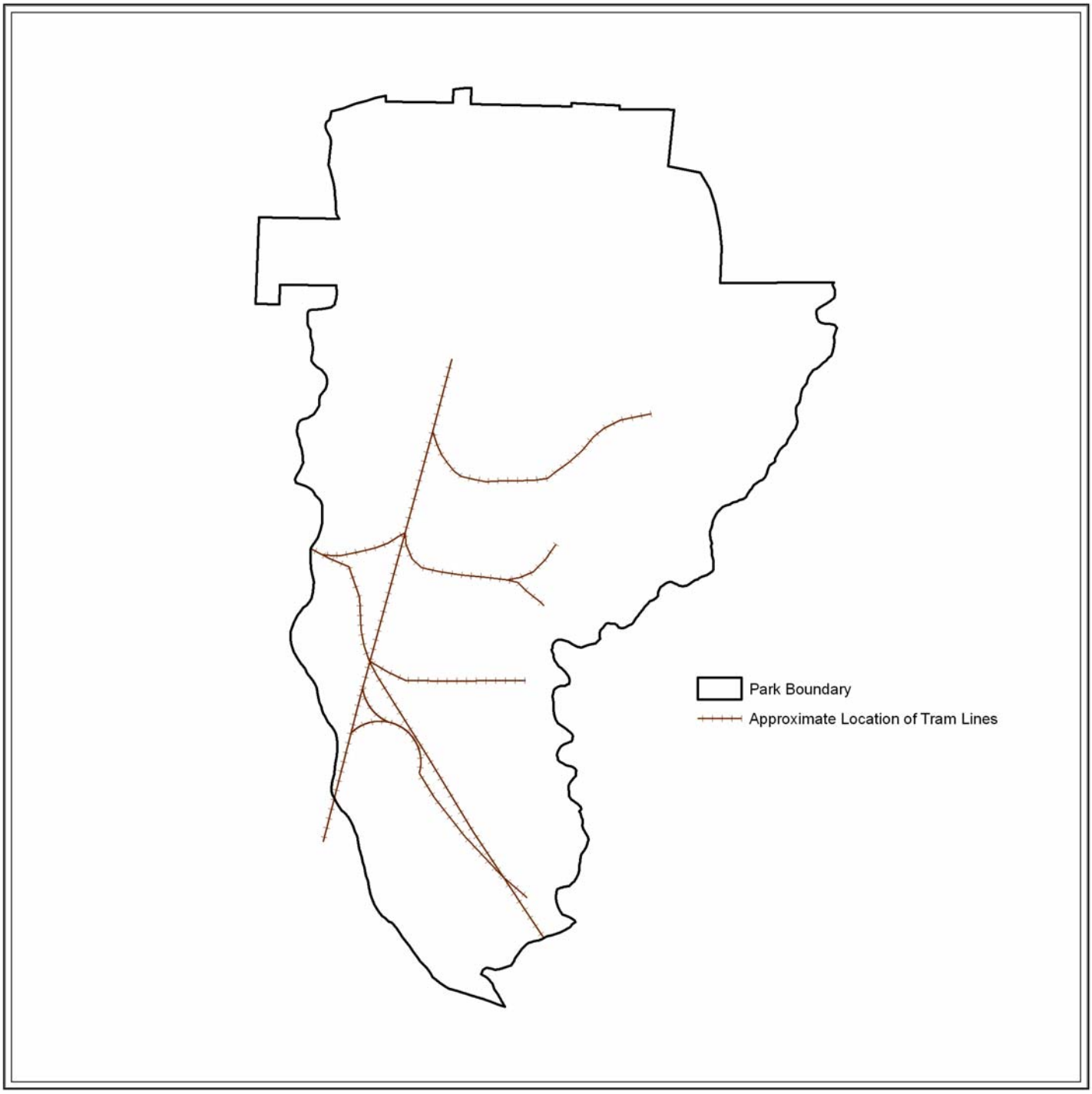
Road and Trail Mapping

This data was derived from both aerial photography and from AEL-acquired GPS data, taken by traversing all of the roads and trails on the Park with GPS equipment.



Tram Road Mapping

The history of the land occupied by the Park today includes the early logging industry. Since there were neither highways nor trucks back in the late 1800's and early 1900's, railroads were extensively used to transport logs to sawmills. The following map shows the known locations of railroad tram roadbeds on the Park. This data is a combination of a 1935 aerial photograph and the AEL field observations.



FOREST CHARACTERIZATIONS

FOREST COMMUNITIES

These descriptions of the various forest communities on the Park are intended not only to familiarize the reader with the basic plants in the forest but also to assist in an understanding of how the soils and hydrology of the Park have shaped the forest. The forest communities, which AEL foresters and biologists have described in this document, are not absolute definitions, but are our interpretations based on an extensive field assessment of the Park, combined with our experience in assessing, interpreting and managing forests across the southern United States.

These forest communities are very general descriptions of areas of forest that have similar vegetation, soils and hydrology occurring over extensive sections of the Park. These characterizations will afford a broad understanding of the forest. The details of the forest at the stand level – smaller areas of forest that are defined for the purpose of developing forest management strategies – are defined and discussed in later sections of this Plan.

The reader should keep in mind that forests are extremely dynamic systems that are shaped by land attributes, climatic influences, and any variety of disturbances to the land. They do not exist in a stable or enduring form; rather they are always in a state of change. These changes may be subtle and occur over a long period of time, or may be sudden and often catastrophic in nature. The appearance of stability in a forest community is often an illusion caused by the forest being observed in a snapshot manner, rather than being studied in a long-term historical context.

Above all we ask the reader to understand that the reasons for the variances or uniformity in a forest are based on the requirements of plants: soil (the source of nutrients), water and sunlight. The relative abundance or scarcity of these resources play a powerful role in what plants grow where, and above all, which combinations provide the ideal environment for the establishment of a given plant community.

Vegetative Species and Landform Relationships

The forest on the Park, when viewed as a whole, is a fairly homogenous mixture of pine and oaks. The dominant tree, in terms of number of trees, is far and away loblolly pine. The oak family is most heavily represented by water oak, followed by laurel, red oaks (primarily southern red, cherrybark

and Nuttall oak) and two members of the white oak group, swamp chestnut oak and white oak. A broad breakdown of the major tree species, by canopy class, is shown in Figure 2.

Figure 2 – Common Trees in Lake Houston Park Forest – by Canopy Class

Overstory	Midstory	Understory
Loblolly pine	Elm	Yaupon
Water oak	Sweetgum	Herbaceous & Grasses
Laurel oak	Yaupon	American beautyberry
Southern Red Oak	Red Oaks	Palmetto
Sweetgum	Hornbeam	Tallowtree
Swamp Chestnut Oak	American holly	Laurelcherry
Baldcypress	Redbay	Switchcane
Nuttall Oak	Blackgum	Japanese Climbing Fern

As AEL analyzed this data, it became apparent that this loblolly pine and oak forest was very uniform across the entire Park. AEL did discover that the species of oak that was present in the overstory and the tree species found in the midstory and understory did vary. Further investigations into these variations led us to look closely at the landform, one of the other land attributes that we examined during our field examinations.

The first notable variation that AEL found concerning the occurrences of plant species was whether the landform was Flatwoods or Uplands. The presence of significant levels of palmetto in the understory was a very strong indicator of a Flatwoods landform. Also notable was a reduction in sweetgum in the overstory and yaupon in the understory in the Flatwoods areas of the Park. When AEL combined the soils, topographic and wetlands inventory GIS data with the species composition and landform field data, the areas of Flatwoods became very apparent. The very poor drainage characteristics of Flatwoods forests are important to forest management decisions and to potential park infrastructure such as trails, roads or buildings.

As AEL continued to analyze the forest species data, it became apparent that there were other factors besides the Landform that was affecting the attributes of the forest vegetation. Utilizing all of the combined forest and geographic data, AEL determined that the soil's drainage characteristic was the key element to delineating the various forest communities on the Park. This factor will undoubtedly greatly affect the development of the Park, since over half of the 4,900-plus acres have relatively poorly-

drained soils. This will affect the management of the forests and the development of Park infrastructure.

The 'poorly-drained areas' are primarily, although not totally, within the Flatwoods landform. These areas have heavy palmetto understory in the southern two-thirds of the Park. The northern 'poorly-drained areas' are not quite as wet-natured, since the northern sections of the Park are on a higher elevation than the southern end, and these areas have much less palmetto. The 'poorly-drained' areas exhibit heavier water oak and laurel oak concentrations in the overstory and midstory than the surrounding 'somewhat poorly-drained' soils types.

The 'somewhat poorly-drained' areas have more of the white oak, a species which prefers better-drained soils. They also have much less palmetto, and have more yaupon than the 'poorly-drained' areas. The overstory and midstory also contains more sweetgum in these 'somewhat poorly-drained' areas. There tends to be higher occurrences of cherrybark, shumard, and southern red oak here than in the 'poorly-drained' areas, where the water oak and laurel oak displace them in the overstory and midstory.

There is little significant variance, however, in the concentrations of loblolly pine. There does tend to be less pine in the Flatwoods landform overall, but there are many exceptions to this, and for one good reason. This Park was a commercial forest holding from about 1947 until the late 1970's. Heavy disruption from forestry harvesting and replanting, combined with hurricanes and southern pine beetle epidemics, have altered the 'natural' character of this forest. Much of the loblolly forest now present on the Park is, in reality, a planted loblolly pine plantation.

These disturbances, especially the site preparation activities which almost without exception were bulldozer clearing operations, have also heavily influenced the oak component of the Park's forests. The areas with the heavy concentrations of water oak and laurel oak are closely tied to this past clearing activity. These two species require nearly full-sunlight conditions in order to create the almost pure oak stands in which they occur.

In fact, it is highly likely that some failed attempts were made to establish cottonwood plantations for pulp production around fifty years ago. These areas were subsequently planted into loblolly after the cottonwood planting failed. This explains several areas of Flatwoods that have heavy pine stands on them; these are obviously planted loblolly pine plantations that had very intensive mechanical site preparation. The wide rows that were established for the cottonwood planting are still

very evident in many places in these areas. These subjects are described in greater detail in the Historical Influence section of this Management Plan.

Forest Community Definitions

The distinction between the 'poorly-drained' and 'somewhat poorly-drained' soils, when combined with the AEL-derived Landform data, the topographic mapping, the forest timber type stratum, and forested wetland data, proved to provide the key to the most difficult differentiations of the forest communities on the Park. These broad Landform areas of Flatwoods and Uplands were defined to a finer level of distinction using these two soil drainage characteristics along with the forest type stratum. This data analysis resulted in the four major Forest Communities of the Park, which are discussed as follows.

Flatwoods Pine-Hardwood

The Flatwoods Pine-Hardwood community is the second-largest community, with approximately 1,419 acres, or about 29% of the Park. It has an overstory of loblolly pine, water oak and laurel oak, with some cherrybark oak, southern red oak and willow oak. The midstory is dominated by laurel oak, elm and sweetgum, with significant percentages of hornbeam and water oak. The understory is heavily covered by palmetto and yaupon, with the more open areas having a variety of herbaceous plants and grasses. These areas also exhibit the highest concentrations of tallowtree, due to its ability to withstand considerable inundation during the growing season.

These areas exhibit the typical flatwoods characteristics: broad or isolated depressions that are seasonally flooded for short periods. Soils are generally clayey or have silt deposition layers near the surface that cause poor soil drainage. The flat to convex nature of the terrain causes rainwater to pond in these areas, and the silt loading carried in this runoff settles in these areas, effectively plugging the pores of the soil surface over time.

The proximity of the Park to the Gulf of Mexico will generally lengthen the flooded or at least the saturated-soil periods due to afternoon thundershowers that commonly come in from offshore. However, the moisture conditions in these forests fluctuate dramatically, with the soils becoming completely dried out in mid-summer. Soil moisture deficits may occur if clay layers limit the rooting space available for trees and prevent the upward movement of water from lower, wetter zones.

This restricted root zone has very important ramifications for forest management and forest succession due to the susceptibility of the trees, especially red oaks, to suffering windthrow. This

windthrow issue will be further discussed in the Forest Management Plan, since it, along with the difficulty for natural pine and hardwood regeneration to survive, presents serious difficulties for management strategies.

Pine-Hardwood, Poorly-Drained

The 'Pine-Hardwood, Poorly-Drained' community comprises the largest forest community acreage, covering approximately 1,478 acres of the Park, or about 30 percent of the total area. It varies from the Flatwoods in that the better drainage character of the soils provide for a somewhat increased diversity of tree and plant species, especially those that require longer periods of time free of ponded water. The Flatwoods sections are flat to concave terrain, and water simply ponds there during wet weather. This causes the silting-in of the pores of the soil surface, therefore trapping the surface water. The soils of this community are generally different only because they have a more sloping to convex terrain that affords slightly better drainage.

The forests in this community have more loblolly pine, cherrybark red oak, sweetgum, southern red oak, hickory and white oak in the overstory than the Flatwoods areas. The midstory changes closely reflect the overstory, except for the heavier water oak component. This is probably due to the better survival conditions afforded by the drier soil conditions here. An increase in hornbeam was also noted in the data.

The understory has more herbaceous plants and grasses, and a considerable increase in the yaupon. This is where the redbay, laurelcherry and beautyberry begin to show up in the understory, as well. The most striking change in the understory is the greatly reduced volume of palmetto.

There is also an increase in the small hardwood saplings and seedlings as the soils become better drained. Many species are unable to sustain long periods of inundation while in the seedling stage. This is most likely the reason there is more willow oak in the Flatwoods than in the other communities. Willow oak is able to survive much longer periods of flooding than most other oak species, and thus is able to become established in the wetter areas. Also it does not compete well with other trees and plants, so it is pretty much restricted by its nature to these wetter areas.

Pine-Hardwood, Somewhat Poorly-Drained

These 924 acres make up about 19 percent of the Park area. The soils in these areas have a much lower water table, about 6 to 24 inches below the surface. In contrast, the Poorly-Drained soils have a

water table from 0 to 18 inches below ground level. The Somewhat Poorly-Drained soils still have a clayey subsurface layer that retards the drainage, but not to the degree of the Poorly-Drained areas.

The vegetative composition of these areas, as compared to the Poorly-Drained sections, tends to include more loblolly pine and white oak in the overstory, with more beautyberry, yaupon and laurelcherry in the understory. There is less tallowtree in these areas. This is probably a combination of the denser shaded conditions due to the higher yaupon levels, and the drier nature of the soils allowing for more competition to the tallowtree. In the much wetter areas, it has reduced competition, since there are not many species that can withstand ponded water during the growing season.

The better-drained nature of these areas will have ramifications from the standpoint of both forestry activities and any Park infrastructure that may be planned, such as roads, campsites, trails and buildings. These broad descriptions of the Community / Landform / Soil Type serve to alert the planner that a closer look needs to be taken before specific plans are made. These better-drained areas will tend to be more attractive for infrastructure than the Poorly-Drained and Flatwoods areas. The Forest Management Plan will be looking at these distinctions on a finer level than these Community descriptions.

Pine-Hardwood, Well-Drained

These forests are on around 426 acres or about 9 percent of the Park's land. They are concentrated in an area just southwest of Lake Isabel, in several areas just west of the San Jacinto River on the southeast side of the Park, and in two sections just north of the Nature Center. These soils are very sandy, and lack the heavy clay and/or silt layers of the poorer-drained soils. Some areas have ironstone gravel mixed in with the sandy loams.

The vegetation growing on these areas differs depending on which part of the Park they are in. The Well-Drained areas in the southern end of the Park and the areas that parallel the San Jacinto River have markedly heavier concentrations of loblolly pine than the neighboring poorer-drained soils. There are some exceptions to this, especially where the before-mentioned heavy site preparation has been done in the past. In some of these areas, the local soil and drainage conditions were altered and loblolly pine survived and grew exceedingly well. The overstory also has more white oak in areas with better-drained soils.

The midstory in these Well-Drained areas has a notably higher constituent of sweetgum and yaupon, compared to the Somewhat Poorly-Drained areas. The trend is heavier in favor of laurelcherry, which really needs well-drained soils to thrive.

There is the effect here of the increased density of species that can tolerate the dryness of these soils during the hotter, drier summer months. The understory reflects this in the increase in yaupon and beautyberry, both of which can tolerate the drier, sandier soils.

Stream Terraces

This forest community type occurs along the Peach/Caney Creek corridor and along the San Jacinto. These 381 acres make up about eight percent of the Park, and have some of the most diverse plant assemblages to be found on the Park. The reason for this is that these soils are the product of flooding and soil deposition from the streams over the millennia, which created a linear pattern of soils that range from extremely well-drained sandbars to heavy, poorly-drained clays. The soils are highly complex in their mix and afford a multitude of ecotones, of which many different plants can take advantage of the varying conditions. The terrain is highly convoluted, with many ridges and old high stream banks running parallel to the present channel of Peach and Caney Creeks. This effect is not as pronounced on the San Jacinto River corridor, as there are more baldcypress sloughs and bottomlands along that stream. There are also a lot of high banks on the San Jacinto where the uplands come right up to the riverbank.

The overstory components of these stream terrace areas are made up of the ever-present loblolly pine, as well as baldcypress, water oak and sweetgum. These are just about the only areas of the Park that have southern magnolia and sycamore. The often-bared sandy soils that are deposited here after large flooding events make excellent seedbeds for magnolia, sycamore and loblolly pine. The midstory components of these terraces contain laurelcherry, sugarberry and hornbeam. These areas have the very highest densities of laurelcherry to be found on the Park. The deep, sandy ridges of the old stream banks and old sandbars are ideal for this species to take root and flourish.

This is where the highest concentration of Japanese climbing fern exists, even though it was detected to some degree all over the Park. There are also heavy stands of tallowtree at the forest margins on the stream banks, especially along the sandbars on the Peach/Caney Creek corridor. Other understory plants include switchcane, yaupon, American holly, hornbeam, beautyberry, various woody vines and bracken fern.

There are small embayment areas where new stream banks have cut off the old streambed, and several of these have seeded into baldcypress forests. These fairly well-drained yet very moist sites, with moderate to light flooding, provide the optimum growth sites for baldcypress. If these areas stay

isolated from the main stream channels for the next century, there will be some very impressive, large baldcypress trees growing there.

Bottomland Hardwood

This forest community encompasses about 170 total acres, or a little over 3% of the forest on the Park. The primary location of these areas is at the very southern tip of the Park, at the confluence of Caney Creek and the San Jacinto River, and along the San Jacinto and Caney Creek corridors.

The most common overstory trees found in these bottoms are water oak, sweetgum, loblolly pine, baldcypress and cherrybark red oak. This is one area of the Park where green ash occurs, along with a small amount of sycamore, southern magnolia and willow oak.

Sweetgum dominates the midstory, and shares this canopy class with hornbeam, American holly, blackgum, redbay, red maple and hickory. The understory plants include hornbeam, swamp privet, yaupon and herbaceous grasses. Some laurelcherry is on the higher, better-drained spots along with beautyberry and palmetto.

These bottom areas are in the floodplains of the two major streams that border the Park. The soils here vary from well- to poorly-drained, and are heavily influenced by outbanking floods, especially from the San Jacinto. Bottomland hardwood forests are complex ecosystems, since the texture and drainage character of the soil varies a great deal over relatively short distances. A wide variance of plants and trees can occupy these bottomlands, depending upon their individual requirements for establishment and growth. Some of the largest pines on the Park are found here, since available moisture is the number one limiting factor for growth, and moisture is abundant in these bottoms.

Generally most of the bottoms on the Park are relatively well-drained. The sandy nature of the soils upstream of the Park has resulted in deposition of coarser, comparatively-drained material following flooding events. Very few areas of heavy clays or silty soils often associated with riverine bottomlands are found in the Park.

Water Oak Flat

This approximately 64 acre area in the northeast section of the Park is a unique area of flatwoods that is heavily dominated by water oak. The second most common tree in the overstory is willow oak, this being one of the largest concentration of that species in the Park. There is some white oak, loblolly pine, cherrybark red oak and southern red oak in this flat. This area is wet natured, and evidently has standing water in it during the winter and early spring months.

The midstory is primarily yaupon, with some areas having only that in the midstory. This indicates that the area dries out fairly well during the late spring through fall months. There is also blackgum present in the midstory. The understory of this flat has a lot of yaupon in it, along with woody vines and beautyberry.

This area of the Park is unique and very interesting. It is strongly suspected that this forest is a by-product of a clearcut-and-replant operation followed some years later by a southern pine beetle outbreak. The rotted trunks of pine trees litter the forest floor in this area, with their corresponding stub or stump immediately adjacent. The stumps are broken off, not cut off as with timber harvesting. It is surmised that the pines in this extremely wet-natured area were either killed off early in a beetle outbreak, or that the area was too wet to allow for salvage / outbreak suppression logging activities.

The death of these pines was sudden and widespread in this area, and released the existing hardwoods to grow and dominate the site. The fact that the dominate hardwood species in this area is water oak tends to point towards heavy site preparation with bulldozers followed by planting with loblolly pine. Water oaks flourish in these situations where the ponding of water on microsites drowns out the pines.

Baldcypress Swamp

These 21 acres are along Lake Isabel, around several smaller ponds and sloughs of the San Jacinto floodplain on the southeast side of the Park. Baldcypress has strict requirements for seedling germination and survival that are met by fluctuating water levels. The soil must be damp but the seed cannot be inundated in order to germinate. The seedling then requires dry conditions during the growing season. This is why baldcypress trees appear to be in rows around water bodies such as creeks, rivers, sloughs and lakes – this is the strip where water levels were appropriate for baldcypress establishment.

The more water that baldcypress stands in, and the longer the period, the slower it grows. Even though it won't naturally seed in on uplands, it has its best growth on upland, well-drained sites. The best stands of baldcypress are often in backwater sloughs that dry out during the growing season, thus affording the moist soils on the banks and slough bottoms for germination, yet are dry out enough to allow good growth.

The common associates with baldcypress include water and swamp tupelo, sweetgum, red maple, green ash and willow oak. There is not much midstory or understory in these areas, mainly wetland plants such as lizard tail, juncus and small trees such as maples and tupelos growing on small

hummocks of soil. These are interesting and dynamic systems that afford a host of benefits for wildlife, water quality and aesthetic beauty. We will discuss possible ways to enhance these areas in the Management Recommendations section of this Plan.

Clay Flat Prairies

These non-forested spots are small depressional areas of the *Waller* soil series that have permanent ponding due to heavy clay and silt soils. They have very wet, mucky soils with high levels of organic materials. All of these are located in the northeast quadrant of the Park.

Only a few taller plants such as tallowtree, common buttonbush and the odd straggler of a pine or sweetgum are growing in the slightly higher spots and around the margin of these flats. They are dominated by wetland plants such as juncus, sedges and lizard tail. These areas are extremely interesting ecotypes and should prove to be popular areas for wildlife observing and educational tours as the Park is developed. Three of these are named ponds on the USGS topographic maps, and this is also reflected on the *Forest Community Map.*

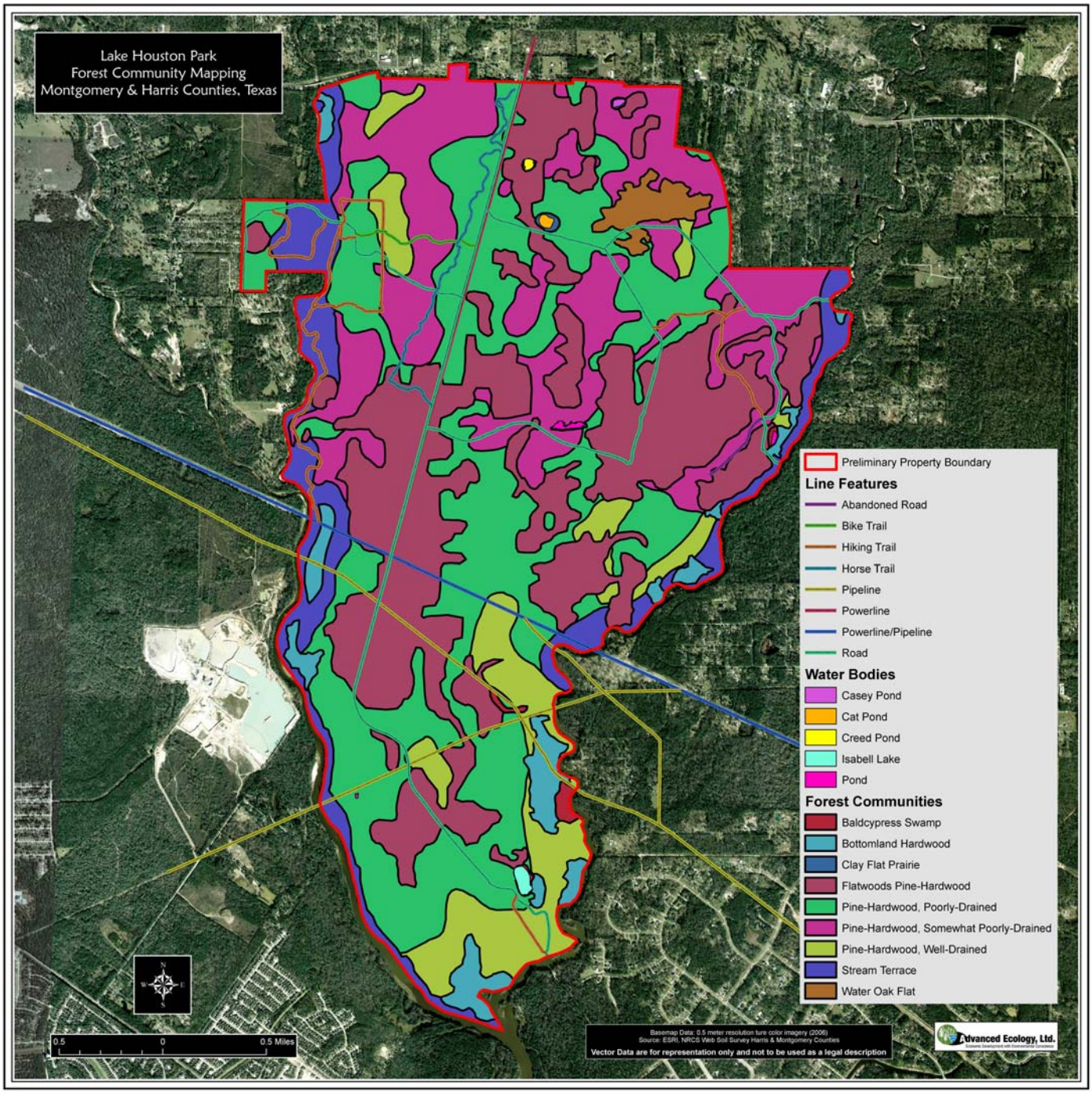
Utility Corridors

There are five major pipeline / powerline right-of-way corridors traversing the Park. These total approximately 76 acres of land or about 1.5% of the total Park acreage. These corridors, while not aesthetically-appealing, do provide an important edge effect between the forest and these open areas. These will be discussed in detail in the Management Areas section, as they will provide some needed access and potential for active management.

Figure 3 – Forest Communities of Lake Houston Park

Community Name	Landform	Acres	% Of Park
Clay Flat Prairie	Clay Flat	11.7	0.2%
Bottomland Hardwood	Bottomland	165.9	3.3%
Baldcypress Swamp	Baldcypress	20.8	0.4%
Pine-Hardwood, Somewhat Poorly-Drained	Upland	924.5	18.6%
Pine-Hardwood, Poorly-Drained	Upland	1,479.7	29.8%
Utility Right-of-Ways	ROW	76.2	1.5%
Flatwoods Pine-Hardwood	Flatwoods	1,419.2	28.6%
Stream Terrace	Stream Terrace	381.3	7.7%
Pine-Hardwood, Well-Drained	Upland	426.3	8.6%
Water Oak Flat	Flatwoods	64.3	1.3%
Total		4,969.9	100.0%

Forest Community Map



WILDLIFE COMMUNITIES

Wildlife Assemblages

No scientific surveys were conducted to collect sampling data on the occurrence of wildlife species on the project site. AEL is aware that there are various records of herptiles and birds frequenting the property, but these are not comprehensive for all terrestrial vertebrates, particularly mammals. Consequently, a reasonable alternative for detailed representation of wildlife on the property is to consider the nearby Big Thicket National Preserve as a surrogate for faunal assemblages on the project. This is possible because the land cover types have substantial similarity.

A detailed checklist for birds that was assembled in 1996, by Marilyn Crane, indicates that approximately 128 species of birds have been recorded in the Park. Similar lists currently available online include, Birds of the Pineywoods of Eastern Texas – A Field Checklist at http://www.tpwd.state.tx.us/huntwild/wild/birding/pif/ecoregions/ and Birds of the Big Thicket National Preserve at: http://www.npwrc.usgs.gov/resource/othrdata/chekbird/r2/bthic.htm .

A preliminary herpetofaunal survey was conducted at the Park in 1995 in which 12 species of amphibians and 10 species of reptiles were recorded. Subsequently, a checklist of the herpetofaunal of the Park was compiled.

From a large mammal perspective, the Park is inhabited with a substantial population of white-tailed deer and feral hogs. Mid-sized mammals such as coyotes, bobcats, fox, beaver and otter are common. Typical small mammal assemblages, such as squirrels, rabbits, raccoons and opossums, are also abundant relative to their habitat type requirements.

In a recent review of natural environments in East Texas, AEL found that the variety of vertebrate animals currently or historically ranging over this region totals approximately 600 species. A general guide to the species assortment is: 60 mammals, 353 birds, 67 reptiles, 32 amphibians, and 84 fish. While this documentation isn't exact in pertaining to Park environments, it is reasonably close, and shows that the potential for vertebrate diversity is excellent.

Today this region is missing some of the parts of wildlife assemblages that occurred during pre-Columbian times. Even ignoring the wooly mammoths, ground sloths, and giant beaver of the dim past, we know that these environs once were inhabited by herds of American bison and large predators such as red wolves, black bears, and eastern populations of mountain lions along with the occasional jaguar

that wandered north from tropical environments to the south. During the early to mid-19th Century, flocks of passenger pigeons and Carolina parakeets frequented the region.

By considering what we know about them, these missing animals give us some idea of early natural conditions. For example, bison needed adequate grass for foraging so tallgrass openings surely were present in the larger forest landscape matrix in order to support the roving herds of these large herbivores. We believe white-tailed deer always were abundant; deer are "generalists" that survive under varying conditions such as those of the disturbance regimes that defined landscapes.

As a corollary, we may suppose that red wolves, mountains lions, and, to a certain extent, black bears were supported by these abundant deer populations. The early records of black bear abundance indicate to us that sanctuary-type cover and foraging habitat in the extensive blowdowns and canebrakes likewise occurred over considerable acreage in the East Texas region. Passenger pigeons required vast quantities of hard mast from oaks and hickories, thus, we know that the presence of pigeon flocks indicate forests with vigorous stands of mast-producing trees.

Carolina parakeets roosted every night in tree cavities. Considering that parakeet flocks were known to number in the hundreds, we may imagine that early forests contained abundant cavities in order to provide nighttime housing for these birds. A similar requirement for tree cavities is associated with Rafinesque's big-eared bat (a state-threatened species in Texas). Nesting and roosting sites of this sort only could be possible in forests containing many large trees with cavities.

In fact, one may envision the pre-Columbian landscape as a patchwork of various forest conditions, including trees were either old and/or had damages that caused the cavity formation, as well as stands of younger trees and forest openings that provide the necessary habitat conditions for other plant and animal species. That is, these forests were not unbroken expanses of old trees, but, rather, consisted of varying forest conditions which essentially, taken together, comprised the landscape matrix. The very existence of biological and botanical diversity depends upon variation in a given ecosystem. This assumption forms the conceptual basis for the management premise to restore natural diversity to the Park lands.

The overall diversity of wildlife species in the Park is negatively impacted by the relatively uniform closed canopy structure of the habitat with little early successional forested habitat or grasslands. This is primarily a result of the past forest management of the Park land with a primary emphasis on even-age plantation silviculture.

Wildlife Habitat Quality

One aspect of this planning process has been to assess the overall quality of wildlife habitat occuring within the Park in a systematic fashion. ("Habitat" may be thought of as the "address" for plant or animal species while "niche" may be regarded as the "job or profession" for any given species.) Frye (1995) developed a method for assessing wildlife habitat through rapid evaluation of certain vegetation characteristics that are easily observable and that can be recorded without lengthy field measurements. This methodology is known as the Wildlife Habitat Appraisal Procedure (WHAP) and is available from Texas Parks and Wildlife Department. The method produces quantified results that represent the quality of wildlife habitat at given sites. Results are expressed in values from 0.0 to 1.0 with 1.0 being the highest quality or optimal habitat.

The WHAP method was applied to assess the overall quality of wildlife habitat for various landform types within the Park. The method produces quantified results that represent the quality of wildlife habitat at given sites. Results are expressed in values from 0.0 to 1.0 with 1.0 being the highest quality habitat. The forest inventory data on vegetative composition by landform were used to determine these rankings. The score sheets for each landform are found in Appendix "B".

Figure 4 – WHAP Scoring by Landform

Landform	WHAP Score	Percent Area
Flatwoods	.465	29.8
Bottomlands	.705	3.3
Uplands	.515	57.0
Clay Flats	.73	.2
Stream Terraces	.585	7.7
Baldcypress Swamps	.84	.4
Utility Corridors	_	1.5
Weighted Score	**.513**	

The scoring, when weighted by the relative Percent Area of each Landform, reveals that the majority of the Park habitat is only realizing about one-half of an optimal condition. This quantified

assessment is reasonable when reviewed in comparison with other physical, chemical, and biological characteristics of the soils and forest habitat found in the Park.

In summary, the conclusion of the WHAP method is that opportunities exist to substantially improve the wildlife habitat on the majority of the Park.

Icon Species

An icon species can be defined as an animal or plant that can instill pride, ownership and awareness of habitat conditions in the general populace. Such an icon species can generate strong feelings and discussion within the public realm, and promote healthy community interest sufficient to generate support for habitat modification activities. The opportunity to actually see wildlife can be a much more powerful motivation than facts and figures could ever hope to be.

There are certain wildlife species that are more likely to stand out in the minds of Park visitors. The most likely candidate species that are especially suitable for the habitat associated with the Park include the bald eagle, wood duck and osprey. All three of these species have a great story that includes a history of endangered populations and strong recoveries; they either are or have the potential to actually nest and forage in the Park; and tend to be highly visible when present and are not particulary secretive in their habits. The bald eagle and wood duck provide the greatest opportunity for viewing by the Park's visitors; the osprey will more than likely be an infrequent visitor.

It is significant that suitable habitat conditions exist for all three of these species in the Park now, and additional improvements can be easily accomplished through the development of new habitat as well as the retention of desirable existing habitat features. The nesting site requirements for bald eagles , while the osprey prefer to build nests near water in tree-tops without any surrounding vegetation at nest height.

The primary proposed management strategies to encourage these species are:

- Creation of additional baldcypress forest around sloughs and ponds to provide nesting sites for bald eagles possibly for ospreys
- Creation of water features to provide nesting and brood-rearing habitat
- Protection of Large Trees along the banks of the San Jacinto River and Caney/Peach Creek

Birds in general, both resident and migratory, should be given significant attention at this Park. One of the major local conservation and ecological themes for Houston is the *Birds and Bayous Initiative*. The geographical location and the landscape of this Park present an excellent opportunity to provide

world class avian habitat while also acting as a bridge or gateway between the urban aspects of Houston and the rural attributes of the Big Thicket National Preserve, the National Forests of Texas, and the Piney Woods of East Texas in general which played such a major role in the development of Houston.

Threatened & Endangered Species and Habitat Activities

At this time no known federally threatened or endangered species are known to inhabit the Park. A separate study is currently underway by other Master Plan team members that will address these species and their potential occurrence in the Park. These comments relate solely to the habitat and any anticipated effects that habitat management may have on them.

The two federally-listed species with the highest likelihood to occur within the Park are the recently delisted bald eagle and the red-cockaded woodpecker. The most likely state-listed candidate is the timber or canebrake rattlesnake. The state-listed alligator snapping turtle and the federal- and state-listed Houston toad also are candidates for investigation at the Park.

Of the habitat requirements associated with these species, the bald eagle is most easily accomodated. As discussed previously in this Plan, this will be accomplished by the establishment of additional baldcypress forest, as well as the protection of existing baldcypress and other large trees that provide potential nesting sites for bald eagles.

The forest management requirements for the red-cockaded woodpecker are so intensive and would require rather frequent and invasive actions upon the exisiting habitat of the Park. The need for intensive removal and control of hardwoods as the first step in preparing the habitat, along with the prerequisite for pine trees of advanced age, would make any near-term potential for these birds problematic at best.

For obvious reasons, efforts will not be undertaken to maximize timber or canebrake rattlensnake populations in the Park other than public education as to their endangered and therefore protected status.

The management activities proposed in this Plan should not have any effect one way or another on the snapping turtle, other than the protection of the riparian zones associated with water features in the Park.

The habitat in the Park has been so thoroughly altered that almost all of the requirements for the Houston toad have been severely degraded. This amphibian is believed to be extinct in the area of the

Park. There are a few limited areas with deep sandy soils within the Park that could provide suitable habitat.

Exotic or Problematic Wildlife Species

Without a doubt, the most problematic species present in the Park at this time is the feral hog. Their primary impacts on the enviromment result from their rooting habits (feeding by digging the soil with their snouts) that disrupt roads, pastures and lawns. While time and space do not allow for a full discussion of this topic, sustained attention will be required to manage the problem. The amount and intensity of hog impacts will be influenced by factors such as the amount of grassland or open space to be created and maintained, the type and location of landscaped and developed areas within the Park, the level of Park visitation, as well as development patterns and pressure on areas adjacent to the Park.

Whitetailed deer and their associated impacts must also be considered. As a species that is highly abundant in the Park, they present both postive and negative attributes. On the positive side, most Park visitors will be thrilled with the constant viewing opportunities associated with these beautiful creatures. However, they pose a threat to both native plant communities from overbrowsing. The potential for vehicle strikes and negative encounters with pedestrians or bike riders will require planning considerations. The association of both deer and feral hogs with ticks and Lyme Disease must be considered in today's environment.

Dependent upon the amount of effort expended upon the enhancement or creation of water features, beavers could become an issue. In recent years, populations of these creatures have soared in Southeast Texas. They are abundant in the waterways adjacent to the Park as well as seasonally present in internal features such as Lake Isabel. Impacts associated with beaver include damage to vegetation, impairment to drainage in water bodies or drainage features, and structural deficiencies in dams, levees, or shoreline features.

It is important to remember that this is not a situation where wildlife species may, on rare occasions, wander into some urban environment, but where humans are entering what remains a wild and functioning forest ecosystem. As the project matures, a strategic plan should be in place for dealing with these issues, the depth and nature of which will be heavily influenced by the timing and level of development within the Park at each given stage.

Initial efforts may not require any actions beyond those previously conducted by personnel associated with the State Park. However it should be noted that some actions such as the annual control hunts conducted by Texas Parks and Wildlife Department have already ceased. At a minimum,

a sustained control program of feral hog should remain constant so that problems are not componded. Effective feral hog reduction programs are in place at areas such the Armand Bayou Nature Center and in The Woodlands.

Older Pine Plantation in the Park – Note trees on left planted in rows

HISTORICAL INFLUENCES ON THE FOREST

The most influential factor that shapes the character of a forest is the land on which it grows. Nowadays the next most important source of forest change is human-based land management practices. The understanding of the natural and human history of a given parcel of land is vital to comprehending how a forest was formed. An ecosystem can be more properly managed for the future once that history is understood. It is important to have specific knowledge of how the plants and animals in a given location have reacted to past land management activities in order to better forecast the effects of potential future actions.

Pre-Settlement Period – up to mid 1800's

The diaries and logs of early European explorers such as La Salle described the Native Americans that they found in this region in the late 1600's. These histories suggest that the Akokisa (also known as Orcoquisacs) lived on the lower San Jacinto River in the area of the Park. These and other Native Americans known to inhabit this area were hunter/gatherers, and, were relatively simple people in terms of development of their culture.

Further north in East Texas tribal land was heavily farmed by the Caddo nation. In those locales, forests were undoubtedly heavily impacted until the eventual population collapse in the face of European disease that occurred after the mid-1500's visits by the early explorer De Soto. However, AEL found no evidence of such massive agricultural clearing of the forests in the region of the Park. We may assume, though, that fires likely burned along the inter-drainage upland divides. Some of these fires likely resulted from the intent and/or carelessness of native people operating in the region.

The commonly-occurring hurricanes and other windstorm events, coupled with natural wildfire and the assumed moderate impacts of Native American woods burning along with some limited, localized agriculture, undoubtedly provided the disturbances that resulted in the pine-dominated forests that greeted the early European settlers. The large stands of almost pure pine could not have existed without a significant disruption of the forest canopy.

Curiously, it may have been those same early explorers such as La Salle that first introduced one of the today's most problematic wildlife species in Texas, the feral hog. Whether the pigs brought in by La Salle as well as early Spanish explorers survived or were eliminated by predators, the stage was set for current situation faced across much of Texas today. Additionally, free-ranging domestic hogs were tended extensively by Anglo settlers who increasingly occupied this portion of Texas after the early

1800s. Remnants of these free-ranging herds along with the propensity of hunters to release strains of European wild swine during the 20th Century can be considered as factors in the remarkable increase of feral hogs to the current problematic proportions in Texas.

Settlement Era – Mid 1800's

The early European settlements in this region were concentrated along the larger rivers such as the Trinity and along the coastal regions. The rivers in East Texas suffer from low water levels during dry periods, except in their lower reaches. The first settlements had economies based on agriculture along with small-scale timber harvesting. The earliest substantial settlement efforts began in the 1820's with Stephen F. Austin's colonizing efforts.

The nearest community to the Park, New Caney, was first established in the 1860's by settlers who farmed corn and cotton, while raising cattle on the open range. The building of the Houston, East and West Texas Railway to New Caney by 1878 established a cattle shipping center for the area.

By 1884 New Caney had four steam-powered sawmills and a general store; at that time the community shipped cotton, syrup, and hogs. By 1890 it had several sawmills, a church, a school, a meat market, a general store, a cross-tie contractor, a justice of the peace, and an agent for the railroad, telegraph and express services.

New Caney began as a farming town, but grew as the local lumber industry developed; among the timber products that the town shipped were mining props used to support mining tunnels. The area economy declined in the 1920s, but later revived with the resurgence of the lumber industry. By 1946 the town had about forty dwellings, three schools, two sawmills, a railroad station, and about twelve other businesses.

Lumber Industry History and Effects on the Forest – Late 1800's to 1940

The eastern forests of the United States had been heavily harvested by the mid 1800's, when the nation looked to the Lake States such as Michigan and Wisconsin for lumber supply. The industry harvested timber in this region from around 1840 to the turn of the century. At that point the industry became focused on the pine forests in the southern states.

The lack of roads or reliable water transportation was a severe restriction on early expansion of the timber industry. The earliest sawmills were found with the major settlements along the large rivers and the coast. It took the establishment of mainline railroads beginning in the post-Civil War period to

provide the means to access the vast timber resources of the interior portions of southeast Texas. This period from about 1880 to the 1930's was the "bonanza era" in the Texas timber industry.

The railroad network developed rapidly and provided transportation to every section of East Texas. Tram railroads that carried the logs to the mills and transported the finished lumber to mainline railroads were built all through the area. In fact, many of the present-day roads and trails in the Park were built on top of these old trams. Additional evidence of these often-temporary rail lines can be found in various locations throughout the Park.

The Bender family had one of the earliest large sawmills at Humble in the late 1800's with extensive land holdings and a railroad system to supply the mill with timber. Another large lumbering operation close to the Park was the Foster Lumber Company southwest of Cleveland, where a large sawmill and the town of Fostoria was built in 1905. This company had extensive land holdings and timbering operations to provide lumber for their retail lumberyards in Kansas and later in Texas. It is likely that both of these businesses were involved in the early harvesting of the original forests found on the Park.

The forest products resulting from this era were much more diverse than today, since this preceded the use of concrete, plastics, steel, gypsum board and other modern building materials. Besides supplying the primary lumber for framing, the walls in most buildings were plaster laid on a framework of narrow wood slats called laths. This provided a very large market for southern pine lumber. The timber was used for roofing and siding shingles, trim and molding, and the packaging material known as excelsior (this was before Styrofoam peanuts). All of the fence posts of the day were wooden and railroads were the only means of interior transportation and required large quantities of wood for crossties and bridges. In fact, crossties were the chief end-use of hardwood timber in southeast Texas.

Barrels were the standard cargo and material carriers of the day. Both slack cooperage made from red oak (for dry goods) and tight cooperage made from white oak (for liquids) provided needed transportation and storage for everything from nails to flour to whiskey. White oaks have 'plugged' pores that allow for the retention of liquid, while red oak's open pore structure does not. The prominence of white oaks in the Park today indicates that that many barrels were probably produced from these woods in the past.

The harvesting of the forests during the late 1800's and early 1900's actually provided for the establishment of agriculture and increased settlement. Farming and grazing again was practiced

following the harvesting of the original forests. In fact, there is widespread evidence of past cattle grazing on the Park, with portions of old barbed wire fences found in large trees and along the ground. There were also free-range hogs introduced into this property by the late 1880's. The practice of ear-branding hogs and letting them run semi-wild in the forest was a widespread practice all across the South, one that lasted in most of this region until the 1950's and 1960's when stock laws began to influence landowner practices .

This logged-over land was sold at low prices, since the extremely high costs of railroad-based logging precluded the use of second-growth pine. The high-moisture content wood from these fast-growing, young trees required expensive kiln drying before being suitable for lumber. This had not been a problem with the old growth timber that was primarily low moisture content heartwood that required minimal open-air drying.

The economy of southeast Texas began to change as the automobile and improved communications began to provide more access to the outside world. In fact, the establishment of roads and the availability of heavy trucks allowed for the beginnings of commercially sustainable forestry in Texas. By the 1930's, reforestation efforts had begun, made feasible by relatively inexpensive truck transportation of logs from the woods to the sawmill. This cost savings allowed for the kiln drying of the sapwood lumber, thereby making replanting a commercially-viable enterprise.

Two organizations that were vital to the establishment of forest conservation in Texas were the Texas Forest Service and the Texas Forestry Association, both created around 1915. The Texas Forest Service provided the wildfire protection needed to establish seedlings, and the Texas Forestry Association promoted the economic development and utilization of the Texas' forests and related resources.

Wildlife populations underwent major changes during this time period as well. Both game and non-game species saw major periods of decline, in some cases extirpation, and in a few cases extinction. Fortunately by the latter portions of this era, positive changes were also taking place as the conservation movement began to gain ground.

Champion Paper Company Purchases the Land – 1940's to 1950's

The establishment of the first papermill in the region around 1933 contributed to the era of modern forestry and conservation by providing a market for the small and poor-quality trees from forest improvement thinnings. The Champion Coated Paper Company of Ohio constructed a bleached-sulfate pulp mill on the Houston Ship Channel at Pasadena. The pulp from this mill was shipped to Ohio,

where it was manufactured into fine printing papers. Interviews with retired Champion foresters provided a wealth of background information about the present-day forests on the Park.

Champion purchased large tracts of land during this time, which included what is now the Lake Houston City Park property. This tract, purchased in 1946, was referred to as the Papermill Pasture, and was utilized for timber production and recreation for the papermill supervisory staff. This papermill used a fifty-fifty mix of hardwood and pine pulpwood as its raw material. The interviewed foresters did indicate that the lands purchased in the New Caney area were targeted originally to provide mainly hardwood pulpwood to the Pasadena papermill.

The mill was later expanded to include paper machines to produce paper that included the stock for the *Time* and *Life* magazines. This market had an impact on portions of the Park. This product required fibers from cottonwood trees, a relatively scarce item in southeast Texas. As procurement efforts up through Kansas proved difficult, Champion attempted to plant cottonwood plantations on their land in East Texas. Areas of forest were cleared and farmed in rows like corn or soybeans, due to cottonwood's strict requirements of controlling all competition from other plants for moisture and nutrients. Since this was tried in previously forested areas, the woody competition caused total failure of these experiments. After several years of multiple disking and plowing efforts, Champion replanted these areas with loblolly pines. There are several areas in the Park that show the wide crop rows (furrows and ridges) on the ground underneath the old planted loblolly pines.

Most of the forest harvesting done in conjunction with pulpwood operations during the 1940's through the 1970's was by shortwood logging. This labor-intensive method used hand felling and bucking of trees with chainsaws into 4, 5 or 6-foot pulpwood bolts. These short logs were either loaded by hand or winches onto modified light-to-medium duty trucks, and then were hauled to concentration yards or directly to the papermill. The need to place the truck virtually next to the stump in order to load the pulpwood sticks caused the shortwood logger to be very selective about where they cut trees. There was also a 24- inch maximum diameter for pulpwood at the Pasadena papermill, so large-diameter trees were not very heavily utilized.

These two factors resulted in a "grazing pattern" of logging, with the forest being harvested heavily in the easily-accessed locations, while the difficult-to-access areas and the large trees were less impacted. This would be especially true of large trees that had some level of rot or other defects. With the level of physical labor that shortwood logging took, a person was very particular about cutting

down a tree that would yield low amounts of useable wood or be difficult to handle. Many of the large hardwoods on the Park today probably owe their existence to this fact.

AEL foresters found old cut stumps all through the forests of the Park. There has been a significant level of forest harvesting done on this land since the late 1940's in the second-growth timber that regenerated following the logging of the original forest in the late 1800's to early 1900's. A few remnant second-growth pines and hardwoods are still found in the forest.

Major Disturbances to the Forest – 1960's to 1970's

Judging from the acreages of loblolly pine plantations that make up a substantial portion of the Park's forests, an extensive level of disturbance to this land has taken place in the recent past. The clearing of previous forests and subsequent mechanical site preparation (clearing with a bulldozer) resulted in some of these plantations being almost pure pine while other areas have varying amounts of water oak, laurel oak, swamp chestnut oak, willow oak, sweetgum and hickory intermixed with the pine. Our conclusion is that the planted pines survived in the higher, better-drained sites while the hardwoods naturally colonized the lower-lying, wetter areas.

After studying the forests, the land and historical records, combined with the interviews with the Champion personnel, we believe that insect infestations and hurricane events are responsible for much of the character of the Park's forests today.

Southern Pine Beetle

AEL first suspected that southern pine beetle infestations affected the forests of the Park during the gathering of the field data. The presence of almost pure stands of water and laurel oak with old rotted pine trees and stumps on the ground pointed strongly to these being old beetle kill areas. As noted in the discussion on the Water Oak Flat area, these pine snags and rotten logs display no evidence of being felled by humans.

The first outbreaks of southern pine beetle, a very destructive insect that can kill large areas of pine, began in this area following the hurricanes of the early 1960's such as Carla and Cindy. The high wind damages the trees' root systems, trunks and crowns. This leads to a general weakening of the tree, making it vulnerable to pine beetle attack. The large area of wind-damaged trees promotes widespread infestations.

The impact of these infestations in the past was sudden and devastating. The treatment system in these early days was to cut the infested trees and to treat them where they fell with insecticides. This

proved ineffective, and the presently-used system of harvesting wide swaths of green, non-infested pines ahead of the infestation was adopted during the 1970's.

According to a retired Champion forester, a large hailstorm hit the Park area in 1974-75, kicking off what proved to be the beginning of the greatest outbreak of southern pine beetle in East Texas, which struck the remainder of East Texas the following year. Large areas of pine forest were lost to the beetle and the control efforts that ensued. Another but less extensive outbreak occurred in the early 1990s', with sporadic, smaller epidemics occurring in the interim. There have been virtually no infestations of southern pine beetle on private forestlands since that time.

An examination of pine growth rings conducted in the summer of 2008 shows several episodes of pine establishment that correspond to the mid-1970's and the early 1990's outbreaks. The Park property was owned by Champion Realty when the 1974 outbreak occurred, but the forest was being managed by the Champion forestland management group. They conducted control and replanting efforts at that time, while there was undoubtedly some natural pine re-seeding occurring following those outbreaks. The Texas Parks and Wildlife Department owned the Park during the latter pine beetle outbreaks; and we assume that the pine regeneration that corresponds to that time period was natural regeneration.

Hurricanes

Windthrow (the uprooting of trees) and wind breakage damage to the crown and trunks of trees are some of the most common disturbance agents in a forest. During the field data inventory work on the Park, AEL foresters noted areas with windthrown trees covering several hundred acres at a time, found in various locations all across the Park. AEL suspected a hurricane due to the variations in the windthrow direction of the old logs on the ground. These almost completely rotted old logs and corresponding mounds of soil where the root systems were uprooted indicated winds primarily from the southwest, with some showing a westerly and southerly wind direction.

These areas tend to be found on the wetter soil types, which is logical since trees on these sites have shallow root systems due to low-oxygen soils, thus making the trees more susceptible to windthrow. These areas also become less stable due to the ponding of rainfall, causing increased windthrow due to the soft, rain-saturated soil.

Another clue concerning widespread wind damages in the past is that AEL found in this forest is the unusually high occurrence of swamp chestnut oaks, which are a member of the white oak group. The white oaks are more windfirm than the red oak group. We have seen evidence of this during

damage assessments following hurricanes Rita and Katrina. The same observation applies, but on a more limited scale, to southern magnolia.

A search of U.S. Weather Service records revealed that Hurricane Debra in 1959 maintained hurricane force winds 100 miles inland, and passed very close to the Park. The well-known massive Hurricane Carla in 1961 certainly affected the forest on the Park property. However, Hurricane Cindy in 1963 corresponds almost exactly with the ages of the loblolly pine and water oaks that constitute the forests now found on these windthrow-affected sections of the Park.

This hurricane came ashore and stalled out for several days over Port Arthur in extreme southeast Texas – thus inundating the region with rainfall amounts in excess of twenty inches. The storm then took an unusual route in heading due west, right over the Park area, then proceeded southwest in a parallel course to the coastline. This track concurs with the somewhat unusual wind patterns indicated by the relic windthrown logs in these areas of the Park.

We can assume that there was salvage harvesting efforts on the part of Champion in response to these storm events. There is strong evidence that forestry site preparation and replanting with loblolly pine followed these incidents, as well.

We see the evidence for this most clearly in the row-planted, even-aged loblolly pines on the slightly higher ground, and in the naturally-regenerated water, willow and laurel oaks that occupy the lower, wetter areas adjacent to the pines. In some areas the pines were able to totally colonize the reforested areas, while in other spots only the oaks were able to survive. In fact, the first attribute that alerted AEL foresters to the fact that these dense stands of oak trees were the product of some massive forest disturbance was that they exhibit a striking similarity to poorly-drained pasturelands that are often colonized by water, willow and laurel oaks.

Transition of the Park – 1970's to 1980's

Due to urbanization of the area north of Houston, Champion naturally examined their timberland holdings for marketing as higher-and-better use properties. An interview with a former manager of the Champion Realty group indicated that in the early 1970's that this land laying between Caney Creek and the East Fork of the San Jacinto had issues that limited its future development potential. The low-laying, poorly-drained soils and the less-than desirable access were the two key factors that led Champion to believe that this land would be best utilized as a park or preserve.

This led to the transfer of the land from the Champion timberland management group to the Champion Realty division. The management of the forest continued with the timberlands group

handling any needed forestry work for the Realty folks. The marketing of this land took almost a decade, and in the interim is when the pine beetle outbreaks occurred. The timberlands forester AEL interviewed distinctly remembers billing the Realty division for time and expenses handling pine beetle control and salvage efforts during this period.

The State of Texas had showed an interest in the property back in the 1970's. This interest became reality in the early 1980's, with the State purchasing the 4,710 acres from Champion in 1981. The State acquired the 202 acres on the west side of Peach Creek in 1990 from the Girl Scouts, who had operated a camp there since 1955.

The Texas Parks and Wildlife Department managed the young forests of the Park with some prescribed burning in the 1990's. The Park looked a lot different during the first twenty years of State stewardship. It must be remembered that the State bought a relatively young forest, with most of the trees only being ten to twenty years old! There was not an overwhelming need for much habitat management during these first fifteen to twenty years, as the forest canopy had yet to fully close in. Sunlight was still able to penetrate to the ground, providing browse and diversity through the varied plant life that abounded.

There were spikes in the pine beetle outbreaks in the 1984-1986 period, and another one in the 1989-1993 time frame. These created large openings scattered about the forest. As the 1990's came to a close, however, the forest canopy closed, and the understory plants died back, creating the forest that we see today.

The Forest Today

The Park has a relatively uniform forest made up of four primary age classes. Note that these ages listed are general range classes of pine and hardwood ages found on the Park. There are, of course, trees that are older and some that are younger. But there are four distinct, broadly-occurring aggregation of tree ages found in the Park's forests.

- Relatively few relic Second Growth trees with ages running from 75 to 110 years old
- A large class of 45-year old trees – most likely the result of early 1960's hurricanes
- A large group of 35-year old trees – probably a result of the mid-1970's pine beetle epidemic
- A smaller batch in their mid-20's – can be tied to the pine beetle activity around the mid 1980's

The forest on the Park can be broadly defined as a mixed pine – hardwood forest with the most common trees being loblolly pine, water oak, swamp chestnut oak that were established through natural and human-caused events over the past 45 years.

This forest suffers from a lack of openings in the forest overstory canopy. This almost unbroken expanse of trees has shaded the forest floor, limiting the variety of plant species that are potentially capable of growing in the Park. This also drastically reduces the wildlife food sources for birds and animals.

Openings in the forest are important for not only providing browse and other fare for wildlife, but also for the next generation of the forest. A large percentage of the tree species in the Park require full or nearly-full sunlight conditions in order to regenerate and thrive. These "early successional" forests are literally a shopping basket full of good things for the ecosystem, from wildlife food to insuring a forest for the future.

Mature Bitternut Hickory in the Park

SUSTAINABLE FOREST MANAGEMENT RECOMMENDATIONS

A thorough knowledge of the tree sizes, species and the number of trees per acre, as well as the history of the Park's forests are important keys to understanding the origins of the forest habitat, and how to best manage it for the future.

The next step in formulating management recommendations for the Park was to thoroughly examine the forest data, calculate some key forest attributes, apply this data to forest growth and yield models and develop long-term management activity plans. The first phase in this process was to fully analyze the forest product inventory data that was obtained in our examination of the forest.

DETAILED FOREST PRODUCTS INVENTORY

As previously described, AEL sampled the forest on 2,310 sample points arranged on a grid pattern across the Park. In addition to the information gathered about the forest stratum, the midstory and understory plants, and landforms, specific data on the larger forest trees was also taken at the same time. This forest products inventory was completed by AEL in May and June 2008.

This sampling was directed at the trees over 5 inches DBH. This is the minimum size tree that could potentially have commercial value in the general forest products markets in East Texas. These trees were selected for sampling using the variable point-radius methodology, with a 20-factor angle gauge/prism. Point sampling is a method of sampling tree data throughout the forest measured at a fixed point. The angle gauge is a specific-sized instrument rotated around the point center, and those trees that appear larger than the width of the gauge are counted. Trees that are smaller than the width of the gauge are not counted.

The species, its DBH and the merchantable height (the portion of the tree trunk that is useful as any one of several forest products) and the potential forest product of each sampled tree thus selected was tallied into a handheld computer / GPS device.

This data was assembled using a suite of forestry computer and GIS software programs. AEL mapped out exactly where the sample points were taken on the Park from the GPS data. This data was processed to derive the quantitative and qualitative data on the forest, by major product and species

classes, for each forest stratum. The detailed summary tables are attached to this report in Appendix "A".

The definitions for each of the product/species classes and the parameters used in evaluating each sampled tree are as follows:

Figure 5 – Forest Inventory Specifications

LHCP TIMBER INVENTORY - MAY 2008 - ADVANCED ECOLOGY, LTD.

CODE	SPP/PRODUCT		DBH RANGE	TOP DIB
1	LOBLOLLY			
	SAWTIMBER	-	12.0	8.0"
	SMALL SAWTIMBER		7.0	6.0"
	PULPWOOD		5.0	4.0"
2	BALDCYPRESS	-		
	SAWTIMBER		16.0	10.0"
	PULPWOOD		7.0	12.0"
3	SUGARBERRY GRADE		12.0	9.0
4	MAGNOLIA GRADE		12.0	9.0
5	SYCAMORE GRADE		12.0	9.0
15	MISC. HARDWOOD			
	SAWTIMBER		12.0	9.0"
	PULPWOOD		7.0	4.0
16	RED OAK GRADE		12.0	9.0
17	WHITE OAK GRADE		12.0	9.0
18	ASH GRADE		12.0	9.0
19	SWEETGUM GRADE		12.0	9.0

Loblolly pine is currently utilized in the southeast Texas timber markets as pulpwood, small sawtimber and larger sawtimber. The pulpwood-grade trees are those that are too small for small sawtimber, or have defects such as sweeping, crooked or twisted trunks, excessive knots or other faults that would preclude their use as sawtimber. These trees could be used for both pulp and paper manufacturing, or for producing oriented strand board (wood panels made from strands or flakes of wood, widely used for roof decking in place of plywood). The small sawtimber grades are normally utilized for producing 2x4 studs and plywood, while the larger sawtimber is used for making larger sizes of pine lumber.

Baldcypress and miscellaneous hardwood sawtimber and pulpwood are similarly utilized, except that neither one is used for plywood or oriented strand board production. A large market for miscellaneous hardwood sawtimber is crosstie production, so much so that a commonly-used term for this grade of tree is "tie-log".

The Grade classification for the various hardwood species reflects its use for flooring and furniture-grade lumber production. The pricing and specifications vary between the species, and this is the reason for these distinctions by tree species.

The following table is a simplified summary of the total estimated forest products inventory for the entire Park. The "Tons of Product" are standard 2,000 pound tons, and the "Cords of Product" are 90 cubic-foot cords.

Figure 6 – Forest Product Inventory Summary – Total Park

Forest Product Inventory Summary - Total Total Park Acres - by Product/Species Classes			
Product /Species Class	*Number of Trees Per Acre*	*Tons of Product Per Acre*	*Average Diameter (Inches)*
Pine Sawtimber	141,360	201,840	15.50
Pine Small Sawtimber	100,752	32,448	8.90
Pine Pulpwood	81,888	13,440	6.20
Baldcypress Sawtimber	960	1,968	19.00
Baldcypress Pulpwood	1,392	1,152	11.10
Hardwood Crosstie Sawtimber	82,896	59,520	16.30
Hardwood Pulpwood	189,216	53,568	9.40
Red Oak Grade Sawtimber	4,272	3,504	16.70
Sweetgum Grade Sawtimber	48	96	18.50
White Oak Grade Sawtimber	528	576	18.30
TOTAL	603,312	368,112	13.99

The following table shows the same tree count and volume information on a per-acre basis. Note the dominance of pine in the volume per acre categories.

Figure 7 – Forest Product Inventory Summary – Per Acre

Forest Product Inventory Summary - Per Acre Total Park Acres - by Product/Species Classes			
Product /Species Class	*Number of Trees Per Acre*	*Tons of Product Per Acre*	*Basal Area Per Acre*
Pine Sawtimber	29.45	42.05	40.20
Pine Small Sawtimber	20.99	6.76	9.20
Pine Pulpwood	17.06	2.80	3.80
Baldcypress Sawtimber	0.20	0.41	0.40
Baldcypress Pulpwood	0.29	0.24	0.20
Hardwood Crosstie Sawtimber	17.27	12.40	22.10
Hardwood Pulpwood	39.42	11.16	19.50
Red Oak Grade Sawtimber	0.89	0.73	1.50
Sweetgum Grade Sawtimber	0.01	0.02	0.01
White Oak Grade Sawtimber	0.11	0.12	0.20
TOTALS, PER ACRE BASIS	125.69	76.69	97.11

This data shows that the Park consists of very dense woodland, dominated by a mixed pine-hardwood forest, with substantial volumes of forest products. The potential economic value of this volume of forest products will depend on the final management strategy, but in any case will be significant to the development of the Park itself.

The details of the various species, their densities and sizes, are vital to a full understanding of the ecological dynamics of this forest. Knowing how many trees that make the size and grade for pulpwood gives the habitat manager a good idea of the level of young trees in the forest that will serve as replacements for the older trees when they inevitably die from any number of natural causes (this process of replacement is referred to as 'recruitment'). These tables show that the pine stocking is good, having a good larger-tree component, but with a serious deficit of younger trees. The hardwood numbers are somewhat better balanced, although this is somewhat skewed by the presence of some older, larger trees that are classed as pulpwood, due to rot and decay in the trunk (remember that the shortwood loggers left the larger trees).

The Red Oak Grade Sawtimber is the only significant grade class that was encountered in the Park. This is indicative of the relative abundance of cherrybark red oak, a very desirable species in terms of aesthetics, wildlife benefits and economic value.

An important term to understand in forest habitat assessments is 'Basal Area'. Basal area is the area of the cross-section of the trunks of the trees stem at DBH, being expressed in square feet per acre. This basal area number is used to calculate several useful numbers, amongst them being the volume of a tree, the trees per acre and the total density of the forest. A given basal area figure may be a lot of small-diameter trees, or a fewer number of large trees. Therefore it is important to judge basal area along with the trees per acre.

The calculation of forest product volumes, expressed in tons, is useful in assessing not only the potential volumes of product in the forest today, but is used in software programs that forecast the growth of forests over long periods of time. These forest modeling programs are very useful in assisting in formulating long-term sustainable forest strategies, one of the major goals of this Plan. A broad range of management activities and scenarios can be assessed to design a plan that has real-world forest growth data as its basis.

It is helpful to remember that the size, species and frequency of trees in the forest have a direct bearing on wildlife habitat quality and ecosystem diversity. These forest growth models have proven to

be good forecasting tools to 'see' how different habitat management activities will affect the future forest.

At the same time, it is a certainty that on a tract of land the size of the Park, there is a significant economic value in the trees themselves. The habitat conditions in the Park are deficient due to the almost complete closure of the forest canopy. A carefully planned and executed habitat management plan that will integrate a sustainable forest thinning program along with invasive plant control and habitat enhancement work will be generating a substantial volume of potentially valuable forest products.

As it is with any public facility, this large Park will require a significant economic investment to provide the infrastructure needed to enable park visitors to enjoy this unique forestland. Trails, restrooms and parking areas are just a few of the items needed in the Park. There are considerations that must be made concerning wildfire mitigation and emergency evacuation planning that will entail some meticulously planned modifications to the almost unbroken expanse of forest.

The key to the conservation of the natural resources of the Park is to use existing, proven and environmentally-sensitive forest management techniques to accomplish the needed management objectives while generating considerable income on a long-term, sustainable basis. The problem with many habitat management plans is the lack of incentives and funding to sustain the necessary activities over many years. It is nice to create forest openings, plant some trees, and control a few acres of invasive plants – once; but to have real, long-term ecosystem health on a parcel of land the size of this Park, plans must be made that are not only sustainable, but are economically practical, implementable and repeatable, and amenable to adaptive management over many years.

FOREST SITE QUALITY AND TREE GROWTH

Once AEL foresters understood the overall structure of the Park's forests, and the relationships between the various landforms and forest communities, targeted sampling of tree growth and site fertility was undertaken. AEL selected trees to sample all across the Park, focusing on the various communities and the forest disturbance areas (such as the areas with windthrown trees and evidence of pine beetle infestations).

This process involves measuring the growth of individual sample trees by extracting cores of wood from the trunk of the tree and examining the growth rings. This is commonly referred to as 'increment coring', being a reference to the incremental growth of trees. This is harmless to pine trees,

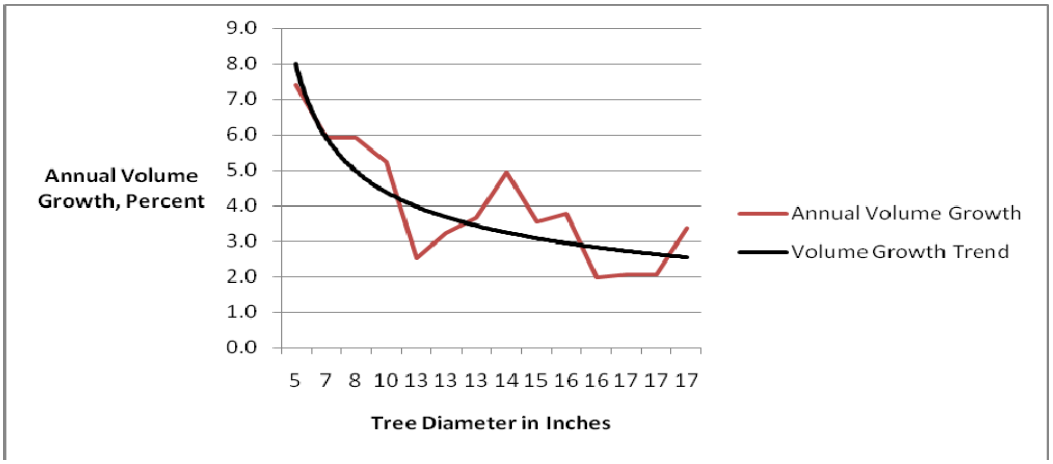
as the small-diameter (1/5th of an inch) boring quickly fills with sap. On hardwoods, we select trees that have a small degree of existing trunk rot and decay where we can get a sound sample. The increment coring is likely to introduce fungal infections in hardwoods, so we pick those that already have disease problems.

The total age of the tree was examined, as well as the growth increment for the past ten years (expressed as number of inches that the tree grew, in radial growth, over the first ten growth rings counted inward from the bark.) The DBH is measured in inches, as well as the total height of the tree in feet.

Two very important forest characteristics are derived from this data, growth and site index. The growth of the tree is calculated by determining the size of the tree ten years ago to its size today. The corresponding volume of the tree trunk at both ages is compared to derive an average annual volume growth percentage over the past ten years. The pine on the Park is growing at an average rate of 11.4% per year in terms of volume. The hardwoods are growing at about 8.5% in annual volume. The growth patterns and history of the pine and hardwoods are very similar on the Park.

The following chart shows the growth curve of the pine (the hardwood trend curve is almost identical) on the Park, with the smaller-diameter trees showing the normal higher growth rate than the older, larger trees:

Figure 8 - Pine Growth Study Chart



The red Annual Volume Growth line shows the actual data points, while the black Volume Growth Trend line shows the averaged pattern of the tree growth. This trend curve is what foresters would normally expect to see in unthinned forests. Note that the curve flattens out with increasing diameter. This is due to the fact that even though the larger trees have a decreased radial growth

pattern, (they slow down with age as the trees compete with one another for sunlight, water and nutrients), the larger trees gather more volume of wood on a percentage basis due to simple geometry.

These growth rates are not particularly good given that the average diameter of the sampled trees was only 12.9 inches DBH. Pines in this average diameter should be growing about 15-20% in terms of volume. The overall high basal area density of the pine is the reason for this slower growth. The same can be said about the hardwoods, especially the smaller diameter hardwoods that have occupied the pine beetle infestation areas. There are very high basal areas of hardwoods, particularly water and laurel oak, in these sections.

Site index is a relative measure of forest site quality based on the height (in feet) of the dominant trees at a specific age (usually 25 or 50 years). Site index information helps estimate future returns and land productivity for both timber and wildlife. A commonly used term for this is 'site quality'. The total height and age of the sample tree is applied to standard site index tables for that particular species. These tables have been derived from detailed studies of forests on a regional basis. The resulting site index value is the number of feet of total height that a particular species will grow to in a given length of time. For the Park's site index measurements, AEL used the 50-year site index tables. (The 25-year tables are primarily intended for short-rotation plantation management.)

The average age of the pines sampled for site index measurements was 32.1 years, and these trees had an average total height of 78.6 feet. Using the industry-standard U.S. Department of Agriculture Forest Service Second-Growth loblolly pine site index table, the average site index in the Park is 100 feet, on a 50-year basis.

This is an excellent site index, indicative of both the soils and the rainfall patterns in this coastal region of Southeast Texas. This is good from the standpoint of forest growth, regeneration and wildlife habitat, but poses some special problems with the pine component of these forests. This will be more fully discussed in the Sustainable Management Recommendations section.

FOREST YIELD AND GROWTH MODELING

Armed with the data on the forest stratum, trees per acre, basal area, soils, growth rates, site index values and the types of landforms in the Park, AEL used forest growth models to derive a management activities plan. This data was entered into a forestry growth and yield software program. This modeling uses the input data to calculate the growth of the forest, how much of the forest can be thinned and still be sustainable (known as the Allowable Harvest), calculate the growth following the thinning, and then repeat this cycle into the future. The number of years between the allowable harvests used in the models was developed in concert with the development of the Sustainable Management Recommendations.

This modeling is a starting point for beginning the management of the Park habitat. It is very flexible in terms of the timing of the harvesting. One must begin any enterprise at a given starting point, and this growth and yield model is just that. The following table details a sustainable forest harvesting plan, over a thirty to one hundred year period, showing the timing of the harvests as well as projected forest yields. It is important to note that at the end of the time periods shown for each stratum, that there will be a more robust and older forest on the Park than is present today.

The table shows the stratum type, harvest cycle (time between harvests) in years and the general target basal area (to be remaining after a thinning harvest) in the left hand column. The note about "% Pine" is the amount of pine volume in each stratum type. Note that none of the hardwood volume was included in the Pine stratum calculations, as it is minimal. The next three columns detail the total average forest age, basal area, trees per acre, sawlog volume and total volume (sawlog and pulpwood). This is shown for the beginning of a given year, the levels that will remain after the harvest, and the harvested values themselves. These numbers help us with a myriad of decisions when planning a sustainable forestry plan. There are minimum levels of basal area and volumes that must be reached before it is economical to consider a forest thinning.

However, the Hardwood and Hardwood/Pine stratums will need several additional years from now before needing thinnings. Our best estimate is about twenty years, since the basal areas are presently about at what would be considered a post-thinning target level. There are, as discussed in the Sustainable Management Recommendations, areas of pines within these two areas that will need thinnings, and this can be accomplished at the same time that adjacent Pine and Pine/Hardwood sections are being thinned. The harvest cycle was set at one thinning harvest every forty years on any

given acre. This will result in the hardwood forests having a large number of trees from 120 to 150 years old at all times, while still providing for regeneration to insure sustainable forests for future generations.

Due to the overstocking of the pine trees, it will need immediate thinning over a large section of the Park. It will be imperative to get the pine basal area down to safe levels to help avoid a potentially devastating southern pine beetle infestation. The model has the thinnings in the Pine and Pine Hardwood strata as beginning in 2009. The harvest cycle on these two strata was set at every fifteen years, which is about as long as AEL feels is prudent, given the high pine beetle risk factor on the Park.

While this model shows the age of the average pine tree on the Park being around 80 to 90 years old in the year 2039, in reality the average age of the oldest pines will probably be in the 75 to 100 year old range, on a sustained level. Of course, there will be very specific areas in which substantial numbers of hardwood and pine trees will be left to reach whatever age they are able to attain. These will be heavily concentrated in the Passive and Riparian management areas, as detailed in the Sustainable Management Recommendations section.

There is much flexibility built into this Plan. As any specific area of the Park is considered for habitat work, very specific prescriptions will need to be formulated to address the precise areas to be thinned, any adjacent Passive or Intermediate Management Area pine stands that need thinning and the details of how the activity is to be accomplished. The structure provided by this Plan will serve as a guide to the habitat manager in preparing and executing activity prescriptions.

The target basal area, harvest cycle, and other details will need to be more closely examined twenty, forty and sixty years from now. We cannot anticipate what outside forces or events will change the dynamics of this forest, the economy, or our society as a whole over such a long period of time. But this Plan affords a framework, a guiding philosophy and strategy for preserving the habitat of the Park while providing for the future regeneration of the forest.

Figure 9 - Growth and Yield Modeling – Lake Houston Park

			Total at Beginning of Year					Residual After Harvest				Harvested			
		Year	Average Age	Basal Area	Trees Per Acre	Sawlog Tons	Total Tons	Basal Area	Trees Per Acre	Sawlog Tons	Total Tons	Basal Area	Trees Per Acre	Sawlog Tons	Total Tons
Bottomland Hardwood															
		2008	50	75	62	41	47								
Harvest Cycle, Years	40	2038	80	108	54	76.2	108.4	75	38	52.3	74.4	33	16	23.9	34
Target Basal Area	80	2078	120	111	33	79.1	121.5								
Acres	118														
24% Pine															
Hardwood															
		2008	45	65	83	23.3	42.2								
Harvest Cycle, Years	40	2028	65	94	74	65.88	89.1	75	59	51.9	70.2	19	15	13.98	18.9
Target Basal Area	75	2068	105	94	46	82.2	120.3	75	31	54	79	19	15	28.2	41.3
Acres	232	2108	145	109	28	78	122.4								
7% Pine															
Hardwood Pine															
		2008	50	79	96	38.2	54.3								
Harvest Cycle, Years	40	2028	70	112	71	78.6	108.8	80	51	55.4	76.7	32	20	23.2	32.1
Target Basal Area	80	2068	110	114	41	82.8	123.5	80	29	57.1	85.2	34	12	25.7	38.3
Acres	1168	2108	150	111	27	79.5	126.1								
28% Pine															
Pine															
Harvest Cycle, Years	15	2009	50	91	68	80.5	88.7	70	52	61.9	68.1	21	16	18.6	20.6
Target Basal Area	70, 80	2024	65	96	50	97.2	101.4	80	41	79.7	83.1	16	9	17.5	18.3
Acres	92	2039	80	89	38	103.8	106.3								
No Hardwood Used															
Pine Hardwood															
		2009	50	107	143	71.3	102.7	80	107	53.3	76.7	27	36	18	26
Harvest Cycle, Years	15	2024	65	107	112	96.7	115.5	80	76	71.7	85.5	27	36	25	30
Target Basal Area	80	2039	90	96	74	102.4	112.9								
Acres	2966														
65% Pine															

SUSTAINABLE MANAGEMENT AREA RECOMMENDATIONS

These habitat management recommendations are prescribed according to data used to understand the attributes of the forest communities, and to develop forest growth and yield projections. The recommendations recognize the need for habitat modifications to promote ecosystem diversity, future forest regeneration and visually-pleasing aspects important to visitors.

The basic philosophy of these recommendations is that the active management activities should be targeted at areas that have heavy pine components, that have the better-drained soils, and that will provide the greatest improvement in habitat conditions. A map of these management areas is found in Appendix "D".

Healthy, dynamic forest ecosystems exhibit an ecologically desirable cycle of establishment, growth, disturbance and regeneration. The preferred condition is a mixed-species, multi-aged forest with prairie-like openings and diverse habitat rather than the closed-canopy, even-aged, low-diversity forest that exists on the Park today. Furthermore, the establishment and growth of new woody and herbaceous species require essential factors such as available sunlight, reduced vegetation competition, bare mineral soil that are increased by management actions. Consequently, selective forest harvesting is indispensable for removing individual trees or small groups of trees to produce all the above-mentioned conditions on a meaningful scale on a tract of land as large as the Park.

Carefully planned, executed and supervised harvesting will be a key part of the integrated natural resource and land management plan that incorporates prudent utilization of resources so they are protected and judiciously extracted while enhancing the resource base. Controlled thinning operations can achieve recreational objectives specified to change forest characteristics needed for scenic appeal, openings, trails and, access roads. Notably, thinning also helps prevent pest problems (such as pine beetles).

Therefore, forest thinning is a practical tool for accomplishing many of the management objectives identified in this plan. Importantly, operations can be conducted to protect environmental quality and reduce visual impacts while generating revenue. Key requirements for environmentally sound harvesting will include good planning, reputable contractors, skilled workers, and professional foresters who understand the concepts and application of sustainable forest management practices.

Active Management Areas – 1,249 Acres

In general, these areas located on the higher elevations in the Park have a higher density of loblolly pine and better-drained soils. These areas are, by and large, found in the "Pine-Hardwood Somewhat Poorly Drained" and "Pine-Hardwood Well-Drained" community types.

The pure pine stands are at risk of southern pine beetle infestations due to the high trees-per-acre densities. However, they are on the better-drained soils that do not have the levels of standing water like the Flatwoods, and are well suited to maintain a pine-dominated forest. They definitely are in need of thinnings to maintain moderate densities and promote desirable attributes in this ecosystem. For example, the opening of the closed canopy will stimulate wildlife food production for a number of guilds of wildlife species. Furthermore, the better-drained areas offer more practical opportunities for affecting plant and animal diversity than the wetter sites of the Park, and are, therefore, a prime candidate for forest thinning activities.

The timing of the management activities would be on a cycle of one thinning about every fifteen years. While this is a bit longer than what would normally be prescribed for uneven-aged forest management (usually every seven to ten years), it will suffice in accomplishing the mission of pine beetle hazard mitigation while protecting the aesthetics and recreational usage of the Park.

The ramifications of no management activity in these heavy pine stands over the long term would include probable loss of large numbers of pines, highly increased wildfire hazards associated with large-scale beetle-killed areas, negative impacts from the aesthetic standpoint, and high costs of snag removal from trails and Park infrastructure as a safety issue.

Intermediate Management Areas – 1,490 Acres

This management intensity category generally encompasses the "Pine-Hardwood Poorly-Drained" and some of the "Flatwoods" forest communities. The recommendation to implement some level of forest thinning activity in these areas is centered on the presence of loblolly pine in these lower-lying, poorer-drained soil types. These pines are at a very high risk of pine beetle infestations, a fact that is dramatically demonstrated by the past pine beetle epidemics in these areas of the Park. An appropriate level of thinning is needed to control the pine densities to a safer level, or the Park risks having catastrophic losses of pines at some point in the future. These events tend to start in the higher-risk areas and then spread into the adjacent pine forests that are more vigorous.

Hardwoods are, in general, more adapted to these community types and would be favored over pine during thinning activities. There are small, pure stands of pine that would be thinned and remain

as such, but solitary medium-aged pines might be removed if this action would enhance surrounding hardwood tree health. Experience has shown in these types of habitats that such thinnings will afford just enough additional sunlight to promote both hardwood and pine regeneration – with the pine re-establishing itself in the appropriate locales on the higher, better-drained microsites. Past commercial timber operations had circumvented this natural selection process by the heavy site preparation of these areas following pine beetle infestations, windstorms or timber harvesting. Pines were planted in locales that often would not occur in a natural ecosystem.

The general time schedule in these areas would have habitat modification activities occurring, on a limited scale, somewhere in the neighborhood of once every fifteen to twenty years. This activity would be more recurrent on the pine component of these areas of the forest.

Passive Management Areas – 1,494 Acres

These sections of the Park have a higher density of hardwoods and are generally located in the wetter "Flatwoods" community types. The primary risk of any habitat management thinnings in these areas is a very high potential for trees being blown down in thunderstorms, commonly referred to as "windthrow". This is caused by the shallow-rooted trees in these saturated, low-oxygen soils. The red oak group, in particular, is susceptible to windthrow, especially willow, water and laurel oaks – all commonly-occurring species in the Flatwoods communities on the Park. A forest thinning can, if not properly planned, result in openings in the canopy that can allow wind to detrimentally subject forest trees to windthrow.

For this reason AEL recommends that these areas be managed with a very light touch, only thinning the areas that have the higher pine densities, many of which are remnant pine plantations established thirty to forty years ago.

These are also the most susceptible areas for tallowtree infestations, due to the wet ground and low-light conditions, both of which offer low-competition, bare-soil environments that are ideal for tallowtree establishment. This is a secondary but important rationale behind limiting disturbance in these areas.

Some of these areas were selected for their open forest understory conditions, and the likelihood that they can be allowed to function naturally over a long period of time. These areas include the bottomland hardwoods along the San Jacinto River and Caney / Peach Creek corridors, the Baldcypress Swamps (characterized by the long-lived baldcypress), and some of the highly-disturbed pine plantation areas in the Flatwoods community.

The inclusion of the latter may seem counterintuitive, but these areas will, over the next fifty to one hundred years, take on a forest structure that will mimic the pre-settlement forests that existed in this region.

The limited forest thinning activities in these areas would be done about once every fifty to seventy-five years on the whole, with a more frequent cycle of every twenty-five to thirty years in the denser pine areas. On the average, any given acre in the Passive Management Areas will have a habitat management thinning about once every forty years.

Candidate Prairie Areas – 75 Acres

The establishment of Prairie Areas is desirable from both a wildlife habitat and a wildlife viewing perspective. These openings in the forest will leave the larger hardwoods for increased acorn production and aesthetic pleasure, as well as providing vertical structure in the opening. The prairies will have the majority of the trees removed and replaced with native grasses, forbs and shrubs. They will be irregularly-shaped to maximize the edge effect and offer enhanced aesthetic views.

These 75-acres of Candidate Areas were chosen on the basis of old pine beetle spots that have been heavily colonized with laurelcherry and/or yaupon. There are more than sufficient examples of this type of brush structure habitat scattered throughout the Park, as opposed to the scarcity of forest openings. The need is much greater for semi-permanent forest openings than for brushy habitat.

To certain degree, these areas were also chosen as being suitably located to roads, trails and utility corridors to provide easy public access and wildlife viewing opportunities. These Candidate Prairie areas were chosen as being perfect alternative uses of those sites. However, the total acres afforded by these targeted areas, even when combined with the open Utility Corridors (approximately 75 acres) only results in 150 acres of open habitat (3% of the total Park area). Ideally, at minimum, 5% of a given forest should be in openings, with 10% being a much healthier number.

AEL recommends that a target of 5% of the Parks forested area be dedicated to permanent forest openings, and 5% be placed in rotating openings that may be characterized more by forbs (e.g. wildflower species) than by perennial grasses. The permanent plots can be chosen as these areas are established, based on the success of the grasses and herbaceous species, and upon use by Park visitors. Some of these areas will prove to be more successful and popular than others, and that can be used as a guidance criteria as well as any other measure.

These rotating areas will be kept open for 15 to 20 years, and then be allowed to naturally regenerate back into forest. While this system will not result in a total of 10% of the Park being open at

any one time, the rotating areas will be in various stages of development, and provide excellent habitat diversity.

It is recommended that these irregularly-shaped herbaceous openings be kept to a maximum of about 5 to 7 acres to provide maximum edge effect, to maximize usage by a variety of species, and to limit potential cowbird nesting parasitism. This last point may not be an issue but is worthy of mention. This may require volunteer monitoring assistance from local groups such as the Audubon Society or the Gulf Coast Bird Observatory.

There is another risk in creating openings in what is essentially a closed canopy forest. Such openings invariably allow much higher wind gusts to penetrate into a forest comprised of trees that have not matured in a wind-exposed environment. Their root systems and trunks are not adapted to wind loadings, and as a result, windthrow and crown breakage damages will occur to the retained forest border around the opening.

Besides limiting the size of the prairie areas as previously discussed, the careful selection of the trees to be retained in the forest border, based on examination of individual trees for windthrow risk factors, can mitigate these wind damages. These risks include trees that exhibit severe lean, show signs of rot and decay, and older trees, especially those with very large crowns. The boundaries of the openings should be marked out in a manner to shield the high-risk trees from the edge of the forest openings. Close-together stands of younger, smaller-crown trees are better to leave along the edge than old, large-crowned trees. An exception to this are large trees that exhibit clear signs of earlier exposure to open conditions, i.e. the presence of many knots low on the trunk. These trees often have sufficient strength to withstand wind exposure.

This concept should be kept in mind when thinning areas adjacent to the existing utility corridors. The existing trees that border these right-of-ways should always be retained, as much as possible, to act as a wind break for the adjacent forest.

This windthrow effect cannot be totally eliminated; in fact, it is desirable from a habitat standpoint to have downed trees provide additional, random openings as well as beneficial coarse woody debris that provides an increased diversity and abundance of invertebrate and vertebrate prey for many species of amphibians and reptiles.

A very important aspect of these openings is the establishment of Habitat Corridors in between forest openings. The Corridors are forest areas will be retained as forest and subject to the appropriate forest management regime depending on the landform involved. They may have various-aged trees and

vegetation in them since they are managed in an identical manner to the surrounding forested area. They are not Retention Areas that are 'left alone' and not managed. These Corridors of forest should be kept at least 300 feet wide at the narrowest point to accommodate as many wildlife species as possible.

The loading areas used in the forest harvesting operations are excellent starting points for forest opening creation. These areas will always require good vehicular access, therefore they will naturally be easily accessed by the public as wildlife viewing areas and educational stops. The treatment of these loading areas should also include a followup of mulching tops and limbs in landing areas to allow for reestablishment of grasses, herbaceous and woody plants. The generated mulch can be used on-site in the Park for a myriad of purposes such as erosion control, mulching around trees in high-traffic areas, etc.

Some of this woody debris can be piled in various locations around the loading area to provide coarse woody debris sources for a variety of wildlife. However this piling should be kept low (not over three feet tall) and be limited in total size. It will be better to have a dozen or so small piles scattered around the periphery of the forest opening rather than one large one in the middle.

The areas scheduled for rotation will eventually return into young forests and the replacing of the openings with new ones will be an integrated part of the uneven-aged management of the forest. The plans for the Loop Road around the interior of the Park will provide the best locations for many of these rotating prairies. The Road will tend to be located in areas of better-drained soils, which fits the overall management guidance of restricting most of the habitat modification work to these areas.

Another excellent location for establishing these openings will be adjacent to the utility corridors. These will serve to maximize the open-habitat effect of both, while breaking up the less-than-desirable aesthetic aspects of these utility right-of-ways.

Openings can also be small irregularities in the boundary of the smaller pipeline right of ways, and be intersperced with areas where the limbs of adjacent trees are allowed to grow into the right-of-way clearing to a certain degree. This will require coordination with and the cooperation of the owner of these right-of-way corridors.

Riparian Zones – 662 Acres

The forests along the major water features on both sides of the Park are unique in that any contemplated activity has the additional burden of extreme sensitivity to soil disturbance and water quality. These areas were not included in with any of the other Management Intensity classes due to this attribute.

As with the other areas, the heavier pine stands are of concern from a forest health standpoint. This addresses the younger-aged pine stands that are 30 to 40 years old, and excludes the older 75-100 year pines. Those older trees will be retained for their uniqueness and character.

The largest and oldest pines found in the Park are along the two major riparian areas, especially along the San Jacinto River corridor. These trees will be protected and hopefully will continue to survive for another hundred or more years (it is not uncommon for loblolly pine to attain ages in excess of three hundred years old). This contingent of very tall, very large pine, in conjunction with the baldcypress, has the potential to provide nesting sites for bald eagles and osprey.

Any thinning activities in these Riparian Zones will require an additional level of planning and integration with activities in adjacent areas, and will be extremely sensitive to weather conditions.

Aquatic Habitat and Baldcypress/Tupelo Swamp Enhancements

The primary exception to this schedule will be the enhancement/creation of additional baldcypress/tupelo stands. In specific areas of the Park, primarily within the San Jacinto River and Caney Creek corridors, suitable low-lying sloughs and depressions will be examined for the existence of baldcypress trees around their periphery. Some of these features will fall within all of the Management Areas, not just in the Riparian Area. Many of these locations are suitable for growing baldcypress, but due to the exacting nature of natural regeneration of baldcypress, it did not become established except in selected spots. In many of these areas the soils are so wet that only species such as baldcypress and water tupelo will grow.

In the areas that are judged suitable for baldcypress, the existing forest will be cleared back from the edge of the depression / slough, and this area will be replanted with baldcypress seedlings. The width of these strips will be set according to the local topography and forest conditions around the depressional feature. If the central portion of the depressional area has standing water most of the year, which will preclude establishing baldcypress, water tupelo seedlings will be planted in the shallower sections of the area. The establishment of these two species in these areas should provide for future regeneration of these areas with the natural fluctuations in the water levels in the depressional feature.

The older trees that may exist in these areas to be cleared must be retained as a source of wood duck nesting cavities, especially the ones that are adjacent to the water. This will apply to any larger, older hardwoods that will supply future cavities for nesting sites for any number of avian or mammalian species.

There may also be some opportunities to create some additional standing water in some of these depressional areas by erecting very low earthen berms at strategic locations on the downstream outlet side of the area. Small drop-riser water-control structures can then be placed in the berm, allowing for the control of the water levels. This will be an excellent aquatic habitat management tool, and will assist greatly in establishing not only baldcypress/tupelo trees in these areas, but also help create better aquatic plant ecosystems that thrive on varying water levels.

Where the opportunity presents itself, there are definitely locations where Lake Isabel-type deepwater habitats can be created with relatively small impoundment structures (which is the genesis of Lake Isabel – the damming of a natural slough). Additional habitat of this nature can favor numerous wildlife species from wood ducks to river otters, not to mention alligator, beaver, turtles and other aquatic species. For successful local production, wood ducks require adequate cavities for nesting, and, abundant brood-rearing habitat in shallow wetlands characterized by emergent herbaceous plant communities and intermixed with shrub stands and downed woody debris. Often these conditions in production habitat occur at the margins of deeper ponds and lakes. The created impoundments described above are expected to provide these needs for wood duck production.

HABITAT MANAGEMENT AND HARVESTING STRATEGY

Uneven-Aged Management Philosophy

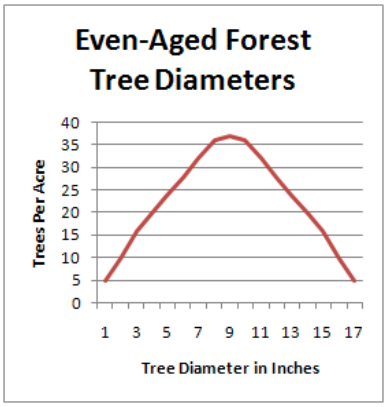
The particulars of the harvesting thinning being proposed in this Plan are based on years of experience in managing private lands to enhance the recreational, aesthetic and environmental aspects of forestland while providing sustainable harvesting income. The management system that is the keystone of this Plan is the Uneven-Aged Group Selection system. This is simply defined as harvesting carefully-selected small groups of trees on a periodic basis so that the age and size classes of the natural reproduction are intermixed.

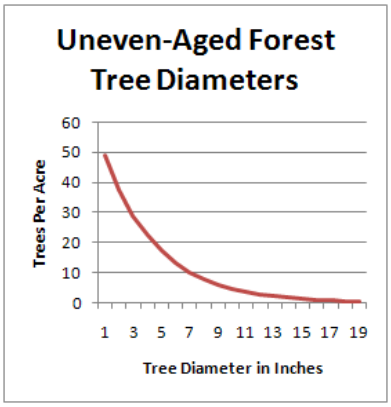
Theoretically, these stands contain trees of all ages ranging from seedlings to mature canopy trees. In practice, Uneven-Aged forests are a matrix of various-aged patches and pockets of trees, with an irregular forest canopy height. The younger, smaller-diameter trees make up the largest number of stems, with a decreasing number of older, larger diameter trees. This pattern is necessary to accommodate the sunlight requirements for natural forest regeneration. Even though you may see some small seedlings and saplings underneath the larger trees, those small ones will not survive to maturity.

While light, uniform forest thinnings may be appropriate in some cases, especially in stands of younger trees, if patches of full sunlight are not introduced into the forest only the shade-tolerant species will regenerate and thrive. In the Park, this translates primarily to yaupon and tallowtree. The yaupon will suppress almost all other plants, including tree seedlings, and it is very difficult to control. We can deal with tallowtree more easily with standard vegetation control methods, but we do not want to encourage this invasive non-native plant.

This is not to say that the shade tolerant species aren't important in the ecosystem, because all of the native plants in the Park have intrinsic value. But those plants generally do not have to struggle to thrive in the forest. There are, and always will be, plenty of shaded areas for these plants to occupy.

The following charts compare how the number of trees per acre reduces at a logarithmic rate as tree diameter increases in uneven-aged forests in a reverse-J curve, as opposed to the bell-shaped curve of even-aged stands.





A management harvest used to begin creating an even-aged forest must not only reduce the number of mid-range diameter trees, but also provide sufficient forest openings to boost the number of smaller trees. The larger diameter trees are basically retained until the young seedlings and saplings are established. This process occurs over many years and through a succession of harvesting events.

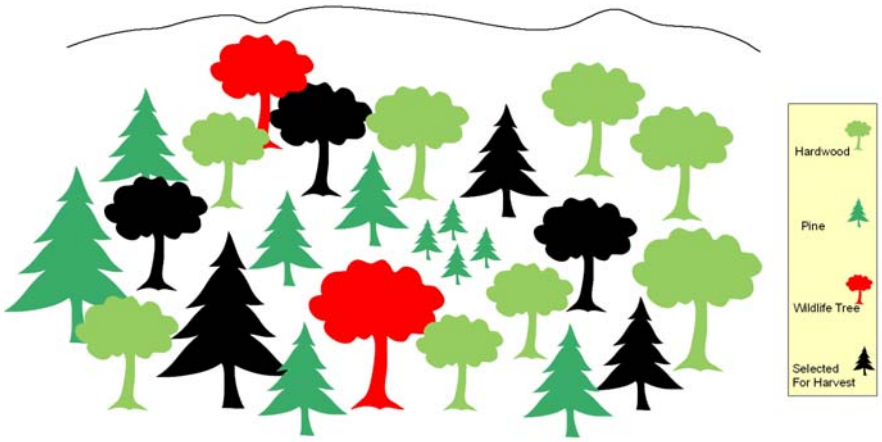
One positive aspect of Uneven-Aged management is that the forest always has a mix of various aged trees and vegetation, thus providing a buffer against catastrophic events such as insect, disease or weather-related disruptions. No matter what the impacts, the chances that a diverse, viable forest will remain in place following such an event are much higher than under the even-aged conditions that exist on the Park today.

This diversity of ages also provides for some economic cushioning, as well. While this may not be as important since this forest is a park, there are advantages in having a variety of forest products available for harvest. This provides a buffer in the pricing structure as markets cycle over time.

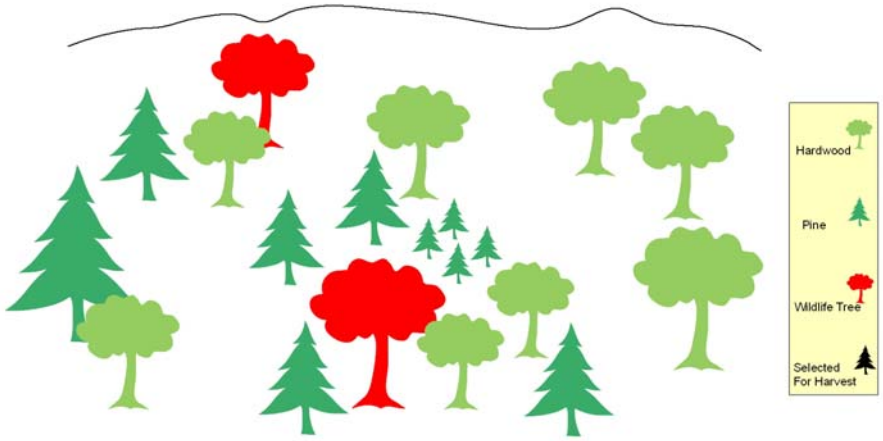
The primary negative of this system is the obligation placed on the manager to insure that the natural regeneration efforts are successful. Once forest openings are made, there will be an inevitable reinvasion of plant life as the sunlight hits the forest floor. Intense monitoring of these sites is necessary to verify that the desired regeneration has occurred. If not, then steps must be taken in terms of vegetation control and possibly planting or seeding of the preferred species. If this step is ignored, the forest will revert to an even-aged character and will cease to offer the advantages of the uneven-aged habitat.

An important aspect is the monitoring of the achieved allowable harvest levels and the growth of the forest. Any major disruption to the forest such as involuntary forest losses (wind, fire, insect infestations) must be assessed and compensated for the future harvest schedule to insure that sufficient forest stocking levels are maintained.

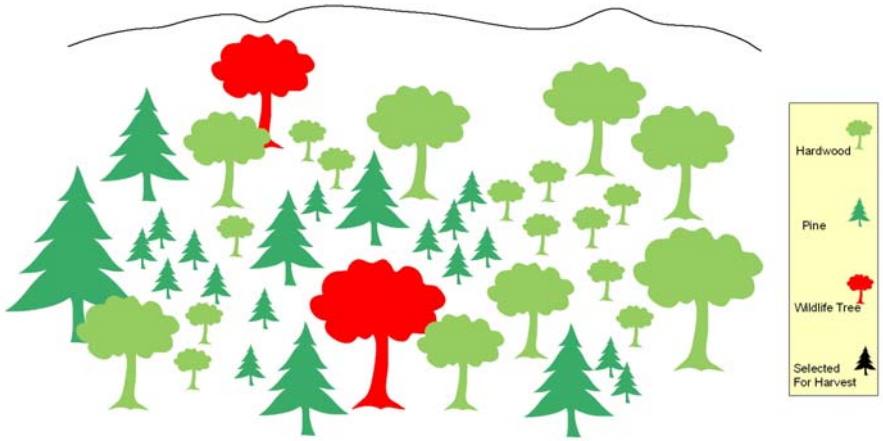
As an illustration of this uneven aged, natural regeneration concept, the following figures show how the progression of selecting trees, harvesting them, and the subsequent regeneration of young trees looks on a simplified scale.



In this slide, hardwood and pines have been selected for harvesting, based on factors that include their relationship to the neighboring trees, opportunities for creating viable regeneration openings, and providing for increased health in the residual forest.



This illustration shows the openings created in the forest canopy by the harvesting of the selected trees. This allows for increased sunlight exposure and greater moisture availability to the residual trees, which in turn improves the overall health of the forest.



This final slide illustrates the establishment of tree seedlings in the created openings. The mixed nature of the forest is retained, since both pine and hardwood trees were retained as seed sources. What this does not show is the immense herbaceous growth that occurs simultaneously in these openings. This allows for establishment of various grasses, forbs and vines that are important, each in their own way, to a wide variety of wildlife species.

While this system of managing a forest was developed for the production of wood products, this is not the focus of this plan. When individual tree selection criteria are implemented for a given harvest area, the selection will be made on the basis of the overall habitat needs. The retention of dead and dying trees, snags and species that have little or no commercial timber value will be paramount to the management of this habitat. In many, many cases there will be a commercially important loblolly pine tree that will be selected for harvesting to favor a hickory, elm or sweetgum that offers diversity in the habitat.

This is simply due to the fact that there is such a preponderance of loblolly pine in the forest. The same criteria can be applied to water oak, the second-most prevalent tree in this forest. There are, and will be, more than enough trees in this forest that offer the side benefits of income production while the habitat diversity and forest health is enhanced.

Harvest Timing and Natural Regeneration Success

The one imperative concerning these thinnings is the time of year in which they occur. Since natural regeneration is a keystone of this Plan, all forest thinnings should be scheduled to occur in the September through October time frame. The overriding reason for this is the timing of the maturing of forest tree seeds. The flowering of most of the species in the Park occur in the spring months. Their seeds fall from the tree in the autumn. White oaks germinate almost immediately; the pines and most of the remainder of hardwoods germinate the following spring.

When harvesting operations occur at the end of the growing season, and coincide with the time of seed dispersal, natural regeneration success is generally improved. In fact, winter harvesting is greatly preferred for all but white oak; however, with the wet-natured, poorly-drained soils of the Park this wil prove to be difficult if not impossible. The forest floor, having the leaf litter stirred about and some temporary exposure of bare mineral soil by harvesting machinery, provides a superior seedbed for germination and regeneration success.

The fact that the harvesting is done as the growing season comes to a close also assists the seedlings in their inevitable competition with other plants. The act of harvesting serves to disturb and temporarily suppress the understory plants, and the newly-germinated seeds have a more even start with this understory when spring rolls around.

Depending on the density of the understory, additional competition control efforts may be needed to assist this natural regeneration on a case-by-case basis. This is covered in more detail in the Vegetation Management section.

The regeneration of the forest depends upon disturbance. With the exception of catastrophic events such as major windthrow or severe wildfire, the typical method of regeneration in the forest system was through single tree fall. The Uneven-Aged management system will mimic this, albeit on a more regulated and dependable basis.

Harvest Setup

While it will be necessary to prepare very detailed prescription plans that are beyond the scope of this Plan, there are some basics of forest harvesting and the sale of forest trees that should be addressed in this Plan. The landowner stays in charge of the harvesting operation and the sale of the trees all through the process by following these guidelines. They have served consulting foresters and landowners well through many years of managing forest resources.

The first step in setting up an uneven-aged selective harvest is a field reconnaisance of the area of forest that is scheduled for a thinning. During this field trip, careful, detailed tree age and diameter data must be collected.

Since it is impractical to measure the age of every tree, only enough increment corings need be taken to verify the forester's association between diameter and age in a given stand of trees. Observations of tree conditions, any existing natural regeneration, understory and midstory conditions and soil types should be noted, as well. Consideration must also be made as to the primary access points for harvesting equipment. The acreage of this management area will need to be verified.

This data is used to prepare a Harvest Plan, and will specify the number of trees in each diameter class, by species, that will be selected for harvest. This is accomplished by plotting the tree diameter distribution on a chart, and then applying the appropriate tree volume by diameter class. Next, the allowable harvest volumes from the growth and yield data are allocated to the tree/volume distribution table to begin to create the reverse-J curve. These numbers and charts are used as a guide for the forester before beginning the actual selection and marking of the trees to be thinned out.

The marked timber volumes are tallied and monitored in the field as the trees are selected, and once the allowable harvest volume estimate has been reached, the selection/marking process is halted. If there are large areas of the management area that have not been marked at that point, a reassessment of the total estimated volume and/or acreage determination must be checked.

While this management system is highly technical, the concept takes on clarity once a forester has been:

1. trained in the application of this management system, and
2. has completed the process from planning to the completion of harvesting, with experienced guidance.

The idea of uneven-aged management of forests has generated much discussion and interest over the past decade or so. Actually, not many foresters or landowners have practiced this management system. It is a highly evolved, heavily-researched, and proven management system that AEL foresters have successfully practiced on forestlands for many years. The keys to successful implementation are a stable, long-term commited ownership and a sufficiently-stocked forest of suitable species.

The forest in the Park more than meets the basic silvicultural requirements, and the City of Houston should be in a perfect position to commit to this for the long haul. We can think of no better way to manage a Park to preserve the natural appearance of the forest while realizing greatly enhanced habitat and economic returns.

The mapping of the management harvest area will be extremely important, not just from the aspect of executing the harvest, but also for long term record keeping and forest monitoring efforts. The GIS system that has been built during this planning phase will be the foundation on which the Park Habitat GIS database is established. This system will need to incorporate all habitat management activities, and will be an unending work-in-progress. It will not just be a mapping tool, but a database management system that will be crucial to the success of the long-term Uneven-Aged management system.

Harvest Execution

Field Work Phase – Area Designation and Tree Marking

Once the planning is complete, the field work setup phase will begin. The boundaries of the harvest area must be delineated with flagging and/or tree marking paint, and be tightly identified by GPS for the GIS database. This marking must be clearly visible from all directions and be distinctly different in appearance when compared to the tree marking work.

The access routes and planned loading area locations are also designated at this time, or can be designed with the harvesting contractor if there are not any clearly-defined factors such as sloughs,

creeks or Habitat Retention Areas. Often these landing areas will be ideal to establish where forest prairie areas are planned. This will assist in reducing the establishment costs of the prairie habitats.

Assisted by the allowable harvest calculations, the actual tree marking process is done at this time. Each tree that is to be harvested receives at least one mark of specialized tree marking paint at eye level or above, and then at least one mark at the ground level, where the tree and the soil meet. The marks serve three purposes: (1) as an aid to the tree marking foresters to see which trees they have marked, (2) assist the felling machine operator in his work, and (3) the stump spot serves as quality control during the supervision of the harvesting operation. All severed tree stumps must have this mark, or unauthorized harvesting may be occurring. While this is a rare event to have unauthorixed cutting, the bottom spot and the harvesting supervision is an absolutely necessity as a practical business matter.

The quality of this marking job is paramount to realizing a quality harvesting operation. If the forest harvesting workers cannot clearly see which trees are to be harvested, they cannot properly plan out their work and prevent unneccessary damages to the residual forest. This marking work must meet several criteria:

(1) Enough trees must be marked for harvesting equipment to operate and to make an economically-viable operation for the contractor. This should not be an issue in this forest – there is more than sufficient stocking of forest trees to provide for this; and

(2) The tree marking is best done on multiple sides of the tree trunk, in a repeated and consistent pattern all throughout the marked area. The expenditure of liberal amounts of tree marking paint and the time to correctly apply it will make a enormous difference in the quality of the harvesting operation. There should be no question in a person's mind when walking through the marked area as to which trees are to be harvested, and this should be visible at the greatest possible distance as allowed by the midstory and understory vegetation conditions.

Each tree thus marked is tallied as to its DBH and merchantable height by species and product class. This marked volume must be monitored as the work is done to insure that the allowable harvest is being properly attained. This 100% inventory of the marked trees is then compiled at the end of the operation, and a detailed marked-volume table is prepared. The final mapping that might reflect some minor changes to the harvest area is then prepared.

The tree volume inventory is not only important from the standpoint of verifying the allowable harvest volume, but also is a key point for the potential buyer and harvesting contractor to evaluate the harvest from the financial standpoint. This inventory becomes a part of the sale process and the sale agreement.

Effective Marketing

The marketing of the harvest is a vital step. If this is not done in a methodical and properly planned manner, all of the other habitat management work will be for naught. It is absolutely imperative that only proven forest harvesting contractors are allowed to place bids on the sale of the trees. These potential contractors must understand the goals of the harvest and have shown through past work history that they can conduct the operations in a sensitive manner, while correctly merchandizing the forest products.

There are strict insurance and legal contracting aspects to conducting forest product sales and harvests that are practiced and must, of course, be adhered to. There are several aspects to this type of business arrangement that are unique to the forest products industry.

This step requires consultation with knowledgeable, independent foresters that are familiar with the region. It must be pointed out that there are no regulations or licensing requirements in this State beyond common business law in regards to the sale and harvesting of forest products. Anyone can label themselves a forester, represent themselves as a private consultant, and actually be in the timber buying business all the while.

Sale Methodology

There are two primary methods of conducting these sales. The Lump Sum sale method is where the contractor makes a bid on paying for the designated trees up front, in cash, in exchange for a restricted-term deed for the designated trees. The potential buyers would bid on the designated trees under strict conditions as set forth in the bid prospectus. These sales are usually for a term of six months to a year within which the buyer can harvest the trees, subject to restrictions concerning weather and forest soil conditions.

This method has the advantage of placing the risks of invisible wood defects causing a downgrading in product class and pricing onto the buyer. For example, if a designated tree shows no external signs of rot or decay, and is valued in the sale as a sawlog, then once harvested it is revealed that it was rotten and must be sold as lower-value pulpwood, the buyer just takes that loss at no

penalty to the landowner. It is up to the buyer to examine the designated trees and contractually relieves the landowner from any liability in regards to tree quality or volume. The only items that the landowner warrants is their legal rights to sell the trees and the tree count as of the date of marking.

The disadvantage to Lump Sum sales is that flexibility is lost in the actual harvesting operation. The buyer has bought the trees within the strict guidelines of the sale agreement document. Once this type of sale is done it can be difficult to alter the harvest plan if conditions in the forest change for some unforeseen reason.

The other method is the Per Unit or Pay-as-Cut sale. The restrictions in the sale agreement are identical except that the buyer pays for the trees as they are transported to the end using facility. The total amount paid by the mill that buys the wood is divided up among the various parties, based on the contract terms. There are normally payment amounts expressed in dollars per green ton for each species and product class delivered to the specific mill. An example might be "X" dollars per ton for pine pulpwood and "Y" dollars per ton for hardwood pulpwood.

The advantages to this type of sale include the ability to share in short-term marketing opportunities that can become available, and would be difficult for a buyer to get guarantees from the mill in a longer-term lump sum contract. In recent years these have become more common due to the volatility in mill pricing and delivery schedules.

While this issue will be a prime topic of discussion and consideration for the City of Houston, it is our general belief at this time that a highly-structured and detailed Lump Sum sale methodology be used in preparing these habitat management harvests. The particular habitat management goals of these harvests will tend to outweigh the highest realization of economic return. In other words, it will be better to take slightly less income from these harvests but get a good, quality harvesting job from the contractor. It is simply the old saying that "you get what you pay for". At AEL we have thirty years experience in dealing with these matters, and have learned that the top dollar paid for trees are not always the best deals.

The Lump Sum method has less administrative processes and offers a total transparency in the financial transactions. The prime issue then becomes careful monitoring of the marked trees being harvested, and that is a straightforward and simple-to-administrate process. The Pay-as-Cut method has some potential difficulties in a public-ownership situation such as this one, especially the verification of proper wood deliveries and payments.

Bidding Process

The detailed sales prospectus is distributed to qualified potential buyers and a in-the-field 'show-me' meeting is arranged. All of the potential bidders are shown the sale area, and specific questions about the harvesting requirements can be discussed there. This is a much more productive process than doing this by telephone. These bidders are then given several weeks to further examine the designated trees and the area on their own before the established bid date. Lump sum sealed bids are submitted, with the right of refusal of any or all bids retained by the landowner. There are no conditions that the highest bid must be accepted.

Normally the landowner consults with their forester after the bid opening during the decision process. If a suitable bid is not offered, then it is customary that all bids be rejected, and re-bidding occurs at a time of the landowner's selection. Under no circumstances should a high bidder or second-high bidder be contacted as to submitting a higher bid during this process. This is referred to as 'peddling the bid' and while it may or may not be illegal in this case, it is a sure way to never get serious, reliable bids ever again from qualified forest product buyers and harvesting contractors.

Harvesting Supervision

This is a brief synopsis of the process of harvesting forest trees. The harvesting contractor cuts the designated tree from the stump using mechanized tree felling machinery. The tree is then moved to the centrally-located loading area with a forestry skidding machine where it is merchandised as to its appropriate wood product. The logs are loaded onto the transport trucks at this loading area. Truckers then move the logs from the woods to the mill.

The tree tops and limbs on the medium and small trees are skidded to the loading area, where they are delimbed and topped by chainsaw or machinery. These limbs and small tops are normally transported back into the forest and scattered about in a limited area around the loading area. The larger tops are utilized as pulpwood and hauled out as a commercial product.

The supervision of this process is critical to the success of the habitat management plan. The specifics of the sale agreement must be monitored by the landowner's forester to insure that the terms are being met. This involves close supervision for the first few days of harvesting, followed by intermittent checks during the operation. Any deficiencies in the harvesting contractors' work must be documented on a Harvesting Supervision Log, and fully discussed with the contractor. These are usually situations such as soft drink cans left lying about, a lodged tree that was missed and needs skidding in to the landing area, or some needed road maintenance following an overnight rain shower

that formed a mudhole in an access road. These are inevitable and are part and parcel of all harvesting operations. The kind of harvesting contractor that will be vetted before working on the Park will be more than willing to work with Park foresters in correcting any such deficiency.

Of course, serious infractions such as heavy damages to residual trees, the soil or unauthorized tree cutting can be grounds for immediate cessation of harvesting operations. These situations and the allowance for the landowner's representative forester to shut down the harvesting operation are provided for in the sale agreeement. Normally these agreeements include binding arbitration when needed in unresolvable disputes. These arbitrations are between three qualified foresters, with two representing the parties and one neutral forester selected by these two foresters.

As the harvesting operation is coming to a completion, more time must be spent to insure that details of cleanup, road maintenance or a myriad of potential issues are addressed before the contractor finishes harvesting and moves off of the site.

Specific Harvesting Strategies

Sawhead Mowing – Top Lopping

The machinery used today to harvest trees has the capability of actually "mowing" selected portions of the understory as an assistance to natural regeneration. A prime example of this use of the 'sawhead' felling machine is to mow down dense thickets of yaupon and tallowtree while conducting a forest thinning. Foresters refer to this as 'sawhead mowing'. Compensation is made to the harvesting contractor for this service.

Another good practice to institute on the Park will be the lopping of limbs from tree tops that are deemed important to leave laying in the forest. This process is simply the sawhead machine straddling the top, severing the upright limbs from the upper tree trunk.

It will be important to have sawhead mowing and top lopping integrated into almost all of the forest harvesting activities. These procedures afford greatly enhanced aesthetics immediately following the harvest operation. The guideline should be given to the harvesting contractors during the marketing phase that certain species such as yaupon and laurelcherry should be targeted for sawhead mowing. This guideline should also stress that the goal is for the sawhead machine to all but eliminate the log skidders having to run over any underbrush or small, undesirable trees. This may well have to involve the marking of the vegetation that is targeted for sawhead mowing.

The sawhead mowing will temporarily suppress the understory vegetation, followed by vigorous resprouting, thus contributing to the available browse for whitetail deer. Lopping greatly reduces wildfire drape loadings by lowering the fuel in the limbs back down to the ground level, where they will rot much quicker. The positive aesthetic effects of having the forest understory relatively free of upright tops and run-over brush cannot be overestimated.

Redbay/Yaupon Enclaves

There are numerous spots where the redbay trees and yaupon shrubs have formed completely closed canopies, almost completely shading the forest floor with very little vegetation in the understory. Most of these were formed following pine beetle infestations in pine plantations. The site preparation methods in the past were done by bulldozing the site, raking the woody debris and burning the piles. The pines were then planted without any herbicide treatments. The regrowth of woody species from the remaining root stocks was very vigorous, resulting in an extremely heavy brush understory in the pine plantation. When the pine beetles killed the pine trees, the understory brush growth flourished, creating these enclaves of solid yaupon and/or redbay.

Numerous species of birds were observed in these areas. The overhead canopy is very dense and is providing an excellent protective cover for the birds from predators such as hawks and owls. An easily-implemented enhancement to this areas will be to thin out the forest quite heavily in a buffer around the enclaves outer edge.

This harvesting should drop the basal area to around 30 square feet or so to insure the regeneration of woody plants. The resulting heavy underbrush growth will provide good escape and foraging cover for birds, as well as to further isolate the enclave. The birds will then have enhanced protection of the enclave for roosting and nesting habitat. These will make great locations for bird watching. Potential species that could benefit from these areas include flycatchers and migrating and wintering woodcock.

Habitat Retention Areas – Habitat Corriders

AEL is recommending that in concert with each habitat management operation one or more areas be set aside that are given no management treatment. These areas will receive no thinning, understory vegetation control or reforestation work. These areas should be anywhere from one to three acres in size, and should be irregular in shape. The purpose will be to preserve niches of the present-day habitat for several reasons:

(1) As a 'control' plot of the present-day forest to serve as a 'before' example; for both educational purposes and for monitoring habitat management success efforts; and

(2) To provide good ecotone or edge effect around the boundary of the retention area and add to habitat diversity.

Invasive Species Management

The lower basal area forest and the wetter soil types have a greater invasion of tallowtree in them. The recommended management area section focuses management activities on better-drained sites to help in reducing tallowtree infestations. The key is to create opportunities for desirable species regeneration to occur following habitat modification activities that will eventually out-compete the inevitable incursion of tallowtree into an forest opening. AEL experience has shown that the native hardwoods and pines will eventually out-compete the tallowtree.

Hazard trees

The removal of hazard trees around infrastructure and heavy-use areas will be important from a safety standpoint, but it will be vital to retain snags and den trees as sites for small mammal dens, and bird roosting and nesting.

Integrating the Construction of Access Infrastructure with Habitat Management Activities

The establishment of crowned roads and trails will be essential to meet needs of hikers, bicyclists and equestrian users. The generally poorly-drained nature of the soils make flat, at-grade trails and roads unusable in all but the driest weather. The forest harvesting operations will be an excellent tool to use in the primary opening of these access routes. The costs of heavy equipment needed for the primary road system will be partially borne by the harvesting equipment. These roads will be necessary to implement the uneven-aged habitat scenario. Of course, they will need to be planned out in great detail, and will be curving, non-linear roads and trails for aesthetic and ecotone enahancement reasons.

These access trails will need 24-inch culverts strategically located to prevent damming of surface water flow, except in locales where impounding water for habitat enhancement purposes is desirable. These locations will benefit from the installation of small drop-riser water control structures to allow for periodic draining of the water for habitat regeneration purposes in appropriate locations.

FOREST VEGETATION MANAGEMENT

It is necessary to plan on managing the understory and midstory vegetation in the forest to make provision for natural regeneration. Without such planning and budgeting, the regeneration and habitat work will be ineffective and provide only temporary benefits.

Vegetation control will be important for ecotone establishment and maintenance, such as the prairie areas. Mechanical treatments such as bushhogging, disking and mulching can be used along with carefully planned and executed applications of approved forestry herbicides to control species such as yaupon and tallowtree as an aid in establishing both new patches of forest and prairie – savannah areas.

These herbicides can be applied by both hand and from specialized forestry tractors. These operations are done in a safe manner by government-approved and regulated specialists. The environmental effects of these forestry herbicides are very minimal, and they are used sparingly and in relative low volumes. The mechanical applications are best for larger areas; they are both more economical and they have computer-controlled equipment to monitor the application rates. The hand application method is good for small areas, but it must be done correctly to avoid over-application of the chemical. Cut-surface treatments work well on tallowtree, for example, where the stem is either severed and then painted with herbicide, or a simple hack-and-squirt method is used on larger stems.

The sawhead mowing work can be followed up with careful application of appropriate and approved forestry herbicides to the cut surfaces to further suppress the targeted plants. The need for this additional treatment following harvesting will need to be addressed in both the pre-harvest prescription plans, and following harvesting in the normal monitoring work.

Japanese climbing-fern poses a tougher problem in that it has colonized most of the Park. It's control is pretty much limited to growing-season applications of herbicide, which has to be done carefully to avoid overspray onto desirable species. Simple mixtures of glyphosate (*Roundup*) are suitable for this work.

Unfortunately, the historic use of prescribed fire will probably not be possible on the Park at the present time. The urbanization of the area poses great risks from a smoke management and liability issue with housing developments, major highways and the approaches to Interncontinental Airport. Fire is a program of repeated burns in order to get lasting results, and with the air pollution non-attainment zones around the Houston area, a program of repeated fires is probably not going to get approval from regulatory agencies.

FOREST MANAGEMENT ACTIVITY SCHEDULE

The following table is an illustration of the timing and economics of some of the recommended habitat activities associated with the harvesting operations. The years shown are not set in stone – they are flexible and can be incorporated easily into adjacent years and broken into several smaller operations. However, the timing and scheduling will need to be modified to reflect these inevitable changes in order to preserve the uneven-aged growth and regeneration of the forest. There is wide latitude for flexibility but it must be taken into account all through the growth model time period.

The estimated / projected costs for administrating the harvesting, conducting needed vegetation management for forest regeneration, and the forest road and firebreak maintenance are real-world estimates based on AEL's thirty years of forest management experience. These are general figures that are useful in such long-term planning. The specific activity prescriptions will further clarify these and 'drill down' into greater detail as each harvesting event is planned.

As the habitat work commences, additional work such as expansion of baldcypress ponds, construction of trails and footbridges, feral hog control or wood duck box building can be plugged in to an overall master planning process.

This table is targeted specifically at dealing with the planning requirements of instituting Uneven-Aged forest management in the Park. The incomes take into account the reduced per-unit forest product values that are anticipated due to the strict requirements of the Uneven-Aged management, to include sawhead mowing costs.

Figure 10 – Forest Harvesting and Management Activity Schedule

		INCOME		EXPENSES				NET	
Year	Acres	Gross Income Per Acre	Total Gross Income	Harvest Prescription, Setup and Supervision	Harvest Administration	Vegetation Management / Education	Forest Road & Firebreak Maintenance	Net Income	Management Area Type
2009	1058	$ 550	$ 581,490	$ 69,779	$ 5,815	$ 64,000	$ 29,075	$ 412,822	Active, Intermediate
2013	400	$ 623	$ 249,200	$ 29,904	$ 2,492	$ 64,000	$ 12,460	$ 140,344	Active
2016	658	$ 505	$ 332,290	$ 39,875	$ 3,323		$ 16,615	$ 272,478	Intermediate
2017	500	$ 623	$ 311,500	$ 37,380	$ 3,115	$ 80,000	$ 15,575	$ 175,430	Active
2022	400	$ 798	$ 319,200	$ 38,304	$ 3,192	$ 64,000	$ 15,960	$ 197,744	Active
2024	658	$ 505	$ 332,290	$ 39,875	$ 3,323		$ 16,615	$ 272,478	Intermediate
2026	400	$ 798	$ 319,200	$ 38,304	$ 3,192	$ 64,000	$ 15,960	$ 197,744	Active
2028	400	$ 850	$ 340,000	$ 40,800	$ 3,400		$ 17,000	$ 278,800	Passive
2031	500	$ 798	$ 399,000	$ 47,880	$ 3,990	$ 80,000	$ 19,950	$ 247,180	Active
2032	658	$ 675	$ 444,150	$ 53,298	$ 4,442		$ 22,208	$ 364,203	Intermediate
2035	400	$ 1,000	$ 400,000	$ 48,000	$ 4,000	$ 64,000	$ 20,000	$ 264,000	Active
2038	698	$ 687	$ 479,350	$ 57,522	$ 4,794		$ 23,968	$ 393,067	Intermediate, Passive
2039	400	$ 1,000	$ 400,000	$ 48,000	$ 4,000	$ 64,000	$ 20,000	$ 264,000	Active
2041	400	$ 850	$ 340,000	$ 40,800	$ 3,400		$ 17,000	$ 278,800	Passive
2044	500	$ 1,000	$ 500,000	$ 60,000	$ 5,000	$ 80,000	$ 25,000	$ 330,000	Active
2045	658	$ 675	$ 444,150	$ 53,298	$ 4,442		$ 22,208	$ 364,203	Intermediate
2048	440	$ 643	$ 283,200	$ 33,984	$ 2,832	$ 64,000	$ 14,160	$ 168,224	Active, Passive
2051	658	$ 930	$ 611,940	$ 73,433	$ 6,119		$ 30,597	$ 501,791	Intermediate
2052	400	$ 620	$ 248,000	$ 29,760	$ 2,480	$ 64,000	$ 12,400	$ 139,360	Active
2054	400	$ 850	$ 340,000	$ 40,800	$ 3,400		$ 17,000	$ 278,800	Passive
2057	500	$ 620	$ 310,000	$ 37,200	$ 3,100	$ 80,000	$ 15,500	$ 174,200	Active
2058	658	$ 930	$ 611,940	$ 73,433	$ 6,119		$ 30,597	$ 501,791	Intermediate
2061	440	$ 646	$ 284,400	$ 34,128	$ 2,844	$ 64,000	$ 14,220	$ 169,208	Active, Passive
2063	658	$ 930	$ 611,940	$ 73,433	$ 6,119		$ 30,597	$ 501,791	Intermediate
2065	400	$ 623	$ 249,200	$ 29,904	$ 2,492	$ 64,000	$ 12,460	$ 140,344	Active
2068	658	$ 525	$ 345,450	$ 41,454	$ 3,455		$ 17,273	$ 283,269	Intermediate
2069	500	$ 623	$ 311,500	$ 37,380	$ 3,115	$ 80,000	$ 15,575	$ 175,430	Active
		TOTAL	**$10,399,390**	**$ 1,247,927**	**$ 103,994**	**$ 1,040,000**	**$ 519,970**	**$ 7,487,500**	
		PERCENT OF TOTAL INCOME		**12.0%**	**1.0%**	**10.0%**	**5.0%**	**28.0%**	
		ANNUALIZED	**$ 173,323**	**$ 20,799**	**$ 1,733**	**$ 17,333**	**$ 8,666**	**$ 124,792**	
		ANNUALIZED PER ACRE	**$ 40.95**	**$ 4.91**	**$ 0.41**	**$ 13.88**	**$ 2.05**	**$ 29.48**	

The Harvest Prescription, Setup and Supervision expense category is taking into account the time requirements for:

1. developing the specific harvesting prescription,
2. the execution of the field work phase such as tree marking, Retention Area and Habitat Corriodor establishment and harvest area layout work,
3. Sale Marketing and Bidding, and
4. Harvest Operation Supervision.

This cost was estimated to include the a portion of the costs of maintaining a full-time forester/biologist on staff at the Park, with additional contracting with consulting forester expertise in planning and implementing uneven-aged management strategies. These expenses are in line with the long-term forest management experience of AEL and other forestry management concerns.

The Harvest Administration expense is a nominal cost that is anticipated to be generated internally, being possibly directly associated with the Park administration, as well as within the City government as a whole.

The idea behind the Vegetation Management /Education section is to capture the anticipated costs of carrying out reforestation and other habitat management costs, as well as covering some of the expenses of the all-important Education effort. These Education expenses are the ones anticipated that deal directly with the Habitat Management activities of the Park. The inclusion of both of these items into one column in the table was strictly for spacing requirements.

These costs were estimated at a a set rate of $160 per treated acre. This rate was chosen as an average of normal forestry vegetation control and replanting costs, with the idea that not every acre thinned will need treatment. There will be many acres that require no extra treatments beyond the effects of the harvesting and some sawhead mowing. This especially applies to the Passive Managemetn areas. It is a reasonable forecast that the $14 per acre per year on all of the forested acreage (over a million dollars over the sixty-year span of this schedule) will provide the majority of funds needed for these two categories.

The expenses in this category are taking into account the need for a variety of efforts in:

- Forest Regeneration work – localized herbicide application, mulching, manual brush control, tree seedlings, hand planting labor,
- Prairie establishment and maintenance – mulching, herbicide application and bushhogging, and
- Education – field tours, signage, website design and maintenance, viewing area infrastructure construction and maintenance

The road and firebreak establishment and maintenance estimates are based on AEL experience in road building and maintenance. The primary planning of the location of forest roads will be driven by the Master Plan in terms of limiting access appropriate levels in various areas of the Park. The forest harvesting operations will be instrumental in providing the initial work in opening a new road where needed. This expense item is taking culverts, surfacing materials such as gravel and some road grading work into account.

Note that this projection forecasts an annualized after-expense positive cash flow of almost $125,000, or almost $7.5 million dollars over a sixty year period. Keep in mind that the forest remaining at this point will be more robust in diversity, forest health and have a greater value and volume of forest products than the present-day forest. The use and enjoyment of the Park by the public will have been

vastly enhanced, with access for a myriad of forest-based recreational opportunities, bird and wildlife viewing and just plain solitude in the midst of a large urban environment.

Additional Forest Management Issues

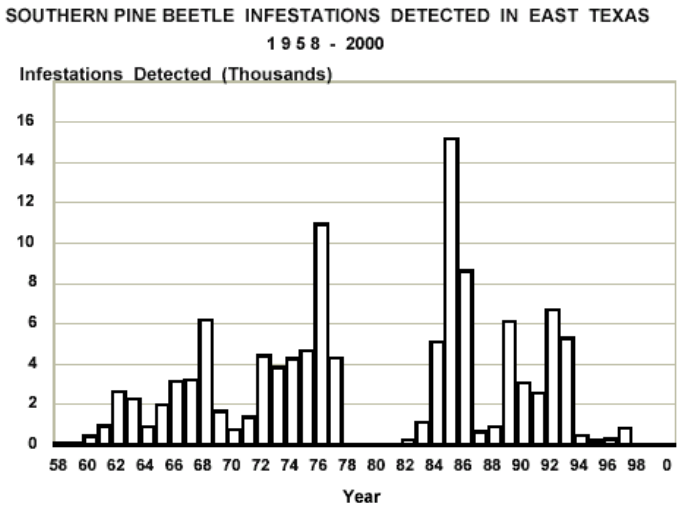
Southern Pine Beetle Risk Factors

The prospect of an outbreak of southern pine beetle in the Park is a vision that is difficult for experienced foresters to contemplate. Having seen hundreds of acres of pine forests lost in a weeks' time has the older foresters that have worked on this Plan in absolute fear of such an outbreak. The suppressed pine stands are a perfect setup for catastrophic losses of trees on a widespread basis across the Park. The loss of aesthetic beauty, the greatly increased buildup of forest fire fuels and the costs of dealing with many acres of dead snags that will fall on roads, trails and infrastructure are some of the after effects of such an infestation.

The risk factors for outbreaks of southern pine beetle are higher when the soil productivity goes up, and the soil drainage decreases. The generally poorly-drained, high site index soils on the Park rank as a High to Very High, using the Southern Pine Beetel Hazard Rating Guide developed in the 1970's by Stephen F. Austin State University and the USDA Forest Service.

While there has been very low to no activity of southern pine beetle outbreaks in recent years, it is prudent to consider the historical impacts that these insects have had on East Texas pine forests. The following graph from the Texas Forest Service illustrates the infestations that have been recorded since 1958. As this chart shows, pine beetle outbreaks are cyclical, and can reappear and disappear very rapidly.

Figure 11 – Pine Beetle Activity – 1958 through 2000



The importance of this discussion is to emphasize the necessity of managing the pine forests on the Park. The results of thinning the pines will not only reduce their susceptibility to southern pine beetle, but also to other insects and diseases. The general health of the forest being improved by careful thinning is an important side benefit to the overall ecosystem enhancement afforded by proper habitat management.

Wildfire Hazard Mitigation

The heavy understory of yaupon holly in many areas of the Park in combination with the almost unbroken continuity of the forest the high pine densities poses a significant hazard from wildfire. The thick, tall understory plants such as yaupon, which burns very hot, serve to trap pine needles, leaves and other forest debris in their crowns. This suspended material provides aerial pathways for wildfires to burn to greater than normal heights during a forest fire. These aptly named ladder fuels are a primary cause of destructive crown fires.

While this subject is not commonly considered in the normally humid climate of the Houston area, it is a serious threat that only needs an extended period of dry weather to become an issue. The summer of 2000 saw large-scale wildfires burning all across southeast Texas. Some of the fires were reminiscent of western U.S.-style conflagrations, with whole towns being threatened.

The fuel conditions present in the Park, under conditions of low humidity, high temperatures and winds could result in a catastrophic situation. A Park full of visitors during such an event is the primary cause for alarm concerning this issue. There is a great potential for serious damages to the forest and park infrastructure, as well.

The problem with wildfire mitagation is that if you wait until the dry weather has created a problem, it is too late to do anything about it. Advance planning and execution of a wildfire mitigation plan is highly recommended for the Park. While such a detailed plan is outside the scope of this document, we can address several related issues as they pertain to the management of this habitat.

The creation of forest openings, along with thinnings and establishing additional forest roads and trails will assist in breaking up the continuity of the forest fuels. The thinning of the heavy pine stands will assist greatly in this regard. The level of understory and midstory trees and shrubs that are left adjacent to the developed infrastructure such as cabins and camping areas should be evaluated as to wildfire hazard.

While there will be a level of screening effect needed between camp and cabin sites as a privacy issue, some thought should go into how wide these screens are, and how they are connected to the remainder of the undeveloped forest. A combination of thinning harvesting, understory mulching. bushhogging and/or herbicide treatments can be used to control the fuel levels and underbrush heights.

The improved acccess afforded by a more extensive access system can be very important for fire suppression equipment such as bulldozers and fire trucks. The issue of rapid evacuation in an emergency situation is also important, and as with the camping areas, considerations should be made concerning the levels of underbrush that is along the roads that will be used as evacuation routes.

Another aspect of wildfire mitigation will be establishing firebreaks along the northern boundary of the Park, from Peach Creek parallel to the Farm to Market Road and then around the Park boundary to the San Jacinto River.

This would also apply to the portion of the Park on the west side of Peach Creek. These firebreaks will basically be unimproved roads that will serve as primary fire suppression by assisting in blocking wildfires coming onto the Park from the north, northeast and west. This could be by targeted disking of the firelanes during times of extreme fire danger, and by offering easy access for fire suppression equipment. These areas are definitely the highest risk areas for wildfire encroachment from the houses and roads in the adjoining areas. The firebreaks also serve as good boundary maintenance and access roads for Park security patrolling.

All of the firebreaks, trails and roads will need regular maintenance, and must be planned for in the Park management budget. AEL also strongly urges the creation of a Firewise Wildfire Mitigation Plan to be completed in coordination with the Texas Forest Service and the local New Caney Fire Department.

Wildlife Habitat Enhancement in Forest Harvesting Activities

Effects of Sustainable Uneven-Aged Forest Harvesting

Lowering forest densities in select areas to provide for increased sunlight to the forest floor to encourage natural forest regeneartion will also significantly enhance browse for herbvoires. This lowering the basal area of this forest will bring about the greatest increase to the overall habitat condition in the Park. The establishment of vertical structure in the forest is important to a wide variety of species.

The redistribution of major limbs and tops throughout treatment areas will be important to provide coarse woody debris, an important aspect of a healthy forest ecosystem. Larger woody debris generally has a greater influence over a more extended period of time. Through decomposition, coarse woody debris returns nutrients to the soil. Coarse woody debris also contributes to moisture retention and habitat quality. The mulching effect of decaying wood helps retain surface soil moisture.

Coarse woody debris also plays a key role in the habitat of both vertebrate and invertabrate animals. This includes animals such as woodpeckers, owls, salamanders, voles, and mice. Invertebrates such as termites, carpenter ants, and bark beetles colonize dead wood, which in turn provides forage for birds and mammals. The fungi that are abundant in dead wood and have a key role in its decomposition provide a food source for a wide range of wildlife, from mice to squirrels to deer.

AEL proposes to retain a percentage of upper portion of some harvested trees in the forest following harvesting operations. These are normally utilized for pine pulpwood and are referred to as "topwood". There will be far more topwood generated during the thinning of the heavier pine areas than would be desirable or practical. The wildfire fuel loadings would be too high if all of the topwood was left for coarse woody debris.

However, by leaving a small percentage of the largest diameter tops the positive effects can be realized while still managing the forest fuel levels. Also, in the Pine-Hardwood and Hardwood areas there will be ample opportunity to leave larger-diameter pine topwood laying in the woods to contribute to the ecosystem health. This will be done in concert with retaining all dead trees and snags that do not pose a safety hazard to infrastructure and heavy-use areas of the Park. These standing snags provide a myriad of foraging and nesting sites for all kinds of wildlife, especially woodpeckers, cavity-nesting passerines, and small mammals.

The contribution to the habitat of mature trees, snags, and large woody debris is important. Mature hardwood trees provide cavities. Over-mature hardwood trees will eventually become snags, and then contribute to large woody debris. Cavity-nesting birds and mammals, reptiles and amphibians will benefit from these habitat features.

Importance of Hardwood Component in Forests

The presence of hardwood is a very important habitat component for many wildlife species. Mixed pine-hardwood stands contained higher winter bird diversity than any age class of pure pine forest. Some bird species are strongly associated with hardwood (e.g. Red-eyed Vireo). Even though

some species may not specifically be associated with riparian or bottomland habitat, they will be found within mixed pine-hardwood forests because of the presence of hardwood.

Hardwood trees are important because:

1. They provide a source of mast;
2. Their branching patterns provide more foliage height diversity and increased feeding and resting surface for birds; and
3. Persistent dead limbs result in a greater prevalence of cavities compared to pines.

The importance of hardwood as a food source for many wildlife species has been well documented. Whitetailed deer are attracted to hardwood areas during fall and winter due to mast production. There is increased fawn survival rates when acorn production was high. Squirrels are located almost exclusively in hardwood areas compared to surrounding pine stands. Research has noted that mixed forests can assist in maintaining wild turkey habitat in areas where pine-hardwood stands have been converted to pine plantations.

Many non-game wildlife species also utilize mast (primarily acorns). However, mast is not the only food source provided by hardwoods. The branching pattern of hardwoods provides increased foraging surfaces for birds and greater vertical diversity than a typical pure pine stand. A hardwood forest containing many layers of vegetation provides niches for a variety of bird species that prefer different levels in the forest.

Another benefit of hardwoods is an increased prevalence of cavities due to more persistent dead limb as compared to pine trees. Some hardwoods, particularly older sweetgum trees, are especially good providers of cavities.

Neotropical Birds

Uneven-Aged Management provides enhancement of the role of this unique forest as a departure and arrival site for migrating neotropical songbirds. The creation of a diverse habitat will serve a broader range of avian species than the current forest. This includes streamside corridors, habitat retention areas, redbay/yaupon enclaves and habitat retention corridors in prairie openings.

Both resident and migratory birds are expected to benefit substantially from accomplishment of the various prescriptions presented in this Plan. In fact, ultimately this plan is expected to be integrated into the habitat delivery components specified for conservation of birds through partnerships associated with the West Gulf Coastal Plain Initiative of the North American Bird

Conservation Initiative as focused through the Lower Mississippi Valley Joint Venture. Similarly, enrollment in the "Birds and Bayous" program of the Citizens Environmental Coalition of Houston is another example of institutional meaning for this wildland tract and its natural resource management.

Notably, the role of the Park in serving life requisite needs of neotropical migratory birds cannot be understated. This site has qualities important to the welfare of migrating birds both departing to and arriving from southern wintering grounds. These "fallout" forested tracts along the Texas Gulf Coast are essential to the ecology of neotropical migratory birds, and, consequently, are targeted for conservation and management. This plan is devised with these functions and values expressly in mind.

Streamside Management Zones / Habitat Corridor Guidelines

Streamside Management Zones (SMZs) or Habitat Corridors (HCs) are specific areas established most commonly in association with streams or water bodies where water quality issues are important. However they can be established for any number of reasons such as providing a means by which wildlife populations can move between two highly developed areas, as escape cover from predators, enhancing edge-effect habitat conditions and providing needed ecosystem services for a myriad of species. On the Park, these SMZs will be established along the major water features and significant creeks. The HCs are features such as the Retention Areas, and bands of undisturbed forest left between successively-established forest prairie areas.

The importance of the habitat contributions of these features is well documented. Researchers have noted that the establishment of SMZs or HCs to be one of the most important practices to integrate forest management and wildlife management.

There are three primary habitat attributes furnished by SMZs or HCs; presence of hardwood, presence of micro-habitat features such as mature trees, snags, and large woody debris, and presence of a moist, shaded, open forest floor condition.

The retention of snags and mature/over-mature trees, and provisions for SMZ width provide considerations for a moist, shaded, open forest floor condition within the SMZ. Each of these habitat attributes are discussed in detail below. However, this should not take away from the habitat attributes furnished by pine forests. There are a great many species (e.g. prairie warbler, indigo bunting, yellow-breasted chat) that thrive in the early successional stages provided by forest harvesting, and some species that exist only within pine stands (e.g. pine warbler). In fact, the greatest bird diversity is often found in early-successional stage clearcuts. It is the combination of SMZs and

managed pine forests that creates the greatest habitat diversity that benefits the widest variety of species.

Moist, Shaded, Open Forest Floor and SMZ/HC Widths

The forest condition within an SMZ or HC can provide habitat for species that prefer a moister, shaded, open forest floor environment. There are many studies that have examined the wildlife habitat implications of various SMZ widths. Some game animals are affected by SMZ width. Studies have indicated that SMZs narrower than about 150 feet were not capable of supporting squirrel populations. Wildlife turkey use of SMZs less than approximately 150 feet in width was significantly less than wider SMZs. No studies have shown any SMZ width effect on white-tailed deer.

SMZ width also has an impact on non-game animals. One study showed bird abundance increased as SMZ width increased. Bird communities found in narrow SMZs under 75 feet were generally the same found in young pine plantations, suggesting the habitat of narrow SMZs is similar to the habitat of a surrounding clearcut. The bird communities found in wide SMZs of about 150 to 300 feet were more characteristic of those found in mature woods, especially bottomland forests. A researcher found yellow-throated vireos, wood thrushes, Acadian flycatchers, and great crested flycatchers in SMZs greater than 130 feet width, while yellow-breasted chats, field sparrows, and prairie warblers were common in SMZs less than 125 feet. The species found in the narrow SMZs are those commonly found in early successional habitat.

A study also showed the presence of more reptiles and amphibians in SMZs wider than 100 feet, while another study showed more amphibians and reptiles in SMZs from 100 to 300 feet wide than narrow ones under 75 feet. This is apparently due to the moist, cool environment in combination with abundant leaf litter.

The establisment of SMZ minimum widths of 150 to 300 feet wide should provide the conditions needed to accommodate wildlife species associated with a shaded, moist, relatively cool environment. These widths can be about 150 feet on the smaller creeks and features, while on the Caney/Peach Creek and San Jacinto River corridors, the 300 foot width should be the minimum. As these Riparian Areas on the Park are to have a light touch in terms of habitat modification, these minimums fall in line with this Plan.

Retention of some native pine within the SMZ has a positiv effect by providing a measure of habitat enhancement and a small degree of diversity. The second-growth pines found in the San Jacinto River and Caney/Peach Creek corridors represent about only old native pine occurrence within the

Park. Besides the wildlife habitat in terms of raptor nesting sites, the conservation of the genetics of these older trees is a part of the preservation of ecosystem diversity.

It may be worth mentioning that single tree and group selection harvesting can also be used as habitat enhancement in SMZs. There are quite a few bird species (e.g. Kentucky Warblers and Wood Thrushes) that prefer rich understories in the hardwood forest. Creating small openings will benefit these species.

One thing to consider adding as guidance to this section is to ensure that the area to be harvested using the group selection method not extend across the entire width of the SMZ, or extend so far as to create a very narrow zone of open forest floor. This will tend to defeat the purpose of leaving the relatively-undisturbed SMZ / HC. The caveat here is to consider the condition of the surrounding forest.

HABITAT EFFECTS ON WILDLIFE SPECIES

This section is provided as a general overview of the relative benefits of various habitat conditions in the Park. These habitat effects show in great clarity that it is impossible to manage for all wildlife on all the acres of a given parcel of land. Whitetail deer need cover for resting while a supply of browse found in openings and forest edges are vital. Various species of birds need brush, some need open, park-like forests, while others require almost pure hardwood stands. Other birds thrive in residential areas, while another species needs more solitude.

This is key to understanding the overall philosophy of this Plan – create as diverse a forest as is possible given the basic resources that exist in the Park.

Large Mammal Species

Species	Habitat Element Beneficial to the Species
White-tailed deer	Year-round available browse. Hardwood mast production.
Wild turkey	Hard and soft mast. Dogwood particularly beneficial.
Squirrels	Cavities, hard and soft mast. Mixed hardwood and pine.

Amphibians and Reptiles

In general, amphibians and reptiles as a class will benefit from moist soil conditions found in relatively closed-canopy conditions. The following species are found in wide SMZs in significantly greater numbers than narrow SMZs or pine plantations. Some of the following species are also associated with water present in the forest, a situation that is seasonally common throughout the Flatwoods and Bottomland Areas, as well as the Baldcypress Swamps.

Box turtle
Five-lined Skink
Little Brown Skink
Six-lined Racerunner
Slender Glass Lizard
Fence Lizard
Anoles
Green frog
Leopard Frog
Cricket Frog
Dwarf salamander
Eastern Narrowmouth Toad
Western Ribbon Snake
Red Racer (Coachwhip)
Rough Green Snake
Eastern Racer
Plain-bellied watersnake
Banded watersnake
Rat snake
Copperhead
Cottonmouth

Small Mammals

In general, small mammals are much more abundant in brushy habitats. The short-tailed shrew is apparently the only small mammal found in greater numbers in closed-canopy forests.

Birds

Following are lists of birds that benefit from mixed species forests within a managed landscape. There are other birds that may utilize specific types of forests but are also found in a variety of other habitats. For instance, summer tanagers will utilize hardwood forests, but are also found in pine woods and residential areas. Bird species that are more habitat generalists are not included in these lists as they are not dependent on the habitat provided by a closed-canopy forest, even though they may utilize an SMZ, HC or Retention Area at times. The following lists are those that are either strongly associated with closed canopy habitat, or will depend on it if the surrounding forest has a more open canopy. ("NTMB" denotes a neotropical migratory bird.)

Species benefiting from forests with a closed canopy

Species	Critical Habitat Element	Comments
Acadian Flycatcher	Strongly associated with mesic, open, mature hardwood forests. Requires a moderate amount of interior forest space. Utilizes snags for feeding.	NTMB. One of the primary species that benefit from establishment of closed canopy.
Red-eyed vireo	Mixed or deciduous forests, not necessarily mesic.	NTMB. Very common species in the presence of hardwood.
Louisiana Waterthrush	Mixed or deciduous forests. Strongly associated with water, particularly rocky streams. Requires a moderate amount of forest interior	NTMB. Another primary species that benefits from the establishment of wide SMZs.
Cerulean Warbler	Associated with mature hardwood forests with an open understory. Utilizes large trees. Requires an extensive forested area.	NTMB. A species of concern due to habitat fragmentation.
Yellow-throated Vireo	Mature, moist, deciduous forests in an open setting.	NTMB. Will benefit from large trees retained in the forest.

Species benefiting from some canopy openings within the Forest

Species	Critical Habitat Element	Comments
Yellow-billed Cuckoo	Mesic deciduous forests. Prefers some thick vegetation and tangles.	NTMB. Forest harvest will create the thick vegetation and tangles that this species prefers.
Wood Thrush	Mesic mixed or deciduous forests with a well developed understory. Requires a small amount of forest interior space.	NTMB. This species benefits from wide SMZs. Single-tree selection harvesting will help develop the rich understory this species prefers.
White-eyed Vireo	Found in dense thickets in streamsides or moist areas	NTMB. Does not require a wide SMZ.
Kentucky Warbler	Moist deciduous forests with an abundant understory. Habitat requirements similar to the Wood Thrush	NTMB. This species thrives where disturbance creates the rich understory it prefers. Benefits from wide SMZs.
Hooded Warbler	Moist mixed or deciduous forests with a rich understory	NTMB. Another bird that could benefit from forest harvesting.
Gray Catbird	Dense thickets in moist areas	NTMB. Similar habitat to the White-eyed Vireo.
Carolina Wren	Associated with a variety of habitats, but do prefer moist bottomland forests. Prefers brushy areas.	Will benefit from brushy areas created by group selection harvesting methods. Utilizes downed woody debris.

Other species that could be associated with SMZ habitat

Species	Critical Habitat Element	Comments
Bald Eagle Osprey	Utilizes large trees near bodies of water for nest sites	Large trees retained in forests along large bodies of water could be used as nest sites, for roosting, or for visual vantage points for foraging.
Black-billed Cuckoo	Mature deciduous forests. Requires extensive forested area.	NTMB. Not a common species, but may be found along streams if the surrounding area is extensively forested.
Scarlet Tanager	Mature deciduous forests. Prefers upland sites, but will use bottomland hardwoods	NTMB. Not a common inhabitant of moist deciduous forests, but will utilize SMZs where there are little upland hardwoods.

Species associated with typical bottomland forests

Species	Critical Habitat Element	Comments
Red-shouldered Hawk	Bottomland forests and swamps.	Strongly associated with bottomland systems, but will utilize large SMZs / HCs
Prothonotary Warbler	Exclusively associated with standing water (ponds, lakes, larger streams) in swamps and bottomland forests. Utilize cavities for nesting	Dependent on cavities and standing water. May be found in wide, extensive SMZs, but more commonly associated with typical bottomlands
Black-and-White Warbler	Mature hardwood forests. Requires a moderate amount of interior forest space.	NTMB. Most common in larger bottomland systems, but could benefit from wide, extensive SMZs.
Swainson's Warbler	Damp deciduous forests with a rich understory. Requires forest interior space.	NTMB. Found primarily in larger bottomland systems.
Yellow-throated Vireo	Moist, mature deciduous forests. Prefers an extensive forested area	NTMB. More likely located in larger SMZs and typical bottomland forests.
American Redstart	Associated with moist bottomland forests. Occur in hardwood forests along streams in north GA	NTMB. Probably more common in extensive bottomland forests.
American Robin	Utilizes bottomland forests for wintering habitat	Very common bird that feeds heavily in hardwood forests in the winter. Found particularly in large bottomland systems, but will utilize SMZs.
Blue-gray Gnatcatcher	Associated with moist, deciduous forests. Requires a moderate amount of older forest.	NTMB. Most likely found in larger SMZs and typical bottomland forests.

Species dependent on cavities in trees

Species	Critical Habitat Element	Comments
Barred Owl	Nest in moist, deciduous forests. Utilize cavities in large trees for nesting.	Generally found in larger bottomland systems.
Hairy Woodpecker	Mature mixed or deciduous forests. Require extensive forested area.	Will utilize uplands and bottomlands.
Red-bellied Woodpecker	A variety of forest types, but do favor bottomland hardwoods	Will exist in a variety of forests, but will particularly inhabit forests containing cavity trees.
Pileated Woodpecker	Mature, extensive deciduous forests with large trees and cavities. Also utilizes downed logs.	The maintenance of large trees will especially benefit this species.
White-breasted Nuthatch	Mature hardwood forests with cavities. Utilizes large trees	Not specific to bottomland hardwoods, but needs mature, large trees.
Tufted Titmouse	Deciduous forests with cavities.	Utilizes both upland and bottomland hardwood forests.
Carolina Chickadee	Mature mixed forests with cavities.	Not necessarily associated with riparian habitats. However, presence of cavities in a mixed pine/hardwood SMZ important.
Prothonotary Warbler	Exclusively associated with standing water in swamps and bottomland forests. Utilize cavities for nesting	Dependent on cavities and standing water. More commonly associated with typical bottomlands

EDUCATIONAL ASPECTS OF HABITAT MANAGEMENT

A vital aspect of the habitat management efforts on the Park geared toward education. The goal of this educational program will be informing the Park visitor about the current, future and past habitat activities. Examples of educational efforts that could be utilized in this endeavor are:

- Signage – both permanent and temporary signs to explain planned activities, on-going operations as well as Before-and-After examples in areas with treatments in place. This signage would help prepare Park visitors for upcoming forest harvesting, as well as serve to explain the benefits of thinning during operations. The locale of the Retention Areas would be a good site to erect signs showing the before and after effects of habitat management. The signage would need to be of high quality in terms of materials and language, and should be large enough to be easily read at an appropriate distance without being too overt in the forest setting.
- Printed Nature Guides – these are very important to be made available to all Park visitors, whether or not they ever visit the more remote portions of the Park or not. These should 'tell the story' of the workings of the forest habitat and the efforts to enhance it.
- Field Tours – there are numerous organizations in the greater Houston area that would take advantage of guided field tours that would blend the habitat management work with natural history and science. This work will take advanced planning and cooperation from a variety of partners such as birding organizations, natural resource consultants and government agency personnel.
- Park Website Design and Maintenance – properly done and kept up-to-date, this can be a powerful tool for keeping the public aware and informed of habitat activities in the Park and the benefits derived from them.
- Viewing Area Infrastructure - these park benches, shaded platforms and other related structures are important for the more serious-minded visitor to delve into longer periods of field observation. These will be strategically located at areas of particular interest such as around water bodies, adjacent to forest openings and recent habitat activity sites. They

should be built out of materials and in a manner to fit in well with the forest scenery yet offer good viewing opportunities.

- Public Outreach – this will work in with the overall advertising strategy for the Park. There should be some information about habitat enhancement work in this area. This may be targeted at schools and community groups with strong interests in the outdoors and the ecosystem.

- Utilization of Park-sourced wood products for infrastructure construction – it is practical and possible to set up a small portable sawmill operation in the Park to process appropriate wood products for use in constructing cabins, walkways, viewing-area infrastructure and other appropriate structures. This will offer not only long-term appreciation for the contribution that forests make to our society in the form of wood products, but be very educational as the public watches this process actually being done. This is an activity that can be done over the long term, as a Park of this magnitude will have a fairly steady need for wood-based materials in both the construction and maintenance phases of the Park.

- Hands-On Activities – from tallowtree and Japanese climbing-fern control to tree planting to building viewing stands, there will be an almost infinite array of actual habitat work that can be accomplished by planned activities and using supervised volunteers. Scout groups and service clubs are just two of the potential pools for this type of 'labor force' to actually accomplish good, meaningful habitat projects. These activities would be in addition to constructing trails and footbridges.

APPENDIX "A" – FOREST INVENTORY DETAILED DATASHEETS

Detailed Summary Report

Tract: LAKE HOUSTON PARK	**Advanced Ecology, Ltd**	*Total Acres:* 4,800
Cruiser: CHRIS ADAMS	**2557 State Highway 7 East**	*Number of Plots:* 2310
Location: MONTGOMERY & HARRIS COUNTIES	**Center,TX 75935**	*Cruise Method:* Point
Owner: CITY OF HOUSTON	*Phone:* **936-598-3053** *Fax:* **936-598-9579**	*BAF:* 20
	E-Mail:	*Cruise Date:* 4/30/2008

Pine

	Total Tract							*Average Acre*	*Average Tree*		
	# Trees	*#16' Logs*	*Tons*	*DMBF*	*Cords*	*Cu.Ft.*	*Top Tons*	*BA*	*CFT/Ft*	*DBH*	*MerchHt*
Loblolly Pine											
Sawtimber	141,354	448,577	201,801.2	18,579	76,151	5,103,558	8,277.9	40.2	0.71	15.5	50.8
Small	100,746	186,934	32,450.7	935	12,246	775,320	1,996.9	9.2	0.26	8.9	29.7
Pulpwood	81,911		13,439.5		5,072	305,106		3.8		6.2	29.7
Shortleaf Pine											
Sawtimber	24	100	44.8	5	17	1,153	4.4	0.0	0.72	18.0	68.0
Total	**324,034**	**635,611**	**247,736.2**	**19,519**	**5,072**	**6,185,137**	**10,279.2**	**53.2**	**0.58**	**11.1**	**38.9**

Cruise Statistics Report

Tract: LAKE HOUSTON PARK	**Advanced Ecology, Ltd**	**Total Acres:** 4800
Cruiser: CHRIS ADAMS	**2557 State Highway 7 East**	**Number of Plots:** 2310
Location: MONTGOMERY & HARRIS COUNTIES	**Center,TX 75935**	**Cruise Method:** Point
Owner: CITY OF HOUSTON	**Phone:** 936-598-3053 **Fax:** 936-598-9579	**BAF:** 20
	E-Mail:	**Cruise Date:** 4/30/2008

All Products

T Value: 1.646

Total Volume Stats:	90% CI	Plots Needed to be +/- 10%	Mean BA	Variance	Std. Dev.	Std. Error	CV
Pine	3.10%	222	53.2	2,316.3	48.1	1.001	90.5
Hardwood	2.50%	144	44.0	1,032.1	32.1	0.668	73.0

Products	90% CI	Plots Needed to be +/- 10%	Mean BA	Variance	Std. Dev.	Std. Error	CV
Sawtimber							
Baldcypress	50.8%	59,526	0.4	36.4	6.0	0.13	1,482.4
Loblolly Pine	3.2%	244	40.2	1,454.6	38.1	0.79	94.9
Shortleaf Pine	164.6%	625,755	0.0	0.2	0.4	0.01	4,806.2
Medium							
Magnolia	87.0%	175,016	0.0	1.2	1.1	0.02	2,541.8
Misc. Hardwood	3.8%	333	22.1	602.5	24.5	0.51	110.9
Red Oak	18.4%	7,803	1.5	60.9	7.8	0.16	536.7
Sweetgum	95.0%	208,404	0.0	0.5	0.7	0.01	2,773.7
White Oak	39.9%	36,772	0.2	6.9	2.6	0.05	1,165.1
Small							
Loblolly Pine	7.1%	1,165	9.2	365.5	19.1	0.40	207.3
Pulpwood							
Baldcypress	53.9%	67,184	0.2	9.8	3.1	0.07	1,574.8
Loblolly Pine	10.1%	2,379	3.8	124.6	11.2	0.23	296.3
Misc. Hardwood	4.0%	368	19.2	499.5	22.3	0.46	116.5
Red Oak	37.0%	31,649	0.3	8.4	2.9	0.06	1,080.9
Sweetgum	164.6%	625,755	0.0	1.6	1.2	0.03	4,806.2
White Oak	95.0%	208,404	0.0	0.5	0.7	0.01	2,773.7

Notes:
Mean - The Average Basal Area - Cruise statistics are calculated using basal area which has a very high correlation to timber volume.
95% CI - 95% Confidence Interval - This % means that there is a 95% probability that the "Cruised" basal area is within this percentage of the "Actual" timber basal area.
Std.Dev. - Standard Deviation - A statistical term that measures the deviation of measurements around the sample mean.
Variance - A statistical term that is equal to the Standard Deviation squared.
Std.Error - Standard Error of the mean - A statistical term that calculates the expected deviation among sample means.
C.V. - Coefficient of Variation - The Standard Deviation divided by the sample mean. The smaller this number, the less variation exists in the cruise, and the less the margin of error.

* These %'s can be applied to all volume estimates, Tons, Cunits, MBF, and Cords, as well as Basal Area!

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ESTIMATED HARDWOOD SAWTIMBER VOLUME BY STRATUM

Tract: LAKE HOUSTON PARK	Advanced Ecology, Ltd	*Total Acres:* 4800
Cruiser: CHRIS ADAMS	2557 State Highway 7 East	*Number of Plots:* 2310
Location: MONTGOMERY & HARRIS COUNTIES	Center,TX 75935	*Cruise Method:* Point
Owner: CITY OF HOUSTON	*Phone:* 936-598-3053 *Fax:* 936-598-9579	*BAF:* 20
	E-Mail:	*Cruise Date:* 4/30/2008

Stratum: BottomlandHardwood *Acres:* 118

Baldcypress

	Average Tree	*Stratum Totals*			*Average Acre*			
	DBH	*Trees*	*Tons*	*DMBF*	*BA*	*Trees*	*Tons*	*DMBF*
	18	45	106.5	11	0.7	0.4	0.9	0.093
	22	15	50.0	6	0.3	0.1	0.4	0.053
Avg/Tot	**19.0**	**60**	**156.5**	**17**	**1.0**	**0.5**	**1.3**	**0.147**
Strata Total	**19.0**	**60**	**132.8**	**17**	**1.0**	**0.5**	**1.1**	**0.147**

Stratum: Cypress *Acres:* 22

Baldcypress

	Average Tree	*Stratum Totals*			*Average Acre*			
	DBH	*Trees*	*Tons*	*DMBF*	*BA*	*Trees*	*Tons*	*DMBF*
	16	115	157.8	15	7.3	5.2	7.2	0.663
	18	68	96.3	10	5.5	3.1	4.4	0.451
	20	110	248.1	30	10.9	5.0	11.3	1.342
	22	45	111.4	13	5.5	2.1	5.1	0.576
	24	38	133.5	18	5.5	1.7	6.1	0.838
	26	33	147.8	20	5.5	1.5	6.7	0.893
	28	9	56.7	9	1.8	0.4	2.6	0.415
	80	1	65.8	11	1.8	0.1	3.0	0.516
Avg/Tot	**20.0**	**419**	**1,017.4**	**125**	**43.6**	**19.1**	**46.2**	**5.695**
Strata Total	**20.0**	**419**	**920.9**	**125**	**43.6**	**19.1**	**41.9**	**5.695**

Stratum: Hardwood *Acres:* 232

Baldcypress

	Average Tree	*Stratum Totals*			*Average Acre*			
	DBH	*Trees*	*Tons*	*DMBF*	*BA*	*Trees*	*Tons*	*DMBF*
	16	57	115.7	11	0.3	0.2	0.5	0.049
	18	23	38.4	4	0.2	0.1	0.2	0.018
	20	18	54.8	7	0.2	0.1	0.2	0.029
	22	30	99.0	13	0.3	0.1	0.4	0.057
Avg/Tot	**18.3**	**129**	**307.9**	**35**	**1.0**	**0.6**	**1.3**	**0.152**
Strata Total	**18.3**	**129**	**298.6**	**35**	**1.0**	**0.6**	**1.3**	**0.152**

ESTIMATED HARDWOOD PULPWOOD VOLUME BY STRATUM

Tract: LAKE HOUSTON PARK	Advanced Ecology, Ltd	*Total Acres:* 4800
Cruiser: CHRIS ADAMS	2557 State Highway 7 East	*Number of Plots:* 2310
Location: MONTGOMERY & HARRIS COUNTIES	Center,TX 75935	*Cruise Method:* Point
Owner: CITY OF HOUSTON	*Phone:* 936-598-3053 *Fax:* 936-598-9579	*BAF:* 20
	E-Mail:	*Cruise Date:* 4/30/2008

Stratum: mlandHard *Acres:* 118

Baldcypress

	Average Tree	*Stratum Totals*			*Average Acre*			
	DBH	*Trees*	*Cords*	*Tons*	*BA*	*Trees*	*Cords*	*Tons*
	12	51	13.2	36.0	0.3	0.4	0.1	0.3
Avg/Tot	**12.0**	**51**	**0.3**	**36.0**	**0.3**	**0.4**	**0.1**	**0.3**

Misc. Hardwood

	Average Tree	*Stratum Totals*			*Average Acre*			
	DBH	*Trees*	*Cords*	*Tons*	*BA*	*Trees*	*Cords*	*Tons*
	8	1,261	70.7	192.6	3.7	10.7	0.6	1.6
	10	1,173	113.9	310.4	5.4	9.9	1.0	2.6
	12	51	12.9	35.3	0.3	0.4	0.1	0.3
	14	37	13.9	37.9	0.3	0.3	0.1	0.3
	18	23	10.2	27.8	0.3	0.2	0.1	0.2
	28	9	7.8	21.2	0.3	0.1	0.1	0.2
Avg/Tot	**9.2**	**2,554**	**5.9**	**625.1**	**10.5**	**21.6**	**1.9**	**5.3**

Red Oak

	Average Tree	*Stratum Totals*			*Average Acre*			
	DBH	*Trees*	*Cords*	*Tons*	*BA*	*Trees*	*Cords*	*Tons*
	10	73	6.7	18.3	0.3	0.6	0.1	0.2
Avg/Tot	**10.0**	**73**	**0.2**	**18.3**	**0.3**	**0.6**	**0.1**	**0.2**

White Oak

	Average Tree	*Stratum Totals*			*Average Acre*			
	DBH	*Trees*	*Cords*	*Tons*	*BA*	*Trees*	*Cords*	*Tons*
	10	73	8.6	23.5	0.3	0.6	0.1	0.2
Avg/Tot	**10.0**	**73**	**0.2**	**23.5**	**0.3**	**0.6**	**0.1**	**0.2**
Stratum Total	**9.3**	**2,752**	**6.6**	**702.9**	**11.5**	**23.3**	**2.2**	**6.0**

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ESTIMATED HARDWOOD MEDIUM VOLUME BY STRATUM

Tract: LAKE HOUSTON PARK	Advanced Ecology, Ltd	*Total Acres:* 4800
Cruiser: CHRIS ADAMS	2557 State Highway 7 East	*Number of Plots:* 2310
Location: MONTGOMERY & HARRIS COUNTIES	Center,TX 75935	*Cruise Method:* Point
Owner: CITY OF HOUSTON	*Phone:* 936-598-3053 *Fax:* 936-598-9579	*BAF:* 20
	E-Mail:	*Cruise Date:* 4/30/2008

Stratum: mlandHarc *Acres:* 118

Magnolia

	Average Tree	*Stratum Totals*			*Average Acre*			
	DBH	*Trees*	*Tons*	*DMBF*	*BA*	*Trees*	*Tons*	*DMBF*
	14	37	15.5	1	0.3	0.3	0.1	0.012
	16	29	39.8	2	0.3	0.2	0.3	0.020
	20	18	21.1	3	0.3	0.2	0.2	0.021
Avg/Tot	**16.0**	**84**	**76.5**	**6**	**1.0**	**0.7**	**0.6**	**0.054**

Misc. Hardwood

	Average Tree	*Stratum Totals*			*Average Acre*			
	DBH	*Trees*	*Tons*	*DMBF*	*BA*	*Trees*	*Tons*	*DMBF*
	12	560	213.2	12	3.7	4.7	1.8	0.098
	14	674	434.1	29	6.1	5.7	3.7	0.242
	16	602	605.7	43	7.1	5.1	5.1	0.368
	18	226	238.4	22	3.4	1.9	2.0	0.184
	20	128	453.7	17	2.4	1.1	3.8	0.143
	22	76	142.5	15	1.7	0.6	1.2	0.126
	24	64	166.4	17	1.7	0.5	1.4	0.142
	26	87	215.1	26	2.7	0.7	1.8	0.220
	28	19	70.4	9	0.7	0.2	0.6	0.075
Avg/Tot	**15.8**	**2,435**	**2,539.5**	**189**	**29.5**	**20.6**	**21.5**	**1.599**

Red Oak

	Average Tree	*Stratum Totals*			*Average Acre*			
	DBH	*Trees*	*Tons*	*DMBF*	*BA*	*Trees*	*Tons*	*DMBF*
	12	102	57.8	2	0.7	0.9	0.5	0.018
	14	262	171.0	10	2.4	2.2	1.4	0.087
	16	115	77.8	7	1.4	1.0	0.7	0.060
	18	23	19.7	2	0.3	0.2	0.2	0.017
	20	18	29.9	3	0.3	0.2	0.3	0.024
	22	15	15.5	2	0.3	0.1	0.1	0.018
	24	76	200.4	20	2.0	0.6	1.7	0.165
	26	22	52.9	7	0.7	0.2	0.4	0.056
	28	28	77.0	10	1.0	0.2	0.7	0.085
Avg/Tot	**16.7**	**661**	**702.1**	**62**	**9.2**	**5.6**	**6.0**	**0.530**

ESTIMATED PINE SMALL VOLUME BY STRATUM

Tract: LAKE HOUSTON PARK	**Advanced Ecology, Ltd**	***Total Acres:*** 4800
Cruiser: CHRIS ADAMS	**2557 State Highway 7 East**	***Number of Plots:*** 2310
Location: MONTGOMERY & HARRIS COUNTIES	**Center,TX 75935**	***Cruise Method:*** Point
Owner: CITY OF HOUSTON	***Phone:*** **936-598-3053** ***Fax:*** **936-598-9579**	***BAF:*** 20
	E-Mail:	***Cruise Date:*** 4/30/2008

Stratum: Hardwood ***Acres:*** 232
Loblolly Pine

Average Tree	*Stratum Totals*			*Average Acre*			
DBH	***Trees***	***Tons***	***DMBF***	***BA***	***Trees***	***Tons***	***DMBF***
10	73	40	1	0.2	0.3	0.2	0.006
Avg/Tot **10.0**	**73**	**40**	**1**	**0.2**	**0.3**	**0.2**	**0.006**
Stratum Total **10.0**	**73**	**40**	**1**	**0.2**	**0.3**	**0.2**	**0.006**

Stratum: rdwood_P ***Acres:*** 1168
Loblolly Pine

Average Tree	*Stratum Totals*			*Average Acre*			
DBH	***Trees***	***Tons***	***DMBF***	***BA***	***Trees***	***Tons***	***DMBF***
8	4,584	998	18	1.4	3.9	0.9	0.015
10	3,320	1,647	56	1.6	3.0	1.4	0.048
12	306	228	11	0.2	0.3	0.2	0.010
Avg/Tot **9.0**	**8,409**	**3,322**	**85**	**3.2**	**7.2**	**2.8**	**0.073**
Stratum Total **9.0**	**8,409**	**3,322**	**85**	**3.2**	**7.2**	**2.5**	**0.073**

Stratum: Pine ***Acres:*** 92
Loblolly Pine

Average Tree	*Stratum Totals*			*Average Acre*			
DBH	***Trees***	***Tons***	***DMBF***	***BA***	***Trees***	***Tons***	***DMBF***
8	2,084	395	7	7.9	22.7	4.3	0.077
10	1,726	672	24	10.2	18.8	7.3	0.256
Avg/Tot **8.9**	**3,810**	**1,221**	**31**	**18.1**	**41.4**	**13.3**	**0.333**
Stratum Total **8.9**	**3,810**	**1,221**	**31**	**18.1**	**41.4**	**11.6**	**0.333**

ESTIMATED PINE PULPWOOD VOLUME BY STRATUM

Tract: LAKE HOUSTON PARK	**Advanced Ecology, Ltd**	**Total Acres:** 4800
Cruiser: CHRIS ADAMS	**2557 State Highway 7 East**	**Number of Plots:** 2310
Location: MONTGOMERY & HARRIS COUNTIES	**Center,TX 75935**	**Cruise Method:** Point
Owner: CITY OF HOUSTON	**Phone:** 936-598-3053 **Fax:** 936-598-9579	**BAF:** 20
	E-Mail:	**Cruise Date:** 4/30/2008

Stratum: rdwood_P **Acres:** 1168

Loblolly Pine

	Average Tree	Stratum Totals			Average Acre			
	DBH	Trees	Cords	Tons	BA	Trees	Cords	Tons
	6	6,723	381.6	1,011.3	1.1	5.8	0.3	0.9
	8	229	30.7	81.3	0.1	0.2	0.0	0.1
	10	147	30.3	80.3	0.1	0.1	0.0	0.1
	12	204	48.1	127.5	0.1	0.2	0.0	0.1
	14	75	24.5	65.0	0.1	0.1	0.0	0.1
	16	29	17.6	46.7	0.0	0.0	0.0	0.0
	18	23	15.5	40.9	0.0	0.0	0.0	0.0
Avg/Tot	**6.5**	**7,428**	**138.6**	**1,453.2**	**1.5**	**6.4**	**0.5**	**1.2**
Stratum Total	**6.5**	**7,428**	**138.6**	**1,453.2**	**1.5**	**6.4**	**0.5**	**1.2**

Stratum: Pine **Acres:** 92

Loblolly Pine

	Average Tree	Stratum Totals			Average Acre			
	DBH	Trees	Cords	Tons	BA	Trees	Cords	Tons
	6	1,308	65.8	174.4	2.8	14.2	0.7	1.9
	10	78	12.6	33.4	0.5	0.9	0.1	0.4
	12	54	12.9	34.1	0.5	0.6	0.1	0.4
Avg/Tot	**6.4**	**1,441**	**1.7**	**241.9**	**3.7**	**15.7**	**1.0**	**2.6**
Stratum Total	**6.4**	**1,441**	**1.7**	**241.9**	**3.7**	**15.7**	**1.0**	**2.6**

ESTIMATED PINE SAWTIMBER VOLUME BY STRATUM

Tract: LAKE HOUSTON PARK	Advanced Ecology, Ltd	*Total Acres:* 4800
Cruiser: CHRIS ADAMS	2557 State Highway 7 East	*Number of Plots:* 2310
Location: MONTGOMERY & HARRIS COUNTIES	Center,TX 75935	*Cruise Method:* Point
Owner: CITY OF HOUSTON	*Phone:* 936-598-3053 *Fax:* 936-598-9579	*BAF:* 20
	E-Mail:	*Cruise Date:* 4/30/2008

Stratum: mlandHarc *Acres:* 118

Loblolly Pine

	Average Tree	*Stratum Totals*			*Average Acre*			
	DBH	*Trees*	*Tons*	*DMBF*	*BA*	*Trees*	*Tons*	*DMBF*
	12	51	30	2	0.3	0.4	0.3	0.014
	14	187	124	10	1.7	1.6	1.1	0.082
	16	229	281	24	2.7	1.9	2.4	0.206
	18	226	364	37	3.4	1.9	3.1	0.317
	20	55	113	13	1.0	0.5	1.0	0.110
	22	45	113	14	1.0	0.4	1.0	0.118
	24	76	214	29	2.0	0.6	1.8	0.247
	26	76	227	28	2.4	0.6	1.9	0.239
	28	56	248	37	2.0	0.5	2.1	0.315
	30	8	42	7	0.3	0.1	0.4	0.057
	32	14	83	14	0.7	0.1	0.7	0.116
	34	6	33	4	0.3	0.1	0.3	0.037
Avg/Tot	**18.8**	**1,031**	**2,330**	**219**	**18.0**	**8.7**	**19.7**	**1.859**
Stratum Total	**18.8**	**1,031**	**2,330**	**219**	**18.0**	**8.7**	**15.9**	**1.859**

Stratum: Cypress *Acres:* 22

Loblolly Pine

	Average Tree	*Stratum Totals*			*Average Acre*			
	DBH	*Trees*	*Tons*	*DMBF*	*BA*	*Trees*	*Tons*	*DMBF*
	18	23	36	3	1.8	1.0	1.7	0.149
	24	13	41	6	1.8	0.6	1.9	0.256
	28	9	45	7	1.8	0.4	2.0	0.310
Avg/Tot	**21.8**	**45**	**141**	**16**	**5.5**	**2.0**	**6.4**	**0.715**
Stratum Total	**21.8**	**45**	**141**	**16**	**5.5**	**2.0**	**5.6**	**0.715**

Summary Report By Strata

Tract: LAKE HOUSTON PARK	Advanced Ecology, Ltd	*Total Acres:* 4800
Cruiser: CHRIS ADAMS	2557 State Highway 7 East	*Number of Plots:* 2310
Location: MONTGOMERY & HARRIS COUNTIES	Center,TX 75935	*Cruise Method:* Point
Owner: CITY OF HOUSTON	*Phone:* 936-598-3053 *Fax:* 936-598-9579	*BAF:* 20
	E-Mail:	*Cruise Date:* 4/30/2008

Stratum **BottomlandHardwood** *Acres* 118

	Stratum Total					*Average Acre*					*Average Tree*	
	Trees	*Tons*	*Topwood Tons*	*Cords*	*DMBF*	*BA*	*Trees*	*Cords*	*Tons*	*DMBF*	*DBH*	*MerchHt*
Baldcypress												
Pulpwood	51	36		13		0.3	0	0.1	0.3		12.0	40.0
Sawtimber	60	156	24	49	17	1.0	1	0.4	1.1	0.147	19.0	48.0
Loblolly Pine												
Sawtimber	1,031	2,330	459	706	219	18.0	9	6.0	15.9	1.859	18.8	44.8
Magnolia												
Medium	84	76	17	22	6	1.0	1	0.2	0.5	0.054	16.0	20.5
Misc. Hardwood												
Crosstie	2,435	2,539	659	690	189	29.5	21	5.8	15.9	1.599	15.8	23.7
Pulpwood	2,554	625		229		10.5	22	1.9	5.3		9.2	23.3
Red Oak												
Pulpwood	73	18		7		0.3	1	0.1	0.2		10.0	23.6
Medium	661	702	141	206	62	9.2	6	1.7	4.8	0.530	16.7	22.0
Sweetgum												
Medium	33	71	30	15	5	0.7	0	0.1	0.4	0.042	20.6	53.4
White Oak												
Medium	271	365	68	109	35	4.4	2	0.9	2.5	0.294	17.9	23.6
Pulpwood	73	24		9		0.3	1	0.1	0.2		10.0	32.0
Total:	**7,328**	**6,944**	**1,397**	**2,055**	**534**	**75.3**	**62**			**4.524**	**14.0**	**26.0**

APPENDIX "B" – WHAP SCORE SHEETS

Cover Type or Plant Association:	**Flat Woods**							
Habitat Components	**Component Points (from Key)**							
Site No.	1	2	3	4	5	6		**Total**
1. Site Potential	7							
2. Temporal Development								
Criteria A (interpolated)	9							
Criteria B (Marsh Wetlands Only)								
3. Uniqueness and Relative Abundance	10							
4. Vegetation Species Diversity								
Criteria A	6							
Criteria B	5							
Criteria C (Swamps Only)								
Criteria D (Marsh Wetlands Only)								
5. Vertical Stratification	3							
6. Additional Structural Diversity Components	3							
7. Condition of Existing Vegetation								
Criteria A (Woody Vegetation)	1.5							
Criteria B (Herbaceous Vegetation)	2							
Criteria C (Croplands Only)								
Criteria D (Marsh Wetlands Only)								
Average Habitat Quality Score for all Sites within this cover type =	46.5	Total Points / Total number of sites		X	1 / 100	=	.4650	

Cover Type or Plant Association:	**Bottomland**							
Habitat Components	**Component Points (from Key)**							
Site No.	1	2	3	4				**Total**
1. Site Potential	18							
2. Temporal Development								
Criteria A	15							
Criteria B (Marsh Wetlands Only)								
3. Uniqueness and Relative Abundance	15							
4. Vegetation Species Diversity								
Criteria A	7							
Criteria B	6							
Criteria C (Swamps Only)								
Criteria D (Marsh Wetlands Only)								
5. Vertical Stratification	4							
6. Additional Structural Diversity Components	2							
7. Condition of Existing Vegetation								
Criteria A (Woody Vegetation)	1.5							
Criteria B (Herbaceous Vegetation)	2							
Criteria C (Croplands Only)								
Criteria D (Marsh Wetlands Only)								
Average Habitat Quality Score for all Sites within this cover type =	70.5	Total Points / Total number of sites		X	1 / 100	=	.705	

Cover Type or Plant Association:	**Uplands**							
Habitat Components	**Component Points (from Key)**							
Site No.	1	2	3	4	5	6	7	**Total**
1. Site Potential	10							
2. Temporal Development								
Criteria A	9							
Criteria B (Marsh Wetlands Only)								
3. Uniqueness and Relative Abundance	5							
4. Vegetation Species Diversity								
Criteria A	8							
Criteria B	7							
Criteria C (Swamps Only)								
Criteria D (Marsh Wetlands Only)								
5. Vertical Stratification	5							
6. Additional Structural Diversity Components	4							
7. Condition of Existing Vegetation								
Criteria A (Woody Vegetation)	1.5							
Criteria B (Herbaceous Vegetation)	2							
Criteria C (Croplands Only)								
Criteria D (Marsh Wetlands Only)								
Average Habitat Quality Score for all Sites within this cover type =	51.5	Total Points / Total number of sites		X	1 / 100	=	.515	

Cover Type or Plant Association:	**Clay Flats**							
Habitat Components	**Component Points (from Key)**							
Site No.	1							**Total**
1. Site Potential	25							25
2. Temporal Development								
Criteria A	5							5
Criteria B (Marsh Wetlands Only)	5							5
3. Uniqueness and Relative Abundance	10							10
4. Vegetation Species Diversity								
Criteria A								
Criteria B								
Criteria C (Swamps Only)								
Criteria D (Marsh Wetlands Only)	15							15
5. Vertical Stratification								
6. Additional Structural Diversity Components	3							3
7. Condition of Existing Vegetation								
Criteria A (Woody Vegetation)								
Criteria B (Herbaceous Vegetation)								
Criteria C (Croplands Only)								
Criteria D (Marsh Wetlands Only)	10							10
Average Habitat Quality Score for all Sites within this cover type =	73							73

Total Points / Total number of sites X 1/100 = .73

Cover Type or Plant Association:	**Stream Terrace**							
Habitat Components	**Component Points (from Key)**							
Site No.	1	2	3	4	5			**Total**
1. Site Potential	15							
2. Temporal Development								
Criteria A	13							
Criteria B (Marsh Wetlands Only)								
3. Uniqueness and Relative Abundance	10							
4. Vegetation Species Diversity								
Criteria A	7							
Criteria B	5							
Criteria C (Swamps Only)								
Criteria D (Marsh Wetlands Only)								
5. Vertical Stratification	3							
6. Additional Structural Diversity Components	2							
7. Condition of Existing Vegetation								
Criteria A (Woody Vegetation)	1.5							
Criteria B (Herbaceous Vegetation)	2							
Criteria C (Croplands Only)								
Criteria D (Marsh Wetlands Only)								
Average Habitat Quality Score for all Sites within this cover type =	58.5	Total Points / Total number of sites		X	1 / 100	=	.585	

Cover Type or Plant Association:	**Bald Cypress Sloughs**							
Habitat Components	**Component Points (from Key)**							
Site No.	1	2						**Total**
1. Site Potential	25							
2. Temporal Development								
Criteria A	15							
Criteria B (Marsh Wetlands Only)								
3. Uniqueness and Relative Abundance	15							
4. Vegetation Species Diversity								
Criteria A	6							
Criteria B	3							
Criteria C (Swamps Only)	10							
Criteria D (Marsh Wetlands Only)								
5. Vertical Stratification	3							
6. Additional Structural Diversity Components	3							
7. Condition of Existing Vegetation								
Criteria A (Woody Vegetation)	3							
Criteria B (Herbaceous Vegetation)	1							
Criteria C (Croplands Only)								
Criteria D (Marsh Wetlands Only)								
Average Habitat Quality Score for all Sites within this cover type =	84	Total Points / Total number of sites		X	1 / 100	=	.84	

APPENDIX "C" – SOILS REPORT

United States Department of Agriculture

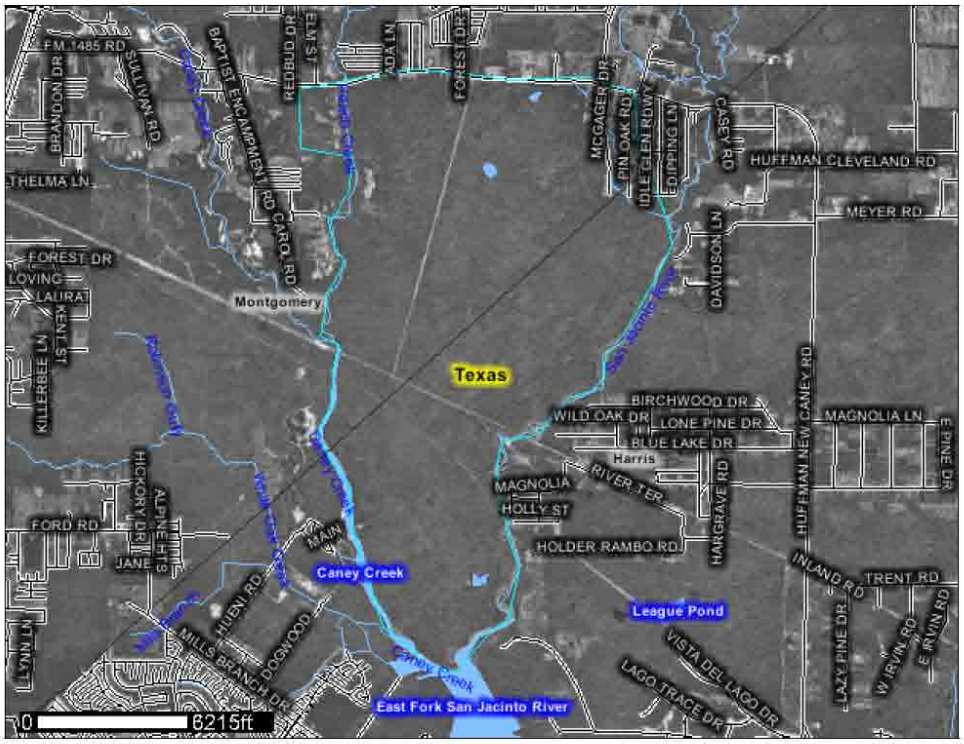
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Harris County, Texas, and Montgomery County, Texas

Lake Houston Park



Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

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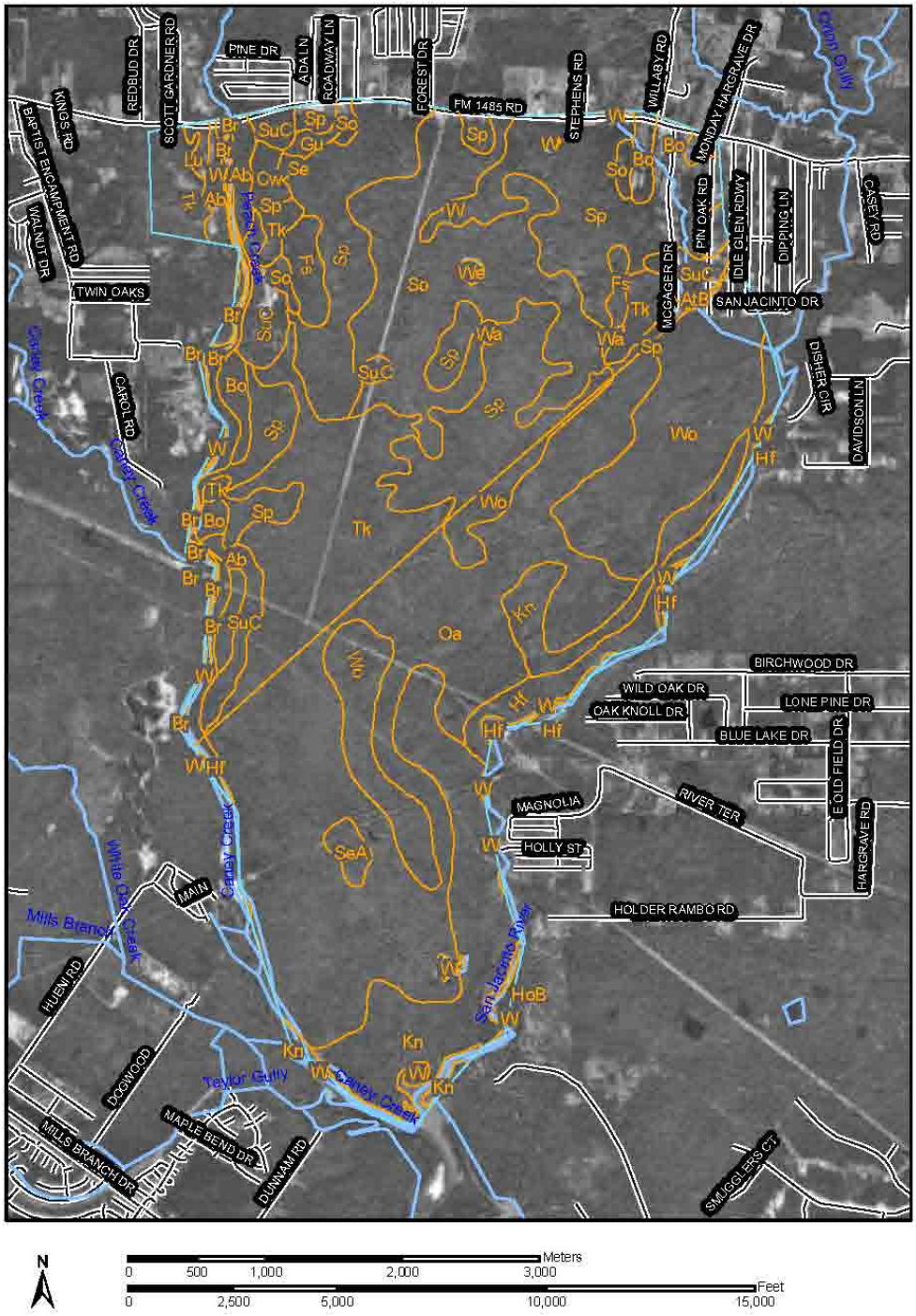
Soil Map



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Legend

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Political Features

Municipalities
- Cities
- Urban Areas

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails

Roads
- Interstate Highways
- US Routes
- State Highways
- Local Roads
- Other Roads

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 15N

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Harris County, Texas
Survey Area Data: Version 6, May 28, 2008

Soil Survey Area: Montgomery County, Texas
Survey Area Data: Version 6, Jan 11, 2008

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Date(s) aerial images were photographed: 1995

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

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Map Unit Legend

Harris County, Texas (TX201)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AtB	Atasco fine sandy loam, 1 to 4 percent slopes	2.1	0.0%
Bo	Boy loamy fine sand	0.1	0.0%
Hf	Hatliff loam	133.1	2.5%
HoB	Hockley fine sandy loam, 1 to 4 percent slopes	6.4	0.1%
Kn	Kenney loamy fine sand	505.8	9.4%
Oa	Ozan loam	1,266.8	23.6%
SeA	Segno fine sandy loam, 0 to 1 percent slopes	25.0	0.5%
W	Water	72.5	1.4%
Wo	Wockley fine sandy loam	580.9	10.8%
Wy	Wockley-Urban land complex	0.0	0.0%

Montgomery County, Texas (TX339)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Ab	Landman fine sand	111.5	2.1%
Bo	Boy fine sand	77.0	1.4%
Br	Bruno loamy fine sand	88.0	1.6%
Cw	Crowley fine sandy loam	24.8	0.5%
Eu	Betis loamy fine sand	0.1	0.0%
Fs	Lilbert loamy fine sand	61.8	1.2%
Gu	Gunter fine sand	12.4	0.2%
Lu	Briley loamy fine sand	11.9	0.2%
Se	Segno fine sandy loam	5.3	0.1%
So	Sorter silt loam	599.7	11.2%
Sp	Splendora fine sandy loam	1,019.5	19.0%
SuC	Woodville fine sandy loam, 1 to 5 percent slopes	136.9	2.6%
Tk	Aris loam, heavy substratum	570.2	10.6%
W	Water	32.8	0.6%
Wa	Waller loam	9.5	0.2%
We	Waller soils, ponded	5.8	0.1%
Totals for Area of Interest (AOI)		5,359.7	100.0%

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Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly

indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

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Harris County, Texas Version date:5/28/2008 11:48:22 AM

AtB—Atasco fine sandy loam, 1 to 4 percent slopes

Map Unit Setting

Elevation: 10 to 200 feet
Mean annual precipitation: 46 to 52 inches
Mean annual air temperature: 68 to 70 degrees F
Frost-free period: 290 to 310 days

Map Unit Composition

Atasco and similar soils: 90 percent
Minor components: 10 percent

Description of Atasco

Setting

Landform: Terraces on river valleys
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loamy fluviomarine deposits of late pleistocene age

Properties and qualities

Slope: 1 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 18 to 21 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 10.8 inches)

Interpretive groups

Land capability (nonirrigated): 2e

Typical profile

0 to 16 inches: Fine sandy loam
16 to 19 inches: Sandy clay loam
19 to 60 inches: Clay

Minor Components

Unnamed, minor components

Percent of map unit: 10 percent

Bo—Boy loamy fine sand

Map Unit Setting

Elevation: 50 to 250 feet
Mean annual precipitation: 40 to 50 inches

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Mean annual air temperature: 66 to 70 degrees F
Frost-free period: 260 to 300 days

Map Unit Composition
Boy and similar soils: 85 percent
Minor components: 15 percent

Description of Boy

Setting
Landform: Terraces
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy alluvium of quaternary age

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 42 to 66 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Low (about 5.0 inches)

Interpretive groups
Land capability (nonirrigated): 3s

Typical profile
0 to 56 inches: Loamy fine sand
56 to 75 inches: Sandy clay loam

Minor Components

Unnamed, minor components
Percent of map unit: 15 percent

Hf—Hatliff loam

Map Unit Setting
Elevation: 50 to 230 feet
Mean annual precipitation: 40 to 48 inches
Mean annual air temperature: 66 to 70 degrees F
Frost-free period: 250 to 270 days

Map Unit Composition
Hatliff and similar soils: 95 percent
Minor components: 5 percent

Description of Hatliff

Setting
Landform: Flood plains

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Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium of holocene age

Properties and qualities
Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 0 to 24 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water capacity: Low (about 5.5 inches)

Interpretive groups
Land capability (nonirrigated): 5w

Typical profile
0 to 10 inches: Loam
10 to 80 inches: Stratified loam to sand

Minor Components

Unnamed, minor components
Percent of map unit: 5 percent

HoB—Hockley fine sandy loam, 1 to 4 percent slopes

Map Unit Setting
Elevation: 50 to 450 feet
Mean annual precipitation: 40 to 56 inches
Mean annual air temperature: 66 to 72 degrees F
Frost-free period: 260 to 300 days

Map Unit Composition
Hockley and similar soils: 85 percent
Minor components: 15 percent

Description of Hockley

Setting
Landform: Low hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loamy fluviomarine deposits of late pliocene and early pleistocene age

Properties and qualities
Slope: 1 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 42 to 60 inches

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Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Moderate (about 8.3 inches)

Interpretive groups
Land capability (nonirrigated): 2e
Ecological site: LOAMY PRAIRIE PE 31-44 (R150AY535TX)

Typical profile
0 to 23 inches: Fine sandy loam
23 to 50 inches: Sandy clay loam
50 to 80 inches: Sandy clay loam

Minor Components

Unnamed, minor components
Percent of map unit: 15 percent

Kn—Kenney loamy fine sand

Map Unit Setting
Elevation: 100 to 500 feet
Mean annual precipitation: 38 to 55 inches
Mean annual air temperature: 66 to 70 degrees F
Frost-free period: 240 to 300 days

Map Unit Composition
Kenney and similar soils: 85 percent
Minor components: 15 percent

Description of Kenney

Setting
Landform: Terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loamy alluvium of quaternary age

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Low (about 5.0 inches)

Interpretive groups
Land capability (nonirrigated): 3s
Ecological site: SANDY PRAIRIE (R150AY543TX)

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Typical profile
0 to 56 inches: Loamy fine sand
56 to 80 inches: Sandy clay loam

Minor Components

Unnamed, minor components
Percent of map unit: 15 percent

Oa—Ozan loam

Map Unit Setting
Elevation: 100 to 240 feet
Mean annual precipitation: 50 to 54 inches
Mean annual air temperature: 63 to 68 degrees F
Frost-free period: 195 to 230 days

Map Unit Composition
Ozan and similar soils: 90 percent
Minor components: 10 percent

Description of Ozan

Setting
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium of late pleistocene age

Properties and qualities
Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water capacity: High (about 9.1 inches)

Interpretive groups
Land capability (nonirrigated): 4w

Typical profile
0 to 18 inches: Loam
18 to 51 inches: Loam
51 to 65 inches: Sandy clay loam
65 to 72 inches: Loam

Minor Components

Unnamed, minor components
Percent of map unit: 10 percent

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SeA—Segno fine sandy loam, 0 to 1 percent slopes

Map Unit Setting

Elevation: 100 to 400 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 66 to 70 degrees F
Frost-free period: 260 to 300 days

Map Unit Composition

Segno and similar soils: 85 percent
Minor components: 15 percent

Description of Segno

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy fluviomarine deposits of early pleistocene age

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.2 inches)

Interpretive groups

Land capability (nonirrigated): 2s
Ecological site: LOAMY PRAIRIE PE 31-44 (R150AY535TX)

Typical profile

0 to 5 inches: Fine sandy loam
5 to 13 inches: Fine sandy loam
13 to 42 inches: Sandy clay loam
42 to 75 inches: Sandy clay loam

Minor Components

Unnamed, minor components

Percent of map unit: 15 percent

W—Water

Map Unit Composition

Water: 100 percent

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Wo—Wockley fine sandy loam

Map Unit Setting

Elevation: 50 to 300 feet
Mean annual precipitation: 42 to 50 inches
Mean annual air temperature: 68 to 70 degrees F
Frost-free period: 250 to 280 days

Map Unit Composition

Wockley and similar soils: 85 percent
Minor components: 15 percent

Description of Wockley

Setting

Landform: Low hills
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loamy fluviomarine deposits of late pliocene to early pleistocene age

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 6 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): 3w
Land capability (nonirrigated): 3w
Ecological site: LOAMY PRAIRIE PE 31-44 (R150AY535TX)

Typical profile

0 to 22 inches: Fine sandy loam
22 to 60 inches: Sandy clay loam

Minor Components

Unnamed, hydric minor components

Percent of map unit: 15 percent
Landform: Depressions

Wy—Wockley-Urban land complex

Map Unit Setting

Elevation: 0 to 4,000 feet
Mean annual precipitation: 8 to 60 inches

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Mean annual air temperature: 54 to 73 degrees F
Frost-free period: 180 to 310 days

Map Unit Composition
Wockley and similar soils: 55 percent
Urban land: 35 percent
Minor components: 10 percent

Description of Wockley

Setting
Landform: Low hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits of late pliocene to early pleistocene age

Properties and qualities
Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 6 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 9.6 inches)

Interpretive groups
Land capability classification (irrigated): 3w
Land capability (nonirrigated): 3w
Ecological site: LOAMY PRAIRIE PE 31-44 (R150AY535TX)

Typical profile
0 to 22 inches: Fine sandy loam
22 to 60 inches: Sandy clay loam

Description of Urban Land

Interpretive groups
Land capability (nonirrigated): 8s

Typical profile
0 to 40 inches: Variable

Minor Components

Unnamed, minor components
Percent of map unit: 10 percent

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Montgomery County, Texas Version date:1/11/2008 6:27:53 AM

Ab—Landman fine sand

Map Unit Setting
Elevation: 170 to 350 feet
Mean annual precipitation: 42 to 52 inches
Mean annual air temperature: 66 to 70 degrees F
Frost-free period: 240 to 285 days

Map Unit Composition
Landman, affr >30, and similar soils: 100 percent

Description of Landman, Affr >30

Setting
Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loamy alluvium and/or sandy alluvium

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 48 to 72 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Low (about 5.4 inches)

Interpretive groups
Land capability (nonirrigated): 3s

Typical profile
0 to 47 inches: Fine sand
47 to 83 inches: Fine sandy loam

Bo—Boy fine sand

Map Unit Setting
Elevation: 50 to 250 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 66 to 70 degrees F
Frost-free period: 260 to 300 days

Map Unit Composition
Boy and similar soils: 100 percent

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Description of Boy

Setting

Landform: Interfluves
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Sandy marine deposits and/or loamy marine deposits

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 42 to 66 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Low (about 5.4 inches)

Interpretive groups

Land capability (nonirrigated): 3s

Typical profile

0 to 47 inches: Fine sand
47 to 70 inches: Sandy clay loam

Br—Bruno loamy fine sand

Map Unit Setting

Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 59 to 72 degrees F
Frost-free period: 200 to 240 days

Map Unit Composition

Bruno and similar soils: 100 percent

Description of Bruno

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 48 to 72 inches
Frequency of flooding: Frequent
Frequency of ponding: None

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Available water capacity: Low (about 4.1 inches)

Interpretive groups

Land capability (nonirrigated): 5w
Ecological site: Loamy Bottomland PE 48-68 (R087AY231TX)

Typical profile

0 to 8 inches: Loamy sand
8 to 42 inches: Loamy fine sand
42 to 60 inches: Sand

Cw—Crowley fine sandy loam

Map Unit Setting

Elevation: 10 to 80 feet
Mean annual precipitation: 55 to 65 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 235 to 300 days

Map Unit Composition

Crowley, affr 30-42, and similar soils: 95 percent
Minor components: 5 percent

Description of Crowley, Affr 30-42

Setting

Landform: Meander scrolls
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Clayey marine deposits

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very high (about 12.5 inches)

Interpretive groups

Land capability (nonirrigated): 3w

Typical profile

0 to 15 inches: Silt loam
15 to 32 inches: Silty clay
32 to 80 inches: Silty clay

Minor Components

Unnamed, hydric minor components

Percent of map unit: 5 percent
Landform: Depressions

Custom Soil Resource Report

Eu—Betis loamy fine sand

Map Unit Setting

Elevation: 400 to 700 feet
Mean annual precipitation: 40 to 48 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 235 to 250 days

Map Unit Composition

Betis and similar soils: 100 percent

Description of Betis

Setting

Landform: Interfluves
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy marine deposits

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.8 inches)

Interpretive groups

Land capability (nonirrigated): 3s

Typical profile

0 to 17 inches: Loamy fine sand
17 to 63 inches: Loamy fine sand
63 to 80 inches: Loamy fine sand

Fs—Lilbert loamy fine sand

Map Unit Setting

Elevation: 350 to 600 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 240 to 275 days

Map Unit Composition

Lilbert and similar soils: 100 percent

Description of Lilbert

Setting

Landform: Interfluves
Down-slope shape: Convex
Across-slope shape: Convex

Custom Soil Resource Report

Parent material: Loamy marine deposits

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 6.6 inches)

Interpretive groups

Land capability (nonirrigated): 3s

Typical profile

0 to 4 inches: Loamy fine sand
4 to 23 inches: Loamy fine sand
23 to 48 inches: Sandy clay loam
48 to 80 inches: Sandy clay loam

Gu—Gunter fine sand

Map Unit Setting

Elevation: 150 to 400 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 66 to 70 degrees F
Frost-free period: 250 to 300 days

Map Unit Composition

Gunter and similar soils: 100 percent

Description of Gunter

Setting

Landform: Interfluves
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy marine deposits and/or loamy marine deposits

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 42 to 60 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.3 inches)

Interpretive groups

Land capability (nonirrigated): 3s

Typical profile

0 to 10 inches: Fine sand

Custom Soil Resource Report

10 to 46 inches: Fine sand
46 to 57 inches: Sandy loam
57 to 75 inches: Sandy clay loam

Lu—Briley loamy fine sand

Map Unit Setting
Elevation: 350 to 600 feet
Mean annual precipitation: 40 to 48 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 240 to 275 days

Map Unit Composition
Briley and similar soils: 100 percent

Description of Briley

Setting
Landform: Interfluves
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Properties and qualities
Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 6.4 inches)

Interpretive groups
Land capability (nonirrigated): 3s

Typical profile
0 to 7 inches: Loamy fine sand
7 to 23 inches: Loamy fine sand
23 to 76 inches: Sandy clay loam

Se—Segno fine sandy loam

Map Unit Setting
Elevation: 100 to 400 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 66 to 70 degrees F
Frost-free period: 260 to 300 days

Map Unit Composition
Segno and similar soils: 100 percent

Custom Soil Resource Report

Description of Segno

Setting

Landform: Low hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.3 inches)

Interpretive groups

Land capability (nonirrigated): 2e

Typical profile

0 to 4 inches: Fine sandy loam
4 to 14 inches: Fine sandy loam
14 to 44 inches: Sandy clay loam
44 to 80 inches: Sandy clay loam

So—Sorter silt loam

Map Unit Setting

Elevation: 50 to 400 feet
Mean annual precipitation: 46 to 56 inches
Mean annual air temperature: 66 to 70 degrees F
Frost-free period: 235 to 270 days

Map Unit Composition

Sorter and similar soils: 90 percent
Minor components: 10 percent

Description of Sorter

Setting

Landform: Flats
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits of early pleistocene age

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained

Custom Soil Resource Report

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: Occasional
Frequency of ponding: Frequent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 2.0
Available water capacity: High (about 10.8 inches)

Interpretive groups
Land capability (nonirrigated): 4w

Typical profile
0 to 19 inches: Silt loam
19 to 68 inches: Silt loam
68 to 80 inches: Very fine sandy loam

Minor Components

Unnamed, minor components
Percent of map unit: 10 percent

Sp—Splendora fine sandy loam

Map Unit Setting
Elevation: 50 to 400 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 66 to 70 degrees F
Frost-free period: 235 to 270 days

Map Unit Composition
Splendora and similar soils: 90 percent
Minor components: 10 percent

Description of Splendora

Setting
Landform: Hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loamy fluviomarine deposits of early pleistocene age

Properties and qualities
Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 6 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.3 inches)

Interpretive groups
Land capability (nonirrigated): 2w

Custom Soil Resource Report

Typical profile
0 to 10 inches: Fine sandy loam
10 to 20 inches: Loam
20 to 32 inches: Loam
32 to 80 inches: Sandy clay loam

Minor Components

Sorter
Percent of map unit: 10 percent
Landform: Flats

SuC—Woodville fine sandy loam, 1 to 5 percent slopes

Map Unit Setting
Elevation: 150 to 450 feet
Mean annual precipitation: 46 to 58 inches
Mean annual air temperature: 66 to 70 degrees F
Frost-free period: 230 to 270 days

Map Unit Composition
Woodville and similar soils: 100 percent

Description of Woodville

Setting
Landform: Interfluves
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Clayey marine deposits

Properties and qualities
Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 9.1 inches)

Interpretive groups
Land capability (nonirrigated): 4e

Typical profile
0 to 9 inches: Fine sandy loam
9 to 48 inches: Clay
48 to 80 inches: Clay

Custom Soil Resource Report

Tk—Aris loam, heavy substratum

Map Unit Setting

Elevation: 10 to 40 feet
Mean annual precipitation: 50 to 62 inches
Mean annual air temperature: 70 to 72 degrees F
Frost-free period: 250 to 280 days

Map Unit Composition

Aris and similar soils: 90 percent
Minor components: 10 percent

Description of Aris

Setting

Landform: Flats
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits of late pleistocene age

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 0 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Sodium adsorption ratio, maximum: 6.0
Available water capacity: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): 4w
Land capability (nonirrigated): 4w

Typical profile

0 to 15 inches: Loam
15 to 37 inches: Clay loam
37 to 78 inches: Clay

Minor Components

Unnamed, minor components

Percent of map unit: 10 percent

W—Water

Map Unit Composition

Water: 100 percent

Custom Soil Resource Report

Wa—Waller loam

Map Unit Setting

Elevation: 20 to 400 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 245 to 285 days

Map Unit Composition

Waller and similar soils: 98 percent
Minor components: 2 percent

Description of Waller

Setting

Landform: Flats
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits of early pleistocene age

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 10.8 inches)

Interpretive groups

Land capability classification (irrigated): 4w
Land capability (nonirrigated): 4w

Typical profile

0 to 4 inches: Loam
4 to 34 inches: Loam
34 to 80 inches: Clay loam

Minor Components

Unnamed, minor components

Percent of map unit: 2 percent

We—Waller soils, ponded

Map Unit Setting

Elevation: 20 to 400 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 64 to 70 degrees F
Frost-free period: 245 to 285 days

Custom Soil Resource Report

Map Unit Composition
Waller and similar soils: 98 percent
Minor components: 2 percent

Description of Waller

Setting
Landform: Flats
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits of early pleistocene age

Properties and qualities
Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 10.8 inches)

Interpretive groups
Land capability (nonirrigated): 6w

Typical profile
0 to 4 inches: Very fine sandy loam
4 to 34 inches: Loam
34 to 80 inches: Clay loam

Minor Components

Unnamed, minor components
Percent of map unit: 2 percent

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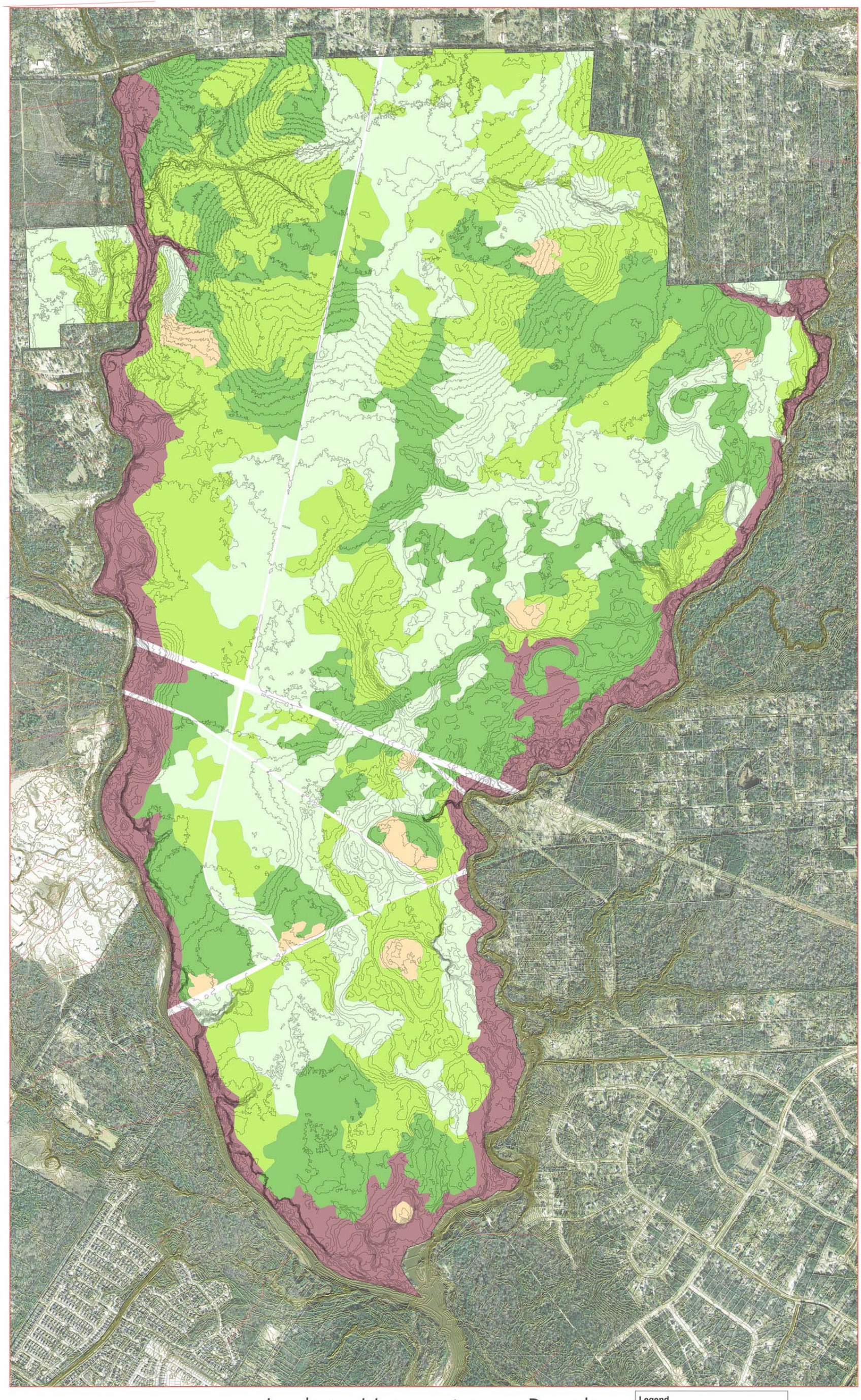
APPENDIX "D" – SUSTAINABLE MANAGEMENT AREAS MAP



Lake Houston Park

City of Houston Parks and Recreation Department

The SWA Group
Advanced Ecology
United Engineers
Economics Research Associates
Conservation Capital
Quadrant
Moore Archeology

North

0 500 1000 2000 3000

3 September 2008

Legend

stands

Stand_Name

- Active Forest Habitat Management Area
- Candidate Prairie Area
- Intermediate Forest Habitat Management Area
- Passive Forest Habitat Management Area
- Riparian Corridor

SWA