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Hickory Creek Orchard Feasibility Study

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Abstract

The study investigates whether a pecan orchard would be appropriate within a 4,000 acre area of the Davy Crockett National Forest in Houston County, Texas. In this project, the study area was selected based on creeks and water sources in the region. After determining that the vicinity of Hickory Creek would be the most suitable geographic area-of-interest (AOI), the second level of research was to conduct two levels of GIS analysis on the soils within the area. The study takes an in depth comparison of the soil types in the AOI and a nearby existing pecan orchard. The existing pecan orchard contains 106 acres of planted trees that lies 3.4 miles to the southeast of the Hickory Creek study area, on U.S. Highway 7, adjoining the city limits of Kennard, Texas. In addition to the comparison between the AOI and existing pecan orchard soils, the study includes an analysis of the soil types that are recommended by the U.S. Department of Agriculture Natural Resources Conservation Service (USDA NRCS) Soil Survey for Houston County, Texas. After performing analysis of the two variations of recommended soil types, the areas were reduced down to include only non-forested agricultural lands that may already host the potential for accommodating a pecan orchard. Then an analysis including the AOI and existing pecan orchard soil types were combined and reduced once again to a smaller AOI based on contiguousness of the soil polygons, in combination with preference to nearby creeks, streams, and road infrastructure. The final analysis included overlaying Houston County land ownership parcel data over the study area and selecting the tracts that offer the highest level of preference based upon the conclusion of this strategic analysis of soil types.

Keywords: geospatial analysis, land-use, agriculture

1. Introduction

East Texas has predominantly been categorized historically as a forestry and timber management region. The nearest region containing a large number of properties that have nut-bearing tree plantations, or orchards, is in the Hill Country or South Texas Regions. During 2012, there was a unique rural real estate transaction that occurred between an East Texas timber landowner and a successful almond orchard farmer. The almond farmer had no previous experience with the practice and management of Texas loblolly pine plantations; however, he had interest in diversifying his real estate investment portfolio to include a pine plantation offering a different soil type than he was used to cultivating for his almond farms. The more than two-thousand acre Neches River property of his choice, was in fact a practical timberland investment, with a desirable projected return-on-investment. As a result, the almond farmer could learn the principles associated with growing, managing, and harvesting pine timber in East Texas, while examining the soil types and preparing the property for his experimental East Texas almond orchard farm. Due to the almond farmers unorthodox endeavor, the transaction encouraged and promoted the basis of the following study; does the East Texas region possess lands that are practical, or even potentially possible, to develop large acreage into nut-bearing orchards.

2. Methodology

This study was conducted with the expectation that the criteria selection of the subject, workflow, and GIS analysis, can, and will undoubtedly offer a reliable form of land-use determination techniques during future accounts of due-diligence. In this particular study, a pecan orchard was selected for the study, as opposed to the previously mentioned topic of almond orchards, primarily because of an already existing pecan orchard within the vicinity of the study area. Coincidently, the two-thousand acre Neches River property purchased by the almond farmer, just happens to be minutes away from the study area. In coordination with the nearby existing pecan orchard, the 4,000 acre AOI was established upon analyzing the area for the most attractive creeks, streams, and road system infrastructure available, to initially support the reality of a potential pecan orchard. In this study, the AOI is referred to as the Hickory Creek area due to the predominant and geographically balanced water features in the study area. The objective for this study is to use available data, scientific facts, and the most foundational principles of geospatial analysis in natural resources, to determine if a pecan orchard is suitable for the selected study area, based on soil type. Additionally, the end goal is to reduce the AOI down to a focused area, as small as 10%, in order to precisely identify the most desirable tracts of land in the study area, with consideration given to existing county tax parcel ownership data.

According to the USDA NRCS Soil Survey for Houston County, Texas, some of the soil characteristics needed for pecan trees that were considered, and regarded as critical during the following analysis, include: 1) deep alluvial soils along rivers and streams; suggested 36" of aerable soil[1]. 2) The soil should have the ability to hold large quantities of water; a permeable clayey subsoil can aid in water holding capacity without waterlogging the rooting zone[1]. 3) The water table should remain at least 6 feet below the soil surface during wet periods[5]. Shallow water tables limit rooting zones, which in turn limit available water during prolonged droughts[1]. 4) The terrain should be level or gently sloping and free of areas that hold water[1]. 5) During the fall, long-term flooding lands can wash the pecan crop downstream[1]. 6) An area prone to frequent and long-term flooding should not be considered[1]. 7) Level or gentle slopes help in air drainage[1]. 8) Alluvial soils are preferred, but uplands with deep well-drained soils and proper managing can also be productive[5]. 9) Surface drainage[1]. 10) No long-term flooding; fall floods can wash the pecan crop downstream or make inaccessible for harvest[1]. April to June flooding can reduce production levels[1].

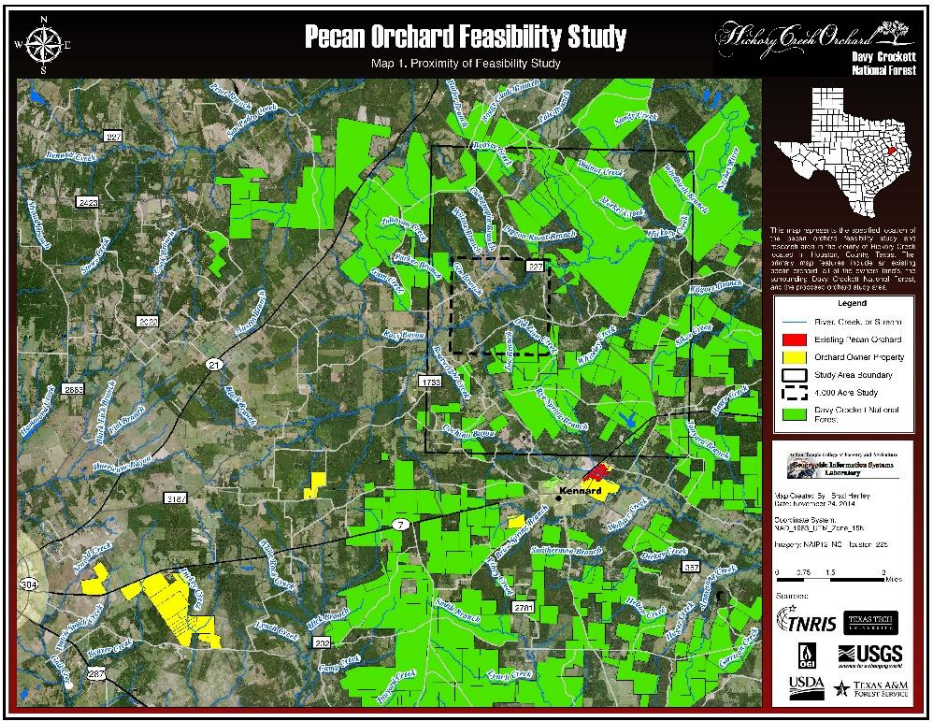


Figure 1. Proximity map for the Hickory Creek feasibility study area.

Figure 1. The first map generated during this study was used to establish the genre for the layout of the remaining analysis maps. It illustrates the location for the existing pecan orchard, all of the owners' real estate properties in Houston County, the surrounding Davy Crockett National Forest, and the proposed orchard study area. This map was presented first so that the audience can gain a clear understanding of where the remainder of the study will take place.

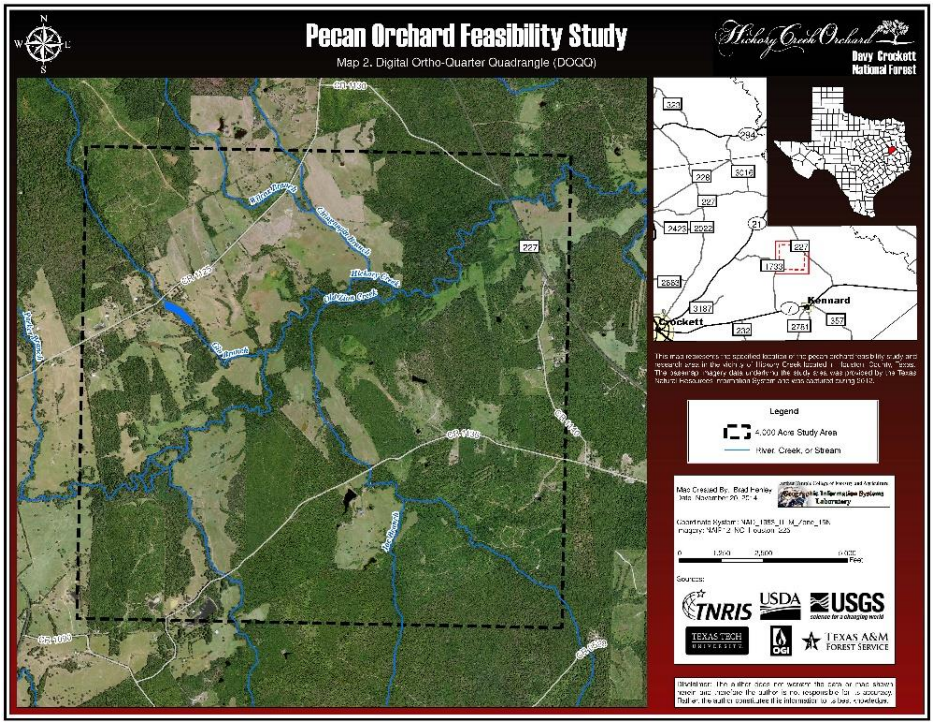


Figure 2. Digital Ortho-Quarter Quadrangle (DOQQ) map.

Figure 2. This map represents the location of the feasibility study area in the vicinity of Hickory Creek. The basemap imagery was provided by the Texas Natural Resources Information System (TNRIS), and was captured during 2012. This map also illustrates roads, creeks, and branches that factored into the search for the most suitable orchard area.

Choosing the location for a new pecan orchard should be a thorough process, because it can become very costly to a pecan farmer, or investor, if the orchard is developed within the wrong climate, soils, water resources, among numerous additional factors.

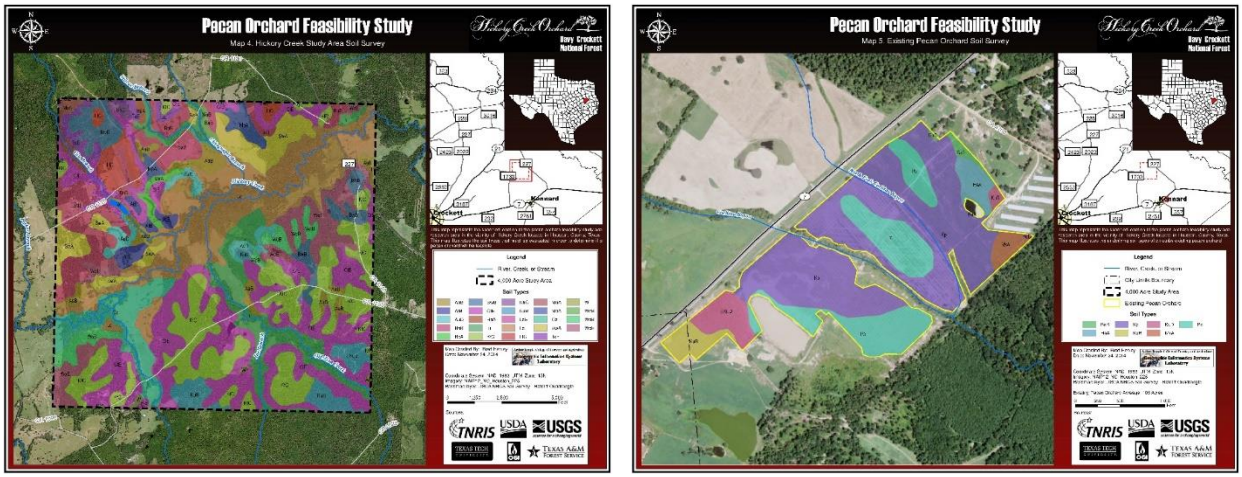
2.1. Incorporating Soil Type Data.

The first question composed during this study was, should additional pecan orchards be established in the Hickory Creek area of the Davy Crockett National Forest? In order to validate the question, it was first necessary to identify the most common factor resulting in mortality among pecan tree orchards, in general. Evidence from research of failed pecan orchards reveals that the largest contributing factor leading to pecan orchard mortality is poor soil[2]. Therefore, this phase of research was designed to use ArcMap to import existing soil data polygon shapefiles into the AOI, as well as the existing pecan orchard.

The nearby existing pecan orchard age is unknown, but believed to be less than ten years old. The orchard contains 106 acres of planted trees that lies 3.4 miles to the southeast of the Hickory Creek study area, on U.S. Highway 7, adjoining the city limits of Kennard, Texas. By examining the soil types of the existing pecan orchard, this offered an easy comparison of soil in the area which has proven to offer a dependable growing environment for pecan trees.

The soil type data for this study was provided by the USDA NRCS Soil Survey for Houston County, Texas. The soil types that remained for the Hickory Creek study area, after the analysis was conducted during the phase of the research were, AaB - Alazan very fine sandy loam, AtB - Attoyac fine sandy loam, AuD - Austonio fine sandy loam, BaB - Bernaldo fine sandy loam, BeA - Besner fine sandy loam, BwB - Bowie fine sandy loam, CtE - Cuthbert fine sandy loam, HaA - Hainesville fine sand, Iu - Iulus fine sandy loam, KfC - Kirvin fine sandy loam, KhC - KhC -

Kirvin soils, KuB - Kurth fine sandy loam, LaE - LaCerda clay loam, Lc - Laneville loam, LtC - Lilbert loamy fine sand, MoA - Mollville loam, MpA - Mollville-Besner complex, Oz - Ozias-Pophers complex, SwA - Sawlit-Latex complex, TaE - Tenaha loamy fine sand, WnB - Woden fine sandy loam, WoB - Woodtell very fine sandy loam, and WoE - Woodtell very fine sandy loam.



(a) (b)

Figure 3. Houston County soil survey polygons for the Hickory Creek study area and the existing 106 acre pecan orchard.

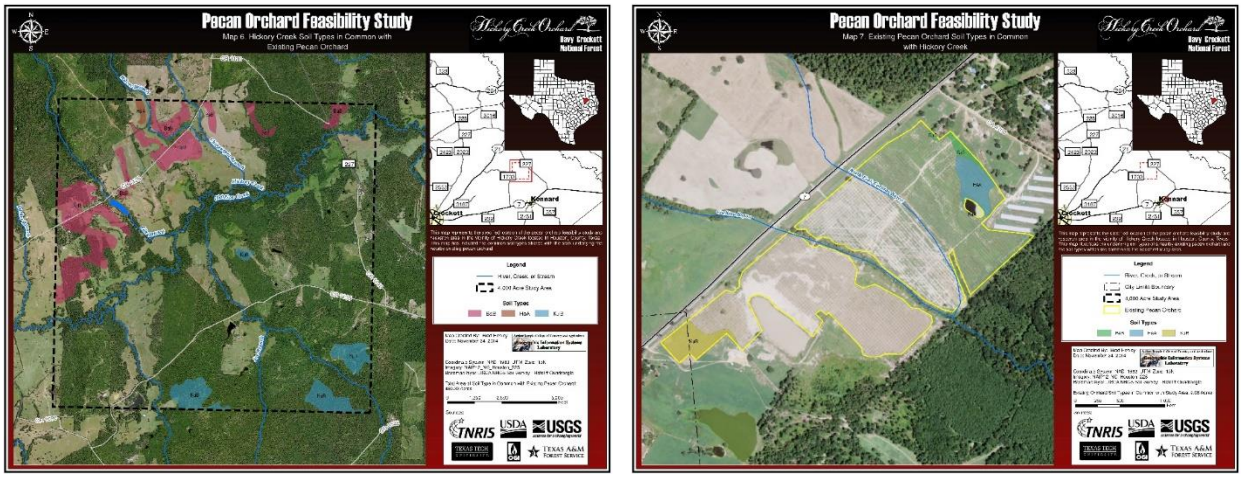
Figure 3. The soil survey data was imported into ArcMap, followed by initiating the clip tool[4] in order to retain the soil data for the Hickory Creek AOI only. The (a) Hickory Creek study area map collages all of the soil types in the AOI that must be evaluated in order to determine if a pecan orchard will be feasible. The symbology for each soil type is represented by its own unique semi-transparent color, offering ease in distinguishing where each soil type area exists. Like the Hickory Creek AOI soil data, the soil survey data for the (b) existing 106 acre pecan orchard was imported into ArcMap, followed by initiating the clip tool[4] in order to retain the soil data for that area only.

The soil types that remained for the existing 106 acre pecan orchard were, BaB - Bernaldo fine sandy loam, HaA - Hainesville fine sand, KuB - Kurth fine sandy loam, Kp – Koury silt loam, KuD - Kurth fine sandy loam, MxA – Moten-Multey complex, and Po – Pophers silt loam.

2.2. Evaluating Common Soil Types.

The next phase involved analyzing the soil types that the Hickory Creek study area and the existing pecan orchard have in common. As previously mentioned, by identifying the soil types of the existing pecan orchard, the study can establish a basis for comparison between the Hickory Creek AOI and an area in which the soils have proven to effectively grow pecan trees.

Using ArcMap, tabular analysis[3] confirmed that the existing pecan orchard has a total of nine acres in common with 480 acres of the Hickory Creek study area soil types. This reveals a ratio of 1:53, or it can be better illustrated by stating that there are approximately fifty-three acres compatible, with the existing orchard soil types, for every nine acres in the Hickory Creek study area. Performing the analysis deduced that the following soil types were determined to share commonality between the Hickory Creek study area and the existing pecan orchard, the BaB - Bernaldo fine sandy loam, HaA - Hainesville fine sand, and KuB - Kurth fine sandy loam, which can be observed in Figure 4.



(a) (b)

Figure 4. Hickory Creek soil types in common with the existing 106 acre pecan orchard.

Figure 4. Tabular analysis[3] revealed that (a) 480 acres of soil types in the Hickory Creek study area have commonality with the (b) existing 106 acre pecan orchard.

2.3. Identifying Non-Forested Areas.

After identifying the common soil types between the two areas, the 2012 digital ortho-quarter quadrangle satellite imagery was then used to construct new polygon shapefiles of the non-forested areas in the Hickory Creek study area, as illustrated in Figure 5. The purpose of identifying these regions was to identify which properties contain vacant agricultural land that may currently embrace an orchard site, without having to suffer the loss of existing timber and land-use conversion costs.

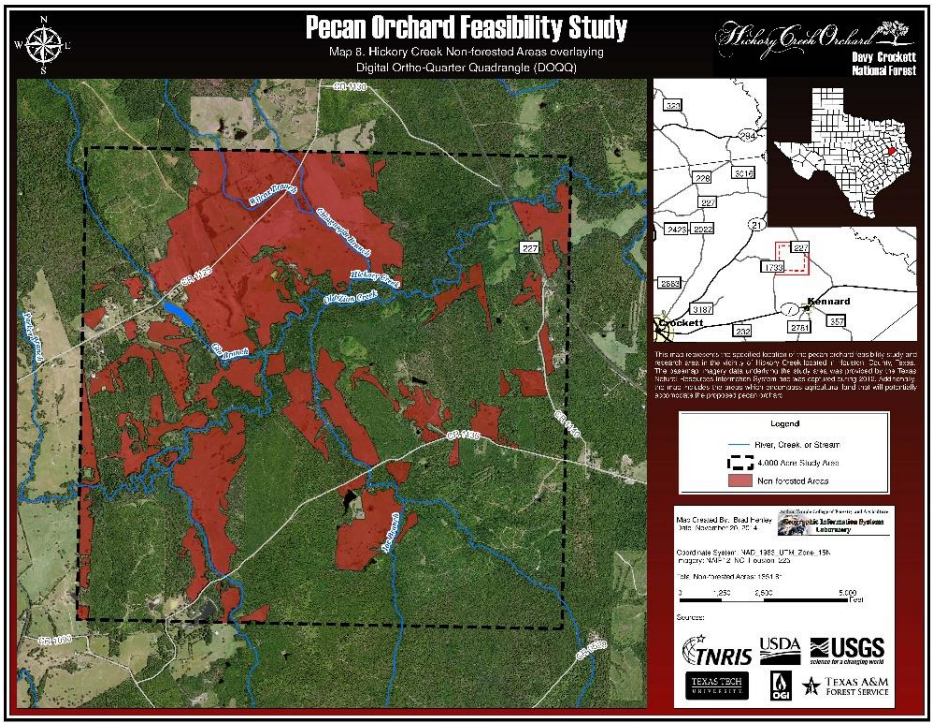
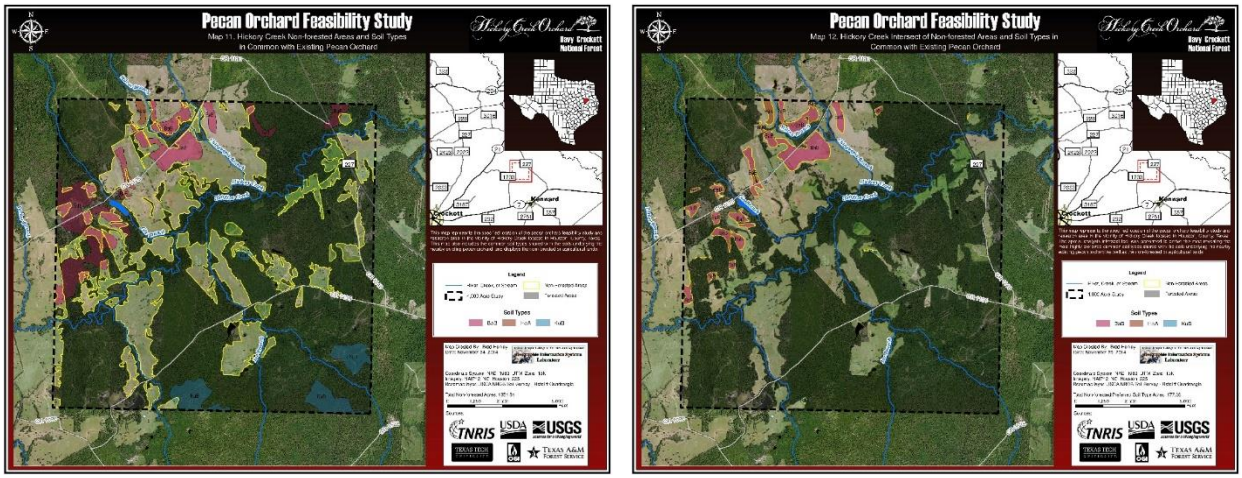


Figure 5. Hickory Creek non-forested areas overlaying satellite imagery.

Figure 5. This map shows 1,351 acres of non-forested land in the Hickory Creek study area that can help to eliminate dramatic land-use conversion costs and promote the practice of sustainable natural resources management.

The non-forested land polygons were then overlaid with the soil types derived during the first two stages of the analysis in order to taper further into strategically selecting prime locations for the potential orchard. The last step of this phase was to execute the intersect tool[4] leaving only the Hickory Creek AOI with non-forested properties that are compatible with the soil types of the existing pecan orchard.



(a) (b)

Figure 6. Hickory Creek non-forested areas and soil types in common with the existing orchard, and the results of executing the intersect operation.

Figure 6. This step in the analysis illustrates (a) 480 acres of soil types in the Hickory Creek study area that are in common with the existing pecan orchard, along with the 1,351 acres of non-forested lands demonstrated as well. The next step was to initiate the ArcMap intersect geoprocessing tool[4] in order to reveal the most highly desired soil types, free of timber, which are also in common with the soils underlying the nearby existing pecan orchard. As a result, the operation led to an output of (b) 177 acres of non-forested areas, with compliant soils, which will continue to be considered as feasible for a potential pecan orchard during the remainder of the study.

2.4. Identifying Recommendations Made By The USDA NRCS.

This phase of the study focused on evaluating the soil data for the Hickory Creek AOI by employing the recommendations made by the USDA NRCS Soil Survey for Houston County, Texas. The USDA NRCS advises that the following soil types are recommended for orchards. Fine sandy loam soils, such as, Alto, Attoyac, Austonio, Bowie, Kirvin, and Woden; as well as, loamy fine sand soils such as, Lilbert and Teneha. After careful review of the USDA NRCS recommendations, the following soil types in the Hickory Creek study area were determined to meet the conditions of the criteria for a desirable pecan orchard development. The AtB - Attoyac fine sandy loam, AuD - Austonio fine sandy loam, BwB - Bowie fine sandy loam, KfC - Kirvin fine sandy loam, LtC - Lilbert loamy fine sand, TaE - Tenaha loamy fine sand, and WnB - Woden fine sandy loam[5].

The spatial processing of the soil types recommended by the USDA NRCS Houston County Soil Survey were conducted in the same manner as the previous phase of the analysis.

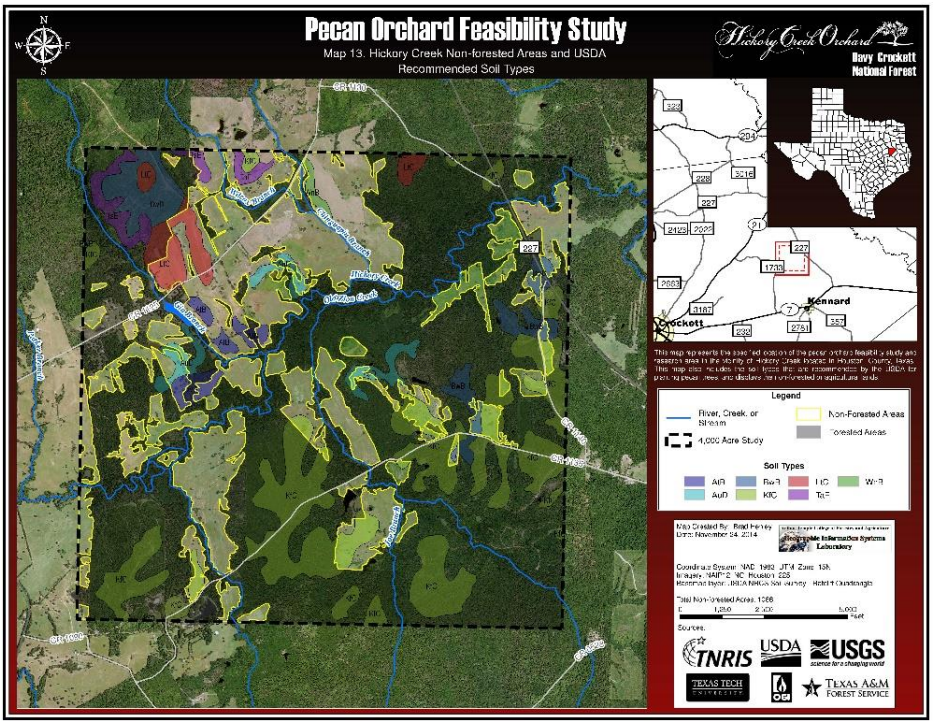


Figure 7. Hickory Creek non-forested areas and USDA NRCS recommended soil types.

Figure 7. This map initiated the first step of this phase of the analysis, analogous to the process undertaken during the previous section. This map resulted in 1,086 acres of soil types that are recommended by the USDA NRCS for an orchard in Houston County, Texas. Additionally, the map contains the 1,351 acres of non-forested polygons in the Hickory Creek study area.

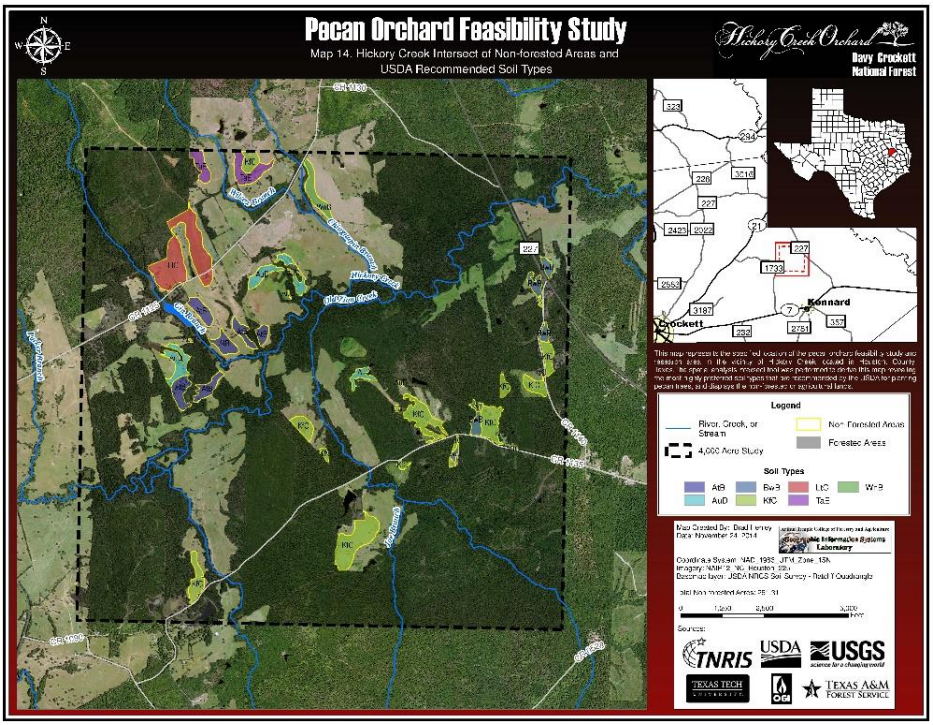


Figure 8. Results of executing the intersect operation between the Hickory Creek non-forested areas and the USDA NRCS recommended soil types.

Figure 8. This map demonstrates the output of running the intersect geoprocessing tool[4], followed by discarding the unneeded soil locations outside of the non-forested areas. In return this process revealed an area of 261 acres of highly desirable soil types with consideration given to the recommendations made by the USDA NRCS Soil Survey for Houston County, Texas.

Section 2.3 was concluded by narrowing down the soil types shared from those underlying the nearby existing pecan orchard, resulting in 177 acres of potential pecan orchard land. After identifying the non-forested USDA NRCS compliant soil types during this phase of the study, the merge tool[3] was utilized in order to combine the soil data derived from section 2.3 with the soil data apprehended from this phase of the analysis.

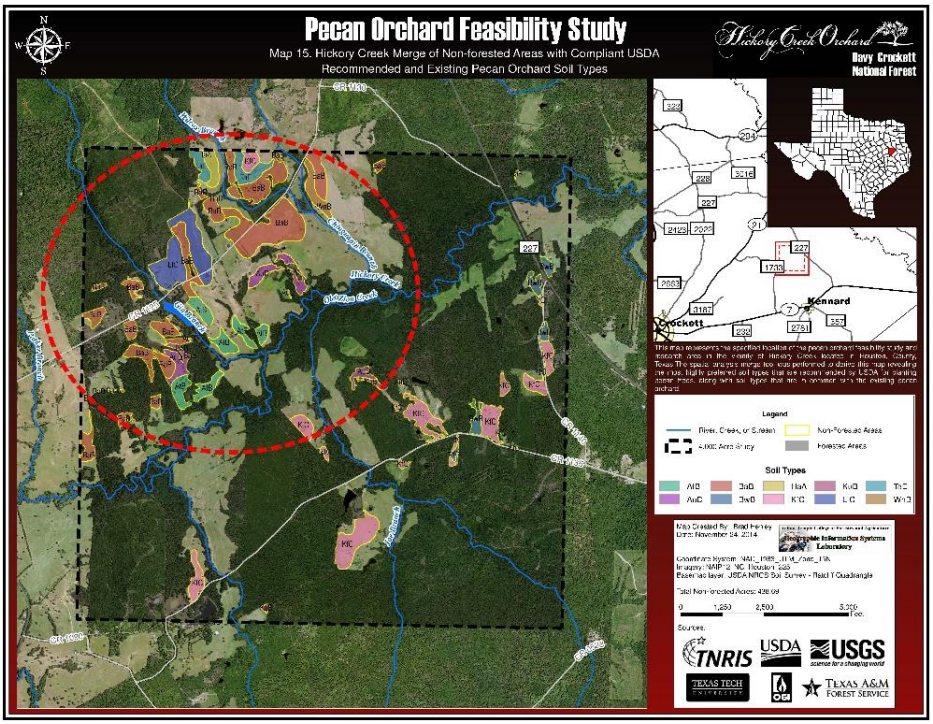


Figure 9. Hickory Creek merge of non-forested areas with compliant USDA NRCS recommended soil types, and the existing nearby pecan orchard soil types.

Figure 9. In this map, the USDA NRCS recommended soil types for an orchard in Houston County, and the soil types in common with the nearby existing pecan orchard were combined by executing the merge tool[3] in ArcMap. The results returned a combined total of 438 acres of highly desirable soil types that can offer a suitable location for a Hickory Creek pecan orchard development. The area that offers the greatest level of appeal is represented in Figure 9 by a red dashed ellipse around the region.

After the data merge of the two previous segments of the analysis, the suitable soil sites were once again condensed. The reduction was based on a visual selection of the soil polygons contiguousness, in combination with the attractiveness of the nearby creeks, streams, and road infrastructure.

2.5. Parcel Selection.

The final phase of this study required performing an analysis of the merged soil type datasets, by overlaying Houston County land ownership parcel data over the study area and selecting the tracts that offer the most evident resources corresponding with the criteria set forth in this study. The analysis results derived in section 2.4 prepared the soil polygons for integration with the land parcel data. The Houston County land ownership parcel data was obtained from OGinfo.com, which is a petroleum industry supplier of various data, including county parcel datasets.

By furthering the geoprocessing abilities of ArcMap even further, the union tool[4] was executed with the parcel boundaries and the desirable soil types. This divided each soil polygon along the perimeter of each parcel boundary, enabling to evaluate the potential amount of soils within each parcel. Some of the tracts only contain a small amount of usable soil for an orchard, however, several of the tracts consist of more than 30% of the desirable soil type within that parcel alone.

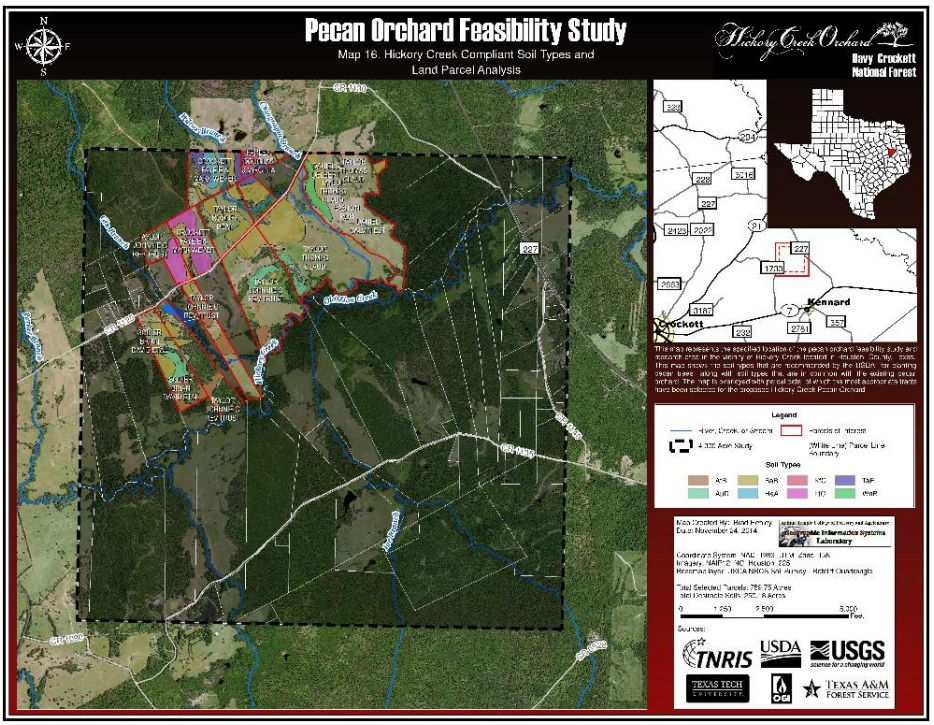


Figure 10. Hickory Creek final selection of compliant soils types and land parcel analysis.

Figure 10. Finally, after evaluating and narrowing the selection of the 438 acres of feasible soils types in Figure 9, the selection was overlaid with land ownership parcel data in this map. This revealed 250 acres of highly desirable soil types within 760 acres of privately owned real estate, represented by the thick red boundary lines. The dark opaque feature within the study area that surrounds the final selection of land parcels denotes all of the areas which were considered to not be of interest as a result of this study.

3. Conclusion

The Hickory Creek pecan orchard feasibility study did effectively meet the overall objective for the assessment. The characteristics used to initially qualify the AOI were appropriate and appear to have contributed to the success of the investigation. In addition to the selected natural resource features and road systems, having the nearby existing pecan orchard in Kennard provided a great opportunity for selecting and comparing soil types. By merging the USDA NRCS Soil Survey of Houston County recommended soil types, with the soils in common with the nearby orchard, it conveyed an excellent concentration for the parcel selection needed in order to determine where to purchase property. Based on the results from this study, with an emphasis on soil types, there is an evident opportunity for the parcels validated in Figure 10 to offer a favorable site for the development of a pecan orchard in the Hickory Creek area.

The results from this study have certified that implementing the appropriate workflow strategies during GIS analysis can tremendously benefit the due-diligence process, while examining land-use in regard to natural resources. The almond farmer described during the introduction that purchased the two-thousand acre Neches River timber land property, can currently manage his pine plantations and eventually convert the land into an orchard. However, despite East Texas consisting largely of pine timber, land owners in the East Texas Region can consider developing pecan

orchards on their agricultural or non-forested land, by examining their property with the analysis methods that were performed during this study.

4. Acknowledgements

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