US Army Corps
of Engineers®
Memphis District

SECTION XII

Northwest Tennessee Regional Harbor

CHIP MILL ANALYSIS

April 2004

Table of Contents

List of Tables

List of Figures

INTRODUCTION

The U.S. Army Corps of Engineers Memphis District is conducting a study to determine if it is feasible to construct a public harbor located at Mississippi River Mile 900, Lake County, Tennessee. Concerns were expressed over the possibility of a chip mill locating to the harbor area if constructed during the scoping process. Analysis does not indicate that a chip mill would locate in the area if a harbor facility is constructed. No economic data from a chip mill were used in the economic analysis to calculate total project benefit to cost ratios. However, there are no guarantees over future development. Therefore, investigations were conducted to determine the existing forest resources in the area and describe impacts to forest resources if a chip mill were to locate in the area.

Chipping wood in satellite locations is becoming popular in the southeast because of rising demands, increasingly competitive substitute products and imports, and rising prices (Prestemon and Abt, 2002). Wood chips have historically been harvested from softwood stands. However, hardwood stands are now being chipped because of changes in technology. Chip mills have been documented to encourage harvesting in areas that have been historically low quality for the timber market (Missouri Department of Natural Resources, 2000). Clear cutting is the method most commonly used to harvest chip products.

Prior to 1990, pulp mills and manufactured wood panel mills relied on remote log concentration yards and maintained chipping facilities at the site (Prestemon and Abt, 2002). Today, it is more economical to chip timber at satellite locations within the vicinity of the harvested area because of associated transportation costs. Water transportation has historically been the least expensive method to ship goods.

The potential sourcing area in which this study will focus on is described as a 75-mile radius from Cates Landing, Lake County, Tennessee. The study area was reduced to only include those areas that are south of the Ohio River, and east of the Mississippi River. Figure 1 provides a map of the study area.

Existing Natural Resources

Existing natural resources were calculated by obtaining existing Geographic Information System (GIS) from different sources and modifying it to the study area.

Land Use

The total study area is approximately 5,277,500 acres (Tennessee = 3,761,700; Kentucky = 1,515,800). Figures 2 and 3 provide a map of existing land use in the study are (Additional acreages were added because of GIS overlay constraints.). Table 1 provides data of existing land use. Pasture/grassland is the dominant land use, followed by row crops, and upland deciduous forests.

Ecological Providences

The study area is broken down into three ecological providences (Figure 4). The Eastern Broadleaf Forest Continental Providence is characterized by low rolling hills, dissected plateaus, and basins. The oak-hickory association is the dominant community. The Southern Mixed Forest Providence is characterized by flat to gentle slopes and local relief of less than 100 feet. Common associations present include, oak, hickory, sweetgum, and winged elm. The Lower Mississippi Riverine Forest Providence is characterized by flat gently sloping broad floodplain and low terraces made up of alluvium loess. Prior to cultivation, the area was dominated by bottomland hardwoods consisting of ash, elm, cottonwood, sugarberry, sweetgum, water tupelo, bald cypress, sycamore, pecan, and oak (SFRA, 2002).

Hydrology

The study area contains 15 watersheds (Figure 5). Water quality is mostly "moderately impacted" (West, 2002).

Endangered and Threatened Species

Table 2 provides a list of threatened and endangered species present by county within the study area.

TIMBER INDUSTRY

History of Timber Practices

All of the components of the modern southern forest were in place by 5,000 B.P. (Owen, 2002). The meander patterns of the Mississippi River greatly influenced the habitat of the Cates Landing area. The geomorphic history of the study area and vicinity reveal that deposits are Holocene aged. Point bar deposits of old meander belts, abandoned channels, and neck and chute cutoffs are found throughout the area and are approximately 3,000 years old. Most of the high ground at Tiptonville and north to Cronanville and Cates Landing was most likely a Tulip-Oak Forest. Floral species included tulip poplar, basswood, chinkapin oak, shumard oak, beech, elm, and hackberry.

Large-scale timber removal began in the South in the years immediately after the Civil War after timber stocks were depleted in the Great Lakes States. By the 1920's most of the forest resources in the area had been depleted with nearly every acre harvested at least once in the last two centuries (Wear and Greis, 2002). Nearly 80% of the bottomland hardwoods in the Mississippi River Valley have been converted to agriculture.

Following the Great Depression there was large-scale land abandonment that allowed for forest regrowth to occur. Much of the current natural stands of pine are a result seeding

of abandoned agriculture fields. The South is currently heavily forested. Forests cover more than 60 percent of most southern states (Wear and Greis, 2002).

Existing Timber Products

Wear and Gries, 2002) described the existing timber industry in the South. The United States is the world's largest producer, consumer, and importer of wood products. Southern forests account for 58 % of U.S. production and 15.8% of world production. Softwood saw logs account for 28% of the total output of southern forests, followed by softwood pulpwood (25%) and hardwood pulpwood (16%). Changes in pulping technology are the reason for hardwood pulpwood accounting for 16% of the total output. Pulpwood requires chipping before it can be used. Hardwood and softwood are used for lumber, plywood, composite boards, poles, paper, and other products.

Current and Future Removal Rates

Wear and Gries (2002) summarized the current removal rates of southern forests. There has been no significant net change in total forest land since the 1970's and 91% of forested land remains of that recorded in 1907. The South could lose 12 million forest acres (8% of forest land) to urbanization by 2020. An additional 19 million acres would be lost by 2040. Many agricultural areas are being converted to forests because of falling crop prices and rising timber prices. Forest gains have been projected to be about 20 million acres between 1992 and 2020. Current growth to removal rates in northwest Tennessee is 1:49 to 1.0 (Ken Arney, personal communication).

CHIP MILLS

Existing Mills

As of 2000, there is currently one chip mill operating within the study area (Figure 6).

Procurement Areas

Three basic costs dictate the geographic area where timber related industries become established. They are as follows:

1. Stumpage Costs – The fee that is paid to the landowner.
2. Harvest Cost – The expense involved in harvesting the trees (e.g., labor and equipment costs).
3. Transportation – The cost associated with transporting the logs from the harvested area to the mill. Chipping the wood at satellite locations and transporting the chip is less expensive then transporting whole logs. Water transportation has historically been the least expensive method for transportation.

TVA et al. (1993) calculated that chip mills utilized a 75-mile radius procurement area. Therefore, a 75-mile radius procurement area was established for this study. The

procurement area was reduced to only include areas east of the Mississippi River and south of the Ohio River. The reason for the reduction was due to the fact that chip mills could become established at existing harbors or other suitable locations west of the Mississippi River and north of the Ohio River.

Harvestable Trees

The U.S. Forest Service's Forest Inventory Mapmaker (Miles, 2001; USFS, 2004) database was queried to obtain existing values of timber resources within the study area (Table 3). The Commonwealth of Kentucky's 1988 Cycle 1 Periodic Inventory and the State of Tennessee's 1999 Cycle 6 Periodic Inventory was used in the database.

There are 1,453,791 acres of forestland within the study area. Timberland is defined as the forested area that is available for commercial timber production. The total timberland within the study area is 1,443,405 acres (99.3% of available forestland). Total timberland makes up 27% of the total land. The total volume of timberland within the study area is 2,735,376,655 cubic feet (cuft).

The timber industry classifies standing timber into two categories. The categories are growing stock and rough and rotten trees. Growing stock is defined as the wood in live trees that are five inches dbh or larger of commercial species with the potential for lumber production now or in the future. Total volume of growing stock within the study area is 2,369,391,639 cuft (86.6% of total timberland volume). Rough and rotten trees are commercially undesirable or contain defects that make them not suitable for lumber (TVA et al., 1993). The total volume of rough and rotten are 339,269,043 cuft (12.4% of total timberland volume) and 26,715,972 cuft (1% of total timberland volume), respectively.

Growing stock is subdivided into species group, size, and tree grade. Species group is defined into softwood and hardwood (Table 4) and size classes. Within the study area 7.1% of growing stock on timberland is softwood. Hardwood was divided into tree grade (Table 5). Within the study area 15% of the hardwood growing stock on timberland was graded as tree grade 1, 17% as tree grade 2, 27% as tree grade 3, and 41 % were too small to be graded or were below grade 3. During logging operations, sawlogs (desirable trees used for lumber production) are usually harvested and undesirable species are left. Chip mill operations encourage timber removal of lower quality timber that normally would not be harvested.

Timber markets are currently excellent for higher quality trees used for saw-timber but weak for low quality trees that are usually used for chips (K. Arney, personal communication). The total volume of potential wood chip on timberland was calculated as follows:

Rough Trees
+ Rotten Trees
+ Hardwoods Graded less than 3
+ .50 (Grade 3)
+ Non Graded Logs
+ Trees too small to grade
Potential wood chip

Whereas the flowing figures were used,

Rough Trees =	**339,269,043**
Rotten =	**26,715,972**
Growing Stock	
Softwood =	168,267,204
Hardwood	
Grade 1 =	328,572,696
Grade 2 =	378, 869,851
Grade 3 =	585,680,644 (50% = **292,840,322**)
> Grade 3 =	**209,678,471**
Non Grade =	**159,613,876**
Too small to Grade =	**538,708,898**
Total	2,735,376,655

Therefore, 1,566,826,582 cuft (57%) of the total volume of all live trees in the study area were classified as low quality trees that could potentially be used for wood chip.

Rate of Harvest

Table 6 provides data on annual growth and removal rates. Within the study area, 51,856,998 cuft of timber is removed annually. Hardwood removal is 44,460,138 cuft/year (86%). Total growth rates are 5,594,749 cuft annually. Hardwood growth rates are 63,841,761 cuft/year. Total growth to removal ratios in the study area are 1.3. Hardwood growth to removal ratios are 1.4.

Chip mills produced 47 million tons of chips in 1998, 45 million tons in 1999, and 39 million tons in 2000. In 1999, 58% of wood chips were obtained from hardwood (Wear and Gries, 2002). An average chip mill produces 200,000 tons of wood chips per year (K. Arney, personal communication).

Potential Chip Mill Locating in Northwest Tennessee

An average size chip mill would produce 200,000 tons of chip annually. One ton of dry chip would approximate 91.6 cuft of hardwood. Therefore a 200,000-ton chip mill would require the removal of 18,320,000 cuft of low grade hardwoods.

Growth to Removal Ratios

Current growth to removal ratio in the study area for hardwood is 1.4. An additional 18,320,000 cuft/year harvest would lower the growth to removal ratio to 1.37.

Increased Harvest

TVA et al. (1993) determined that 38.56 tons of hardwood chip are produced on a one-acre clearcut plot. The additional harvest of 200,000 tons would impact an additional 5,186 acres of timberland. This figure represents less than 1% of the total timberland in the area.

It is important to note that clearcutting is widely used to obtain chips. The impacts and potential benefits of clearcutting forested areas have been widely studied.

CONCLUSION

It is highly unlikely that a chip mill would locate in the study area because current markets are excellent for higher quality trees used for saw-timber but weak for low quality trees used for chips. The United States is currently not competitive for hardwood fiber chips (K. Arney, personal communication). However, the following impacts would occur if new markets were to become established and an average size chip mill was to locate to the study area:

1. A chip mill would lower the growth to removal ratio from 1.4 to 1.37. This is still a positive ratio.
2. A chip mill would require an additional 5,186 acres of timberland to be cleared.

Literature Cited

Kentucky Gap Analysis Program. 2002. Kentucky Gap data.

Miles, P.D. 2001. Forest inventory mapmaker users guide. Gen Tech. NC-221. U.S. Department of Agriculture, Forest Service, North Central Research Station, St. Paul, MN. 52 pp.

Prestemon, J.P. and R. C. Abt. 2002. Timber products supply and demand. Pages 299 – 325 In: D. N Wear and J.G. Gries, editors. Southern forest resource assessment. General Technical Report SRS-53. U.S. Department of Agriculture, Forest Service, Southern Research Station. Asheville, North Carolina.635 pp.

Owen, W. 2002. The history of native plant communities in the South. Pages 47 – 61 In: D. N Wear and J.G. Gries, editors. Southern forest resource assessment. General Technical Report SRS-53. U.S. Department of Agriculture, Forest Service, Southern Research Station. Asheville, North Carolina.635 pp.

Southern Forest Research Assessment. 2002. Ecological providences of the southern United States. U.S. Department of Agriculture, Forest Service, Southern Research Station. (GIS Database). http://www.srs.fs.usda.gov/sustain/data/index.htm (Date accessed: March 15, 2004).

U.S. Forest Service. 2004. Forest Inventory Mapmaker Version 1.0. U.S. Department of Agriculture Division of Forestry. http://ncrs2.fs.fed.us/4801/fiadb (Data accessed March 23, 2004).

Wear, D. N. and J. G. Greis. 2002. The southern forest resource assessment, summary report. U.S. Department of Agriculture, Forest Service, Southern Research Station. Asheville, North Carolina. 103 pp.

Tennessee Wildlife Resources Commission. 1997. Land use/ land cover of Tennessee. (GIS Database). http://63.148.169.50/landcover.html (Date accessed: February 9, 2004).

West, B. 2002. Water quality in the South. Pages 455 – 477 In: D. N Wear and J.G. Gries, editors. Southern forest resource assessment. General Technical Report SRS-53. U.S. Department of Agriculture, Forest Service, Southern Research Station. Asheville, North Carolina.635 pp.

Table 1 Land Use			
Land Use	**Tennessee (acres)**	**Kentucky (acres)**	**Total (acres)**
Forested Wetland	207,437	624,191	649,863
Non-vegetated	688	2,768	2,309
Nonforested Wetland	23284	54,255	6,9472
Open Water	55687	631,187	276,308
Pasture/Grassland	848114	1,690,002	2,467,617
Row Crop	329898	3,706,527	1,629,700
Upland Coniferous Forest	21595	66,199	67,921
Upland Deciduous Forest	332990	1,787,860	1,215,842
Upland Mixed Forest	28290	1,062	70,160
Urban/Developed	15884	191,221	81,270

Table 2
Federal Threatened and Endangered Species By County

County	*Apios priceana* (T)	*Helianthus verticillatus* (C)	*Plethobasus cooperianus* (E)	*Plethobasus cicatricosus* (E)	*Obovaria retusa* (E)	*Epioblasma torulosa tolutsa* (E)	*Lampsils orbiculata* (E)	*Plethobasus cooperianus* E)	*Potamilus capax* (E)	*Pluerobema clava* (E)	*Pleurobema plenum* (E)	*Cyprogenia stegaria* (E)	*Scaphirhyncus albus* (E)	*Etheostoma chienense* (E)	*Haliaeetus leucocephalus* (T)	*Sterna antillarum* (E)	*Campephilus principalis* (E)	*Picoides borealis* (E)	*Mycteria americana* (E)	*Charadrius melodus* (T)	*Myotis grisescens* (E)	*Myotis sodalis* (E)	*Canis rufus* (E)
Kentucky																							
Fulton															X	X	X			X		X	
Hickman													X	X	X	X						X	
Carlisle															X	X				X		X	
Ballard			X		X										X	X	X						
Graves														X							X		
McCracken			X		X	X	X		X						X	X						X	X
Livingston	X		X	X	X		X		X	X		X			X	X					X	X	
Marshall			X			X	X			X	X				X								
Calloway	X														X					X	X		
Tennessee																							
Lake													X		X	X							
Obion															X								
Weakley																							
Henry															X								
Benton			X		X	X	X								X						X		
Carroll																							
Gibson																							
Dyer													X			X							

Table 2
Continued

County	*Apios priceana* (T)	*Helianthus verticillatus* (C)	*Plethobasus cooperianus* (E)	*Plethobasus cicatricosus* (E)	*Obovaria retusa* (E)	*Epioblasma torulosa tolutsa* (E)	*Lampsils orbiculata* (E)	*Plethobasus cooperianus* E)	*Potamilus capax* (E)	*Pluerobema clava* (E)	*Pleurobema plenum* (E)	*Cyprogenia stegaria* (E)	*Scaphirhyncus albus* (E)	*Etheostoma chienense* (E)	*Haliaeetus leucocephalus* (T)	*Sterna antillarum* (E)	*Campephilus principalis* (E)	*Picoides borealis* (E)	*Mycteria americana* (E)	*Charadrius melodus* (T)	*Myotis grisescens* (E)	*Myotis sodalis* (E)	*Canis rufus* (E)
Lauderdale															X	X							
Crocket																							
Henderson																							
Madison		X																					
Haywood																							
Tipton																	X						
Shelby						X									X	X			X			X	
Fayette																							
Hardeman																		X			X		

Table 3
Existing Timber Values in the Study Area

County	Forestland (acres)	Timberland (acres)	Volume of all live on timberland (cu/ft)	Volume of growing stock	Volume of Rough	Volume of Rotten	Volume of sawlog cu/ft	Volume of Sawtimber bd/ft
21007 BALLARD	58,137	58,137	72,229,933	69,604,416	2,332,899	292,618	44,889,471	251,057,696
21035 CALLOWAY	56,898	56,898	91,141,071	84,067,480	6,798,355	275,236	41,672,888	230,731,628
21039 CARLISLE	40,527	35,018	45,954,709	42,581,004	3,027,718	345,987	23,949,481	138,647,013
21075 FULTON	29,662	29,662	65,593,577	61,504,311	4,014,434	74,832	42,493,130	255,270,792
21083 GRAVES	76,390	76,390	99,782,337	92,647,828	6,511,822	622,688	50,900,625	277,532,351
21105 HICKMAN	20,391	20,091	26,727,586	24,623,226	1,896,897	207,463	13,531,925	79,911,902
21139 LIVINGSTON	7,363	7,363	16,578,816	14,492,173	1,657,108	429,535	9,825,667	52,964,270
21145 MCCRACKEN	41,635	40,435	42,105,284	41,386,857	371,809	346,618	24,095,029	124,113,368
21157 MARSHALL	74,663	72,263	90,030,399	86,792,925	2,935,455	302,019	43,282,181	232,403,230
47005 BENTON	6,080	6,080	459,997	256,997	203,000	0	0	0
47017 CARROLL	151,643	151,643	294,125,933	246,990,973	44,388,965	2,745,995	146,076,987	795,340,038
47033 CROCKETT	17,234	17,234	31,834,953	21,366,974	10,467,980	0	15,732,978	86,125,885
47045 DYER	48,580	48,580	64,136,070	55,828,049	7,732,019	576,002	37,248,040	204,082,207
47047 FAYETTE	8,415	8,415	28,618,107	16,312,058	12,306,049	0	12,978,048	70,571,274
47053 GIBSON	74,498	74,498	125,337,172	106,862,186	18,345,990	128,996	55,403,138	286,804,675

Table 3 Continued								
47075 HAYWOOD	97,510	97,510	197,548,074	168,272,223	27,085,863	2,189,988	126,287,384	734,752,364
47077 HENDERSON	16,754	16,754	19,226,021	15,852,007	2,553,010	821,004	8,057,996	39,153,957
47079 HENRY	144,509	144,509	275,015,846	228,974,858	45,280,988	759,999	141,444,890	761,449,372
47095 LAKE	25,204	25,164	74,580,980	70,573,984	3,230,992	776,003	62,067,018	348,635,988
47097 LAUDERDALE	93,335	92,635	203,991,461	177,996,526	24,476,937	1,517,999	143,635,635	810,539,926
47113 MADISON	119,862	119,862	253,109,778	206,201,857	41,259,922	5,647,999	133,629,908	723,683,464
47131 OBION	86,961	86,961	291,899,962	260,182,042	26,263,935	5,453,985	200,470,218	1,124,449,673
47167 TIPTON	70,614	70,614	133,056,032	102,389,100	29,051,933	1,614,999	62,353,065	333,314,386
47183 WEAKLEY	86,926	86,689	192,292,558	173,631,586	17,074,964	1,586,008	122,658,703	669,594,384
Total	**1,453,791**	**1,443,405**	**2,735,376,655**	**2,369,391,639**	**339,269,043**	**26,715,972**	**1,562,684,404**	**8,631,129,841**

Table 4
Major species group of growing stock on timberland by county, cuft.

	Total	Softwoods	Hardwoods
21007 BALLARD	69,604,416	0	69,604,416
21035 CALLOWAY	84,067,480	97,274	83,970,206
21039 CARLISLE	42,581,004	0	42,581,004
21075 FULTON	61,504,311	0	61,504,311
21083 GRAVES	92,647,828	2,591,090	90,056,737
21105 HICKMAN	24,623,226	0	24,623,226
21139 LIVINGSTON	14,492,173	0	14,492,173
21145 MCCRACKEN	41,386,857	4,758,102	36,628,755
21157 MARSHALL	86,792,925	0	86,792,925
47005 BENTON	256,997	0	256,997
47017 CARROLL	246,990,973	18,488,994	228,501,979
47033 CROCKETT	21,366,974	0	21,366,974
47045 DYER	55,828,049	0	55,828,049
47047 FAYETTE	16,312,058	11,991,040	4,321,017
47053 GIBSON	106,862,186	745,999	106,116,187
47075 HAYWOOD	168,272,223	4,187,999	164,084,224
47077 HENDERSON	15,852,007	0	15,852,007
47079 HENRY	228,974,858	8,980,995	219,993,864
47095 LAKE	70,573,984	33,916,987	36,656,997
47097 LAUDERDALE	177,996,526	3,107,989	174,888,537
47113 MADISON	206,201,857	18,178,945	188,022,912
47131 OBION	260,182,042	45,010,808	215,171,234
47167 TIPTON	102,389,100	0	102,389,100
47183 WEAKLEY	173,631,586	16,210,981	157,420,605
Total	**2,369,391,639**	**168,267,204**	**2,201,124,436**

Table 5
Hardwood tree grades of growing stock on timberland, cuft.

	Total	Tree grade 1	Tree grade 2	Tree grade 3	Gradeable log but does not meet grade 3 standards	Graded but does not contain gradeable log	Tree too small to grade
21007 BALLARD	69604416	10607077	11387121	14800433	11377756	6327315	15104715
21035 CALLOWAY	83970206	7870652	7482898	8122978	21613422	6440233	32440024
21039 CARLISLE	42581004	2499329	955587	4507970	12481848	8413873	13722398
21075 FULTON	61504311	5553062	5198053	11561226	22526239	6130787	10534945
21083 GRAVES	90056737	16372243	8003427	22091049	8628626	4046412	30914981
21105 HICKMAN	24623226	0	2997044	6292053	5973270	1229958	8130900
21139 LIVINGSTON	14492173	3602612	970871	5076000	2129720	0	2712970
21145 MCCRACKEN	36628755	1583611	7124081	10146972	5837608	810219	11126264
21157 MARSHALL	86792925	5139725	10576189	17579485	13869142	5988319	33640065
47005 BENTON	256997	0	0	0	0	0	256997
47017 CARROLL	228501979	24699990	51549004	61479041	8151983	13010979	69610982
47033 CROCKETT	21366974	6725997	8380990	2649994	0	0	3609992
47045 DYER	55828049	10814020	7944008	17107010	725001	7886003	11352007
47047 FAYETTE	4321017	0	0	1594007	1423006	0	1304004
47053 GIBSON	106116187	7928049	21414058	23988021	3984016	9043017	39759027
47075 HAYWOOD	164084224	36473778	38159843	28467881	11014954	23064866	26902902
47077 HENDERSON	15852007	0	759004	7833989	1552001	0	5707013
47079 HENRY	219993864	26349952	44581975	54906995	17206968	16238993	60708980
47095 LAKE	36656997	12189993	3007001	14074006	3185006	3824994	375997
47097 LAUDERDALE	174888537	36579887	23811925	75103846	6711986	13950964	18729930
47113 MADISON	188022912	36663999	42636969	45895959	11327004	4815002	46683980
47131 OBION	215171234	36874847	44380847	69569766	17418926	10632961	36293887
47167 TIPTON	102389100	4763988	16302019	41196074	5292009	7036012	27798997
47183 WEAKLEY	157420605	35279885	21246938	41635890	17247980	10722969	31286944
Total	**2201124436**	**328572696**	**378869851**	**585680644**	**209678471**	**159613876**	**538708898**

Table 6
Growth to removal rates

	Softwoods			Hardwoods			Total		
County	Growth	Removal	G:R Ratio	Growth	Removal	G:R Ratio	Growth	Removal	G: R Ratio
21007 BALLARD	0	0	0	219,641	2,062,678	0.106483	219,641	2,062,678	0.106483
21035 CALLOWAY	0	0	0	1,196,023	719,053	1.663331	1,196,023	719,053	1.663331
21039 CARLISLE	0	0	0	1,257,105	402,345	3.124445	1,257,105	402,345	3.124445
21075 FULTON	0	0	0	1,513,754	190,546	7.944297	1,513,754	190,546	7.944297
21083 GRAVES	173,469	200,347	0.865843	623,798	1,803,956	0.345794	797,267	2,004,303	0.397778
21105 HICKMAN	0	0	0	261,861	3,375,498	0.077577	261,861	3,375,498	0.077577
21145 MCCRACKEN	0	0	0	952,918	1,539,449	0.618999	952,918	1,539,449	0.618999
21157 MARSHALL	0	0	0	1,389,806	387,055	3.59072	1,389,806	387,055	3.59072
47005 BENTON	0	0	0	17,000	216,500	0.078522	17,000	216,500	0.078522
47017 CARROLL	1,220,048	0	0	7,608,042	2,836,869	2.681845	8,828,090	2,836,869	3.111913
47033 CROCKETT	0	0	0	714,023	0	#DIV/0!	714,023	0	#DIV/0!
47045 DYER	0	0	0	1,891,024	2,094,184	0.902988	1,891,024	2,094,184	0.902988
47047 FAYETTE	163,180	0	0	221,996	0	#DIV/0!	385,175	0	#DIV/0!
47053 GIBSON	0	0	0	1,875,099	1,152,202	1.627405	1,875,099	1,152,202	1.627405
47075 HAYWOOD	0	0	0	4,754,090	1,498,402	3.172773	4,754,090	1,498,402	3.172773
47077 HENDERSON	0	0	0	381,022	0	#DIV/0!	381,022	0	#DIV/0!
47079 HENRY	287,009	0	0	8,533,167	6,219,425	1.372019	8,820,176	6,219,425	1.418166
47095 LAKE	911,012	0	0	418,010	0	#DIV/0!	1,329,022	0	#DIV/0!
47097 LAUDERDALE	848,997	1,859,315	0.456618	3,841,062	5,612,494	0.684377	4,690,060	7,471,809	0.627701
47113 MADISON	392,024	0	0	6,675,064	6,740,027	0.990362	7,067,088	6,740,027	1.048525
47131 OBION	111,002	0	0	8,900,121	2,014,992	4.416951	9,011,124	2,014,992	4.47204
47167 TIPTON	0	0	0	5,099,019	2,649,682	1.924389	5,099,019	2,649,682	1.924389
47183 WEAKLEY	1,488,007	5,337,199	0.278799	5,498,115	2,944,779	1.867072	6,986,122	8,281,978	0.843533
Total	**5,594,749**	**7,396,861**	**0.756368**	**63,841,761**	**44,460,138**	**1.435933**	**69,436,510**	**51,856,998**	**1.339**

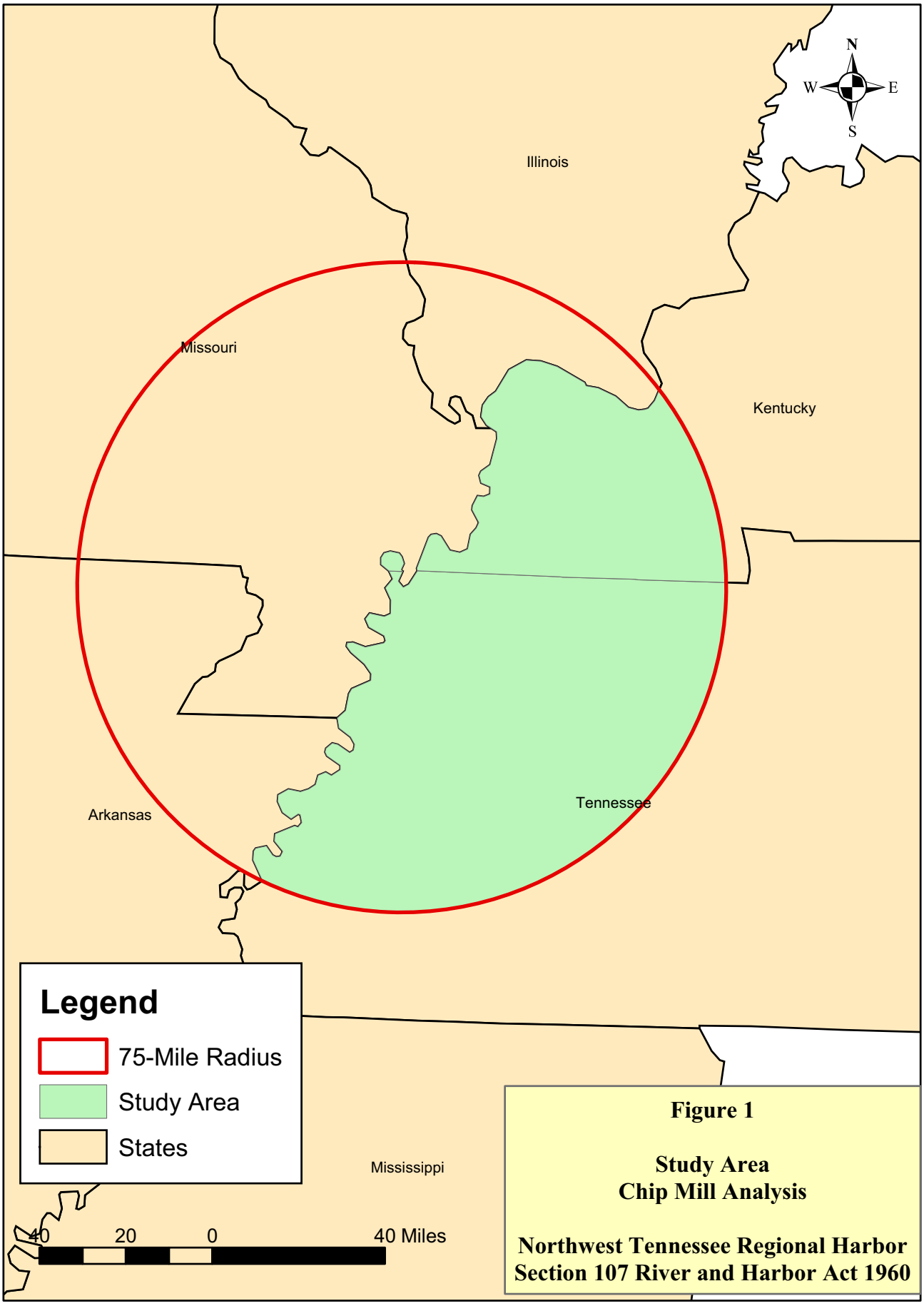


Figure 1

Study Area
Chip Mill Analysis

Northwest Tennessee Regional Harbor
Section 107 River and Harbor Act 1960

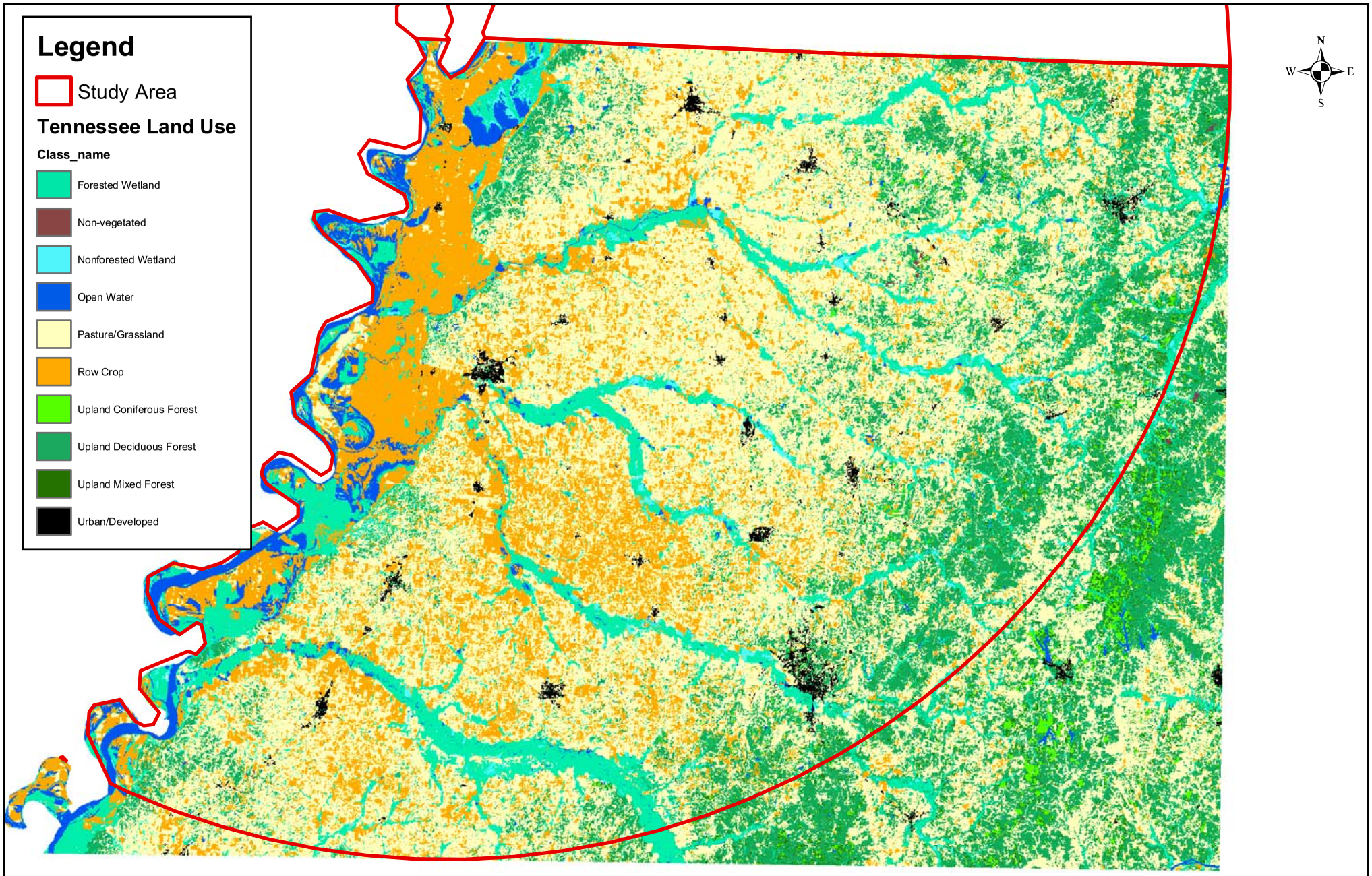
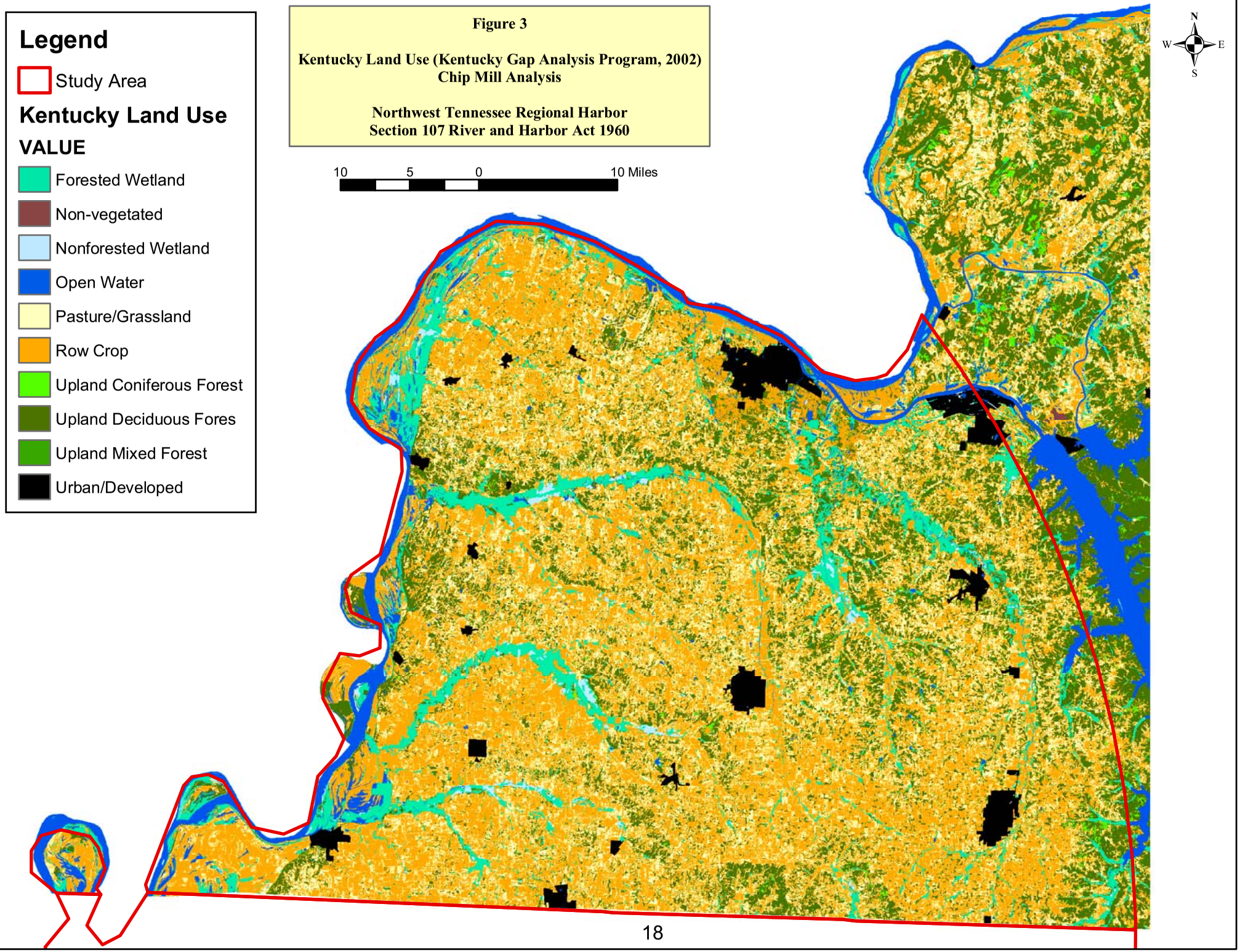


Figure 2

Tennessee Land Use (TWRA, 1997)
Chip Mill Analysis

Northwest Tennessee Regional Harbor
Section 107 River and Harbor Act 1960


Legend
Study Area
Kentucky Land Use
VALUE
Forested Wetland
Non-vegetated
Nonforested Wetland
Open Water
Pasture/Grassland
Row Crop
Upland Coniferous Forest
Upland Deciduous Fores
Upland Mixed Forest
Urban/Developed
Figure 3
Kentucky Land Use (Kentucky Gap Analysis Program, 2002)
Chip Mill Analysis
Northwest Tennessee Regional Harbor
Section 107 River and Harbor Act 1960
10 5 0 10 Miles
N
W
E
S

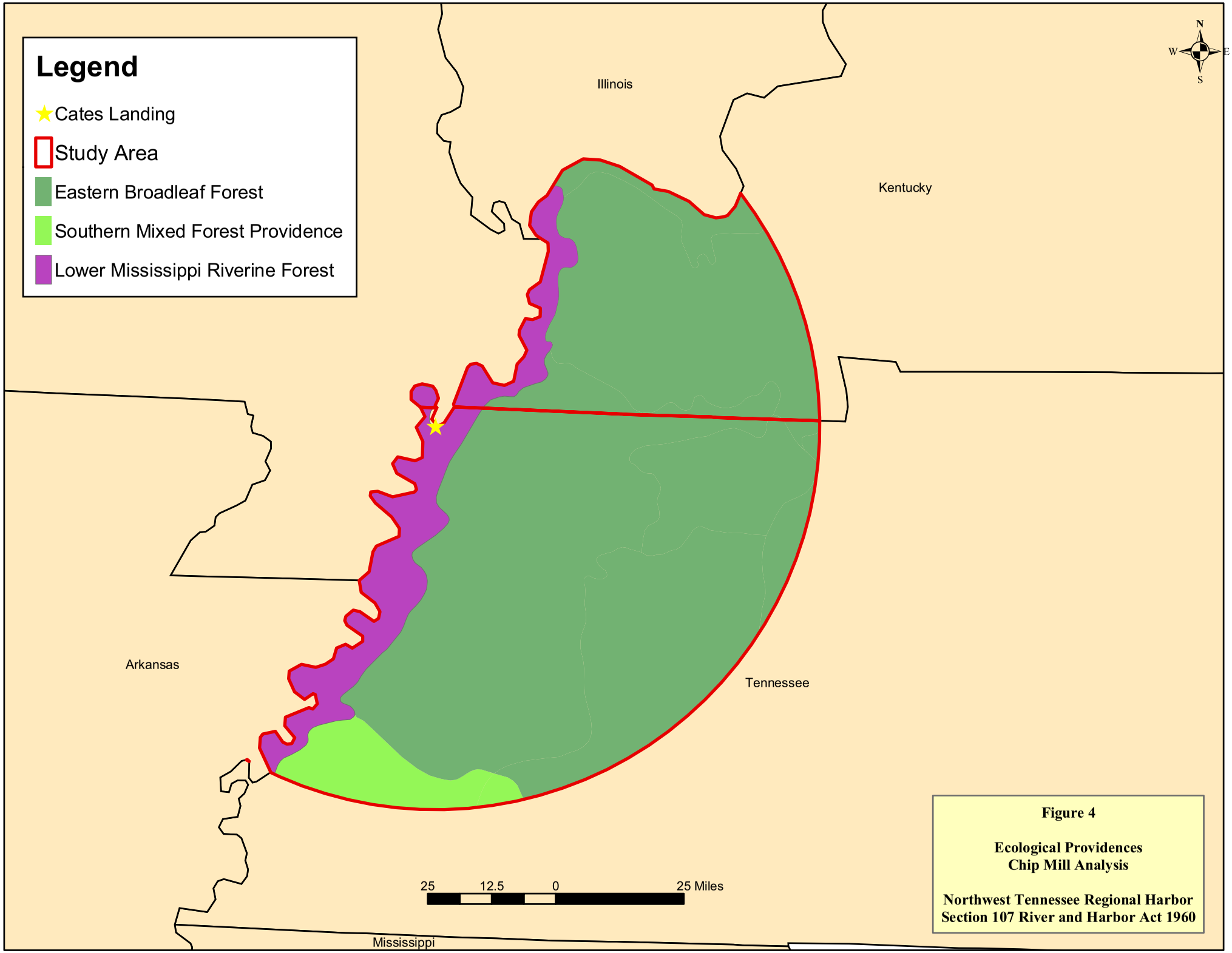


Figure 4

Ecological Providences
Chip Mill Analysis

Northwest Tennessee Regional Harbor
Section 107 River and Harbor Act 1960

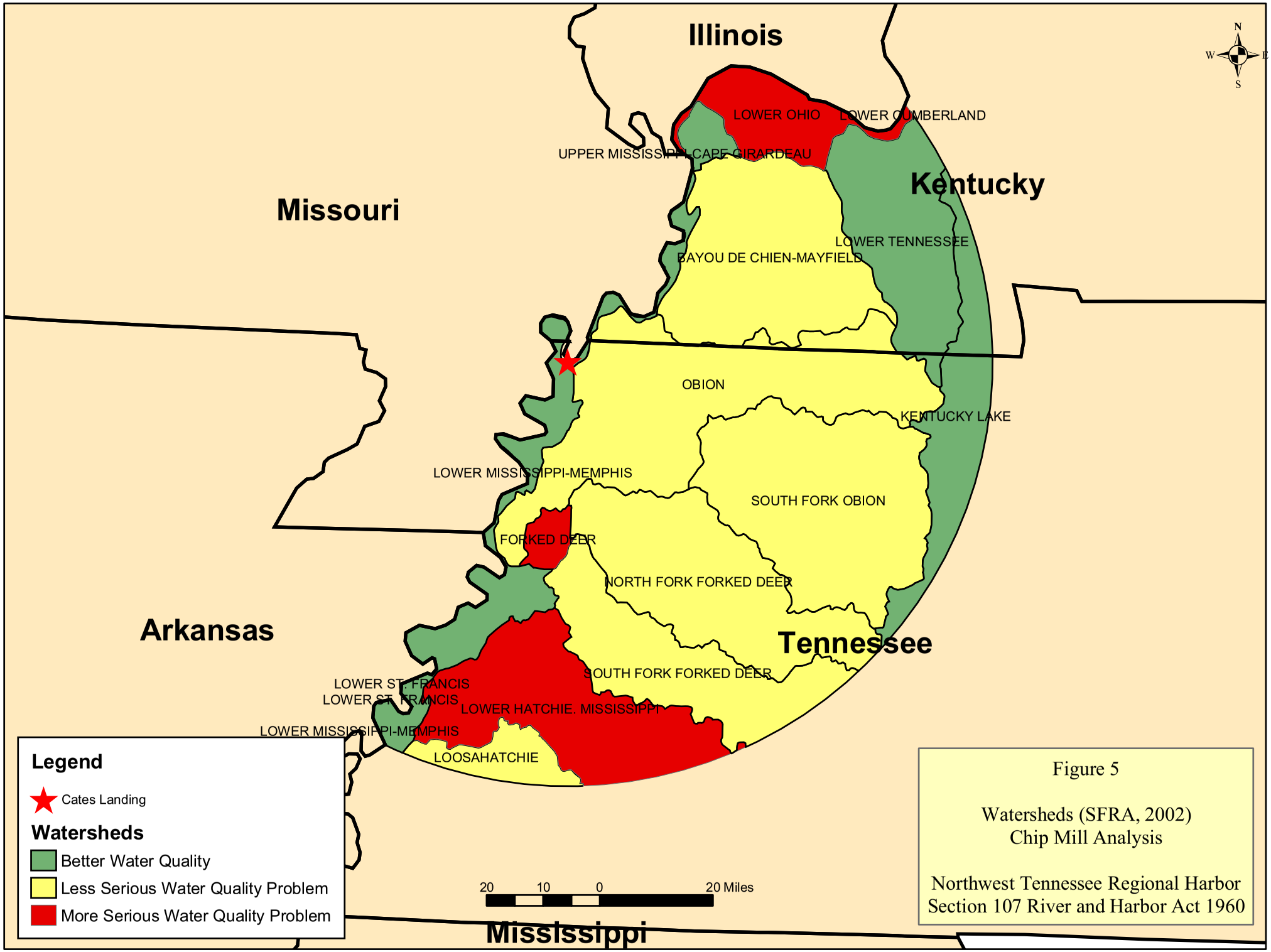
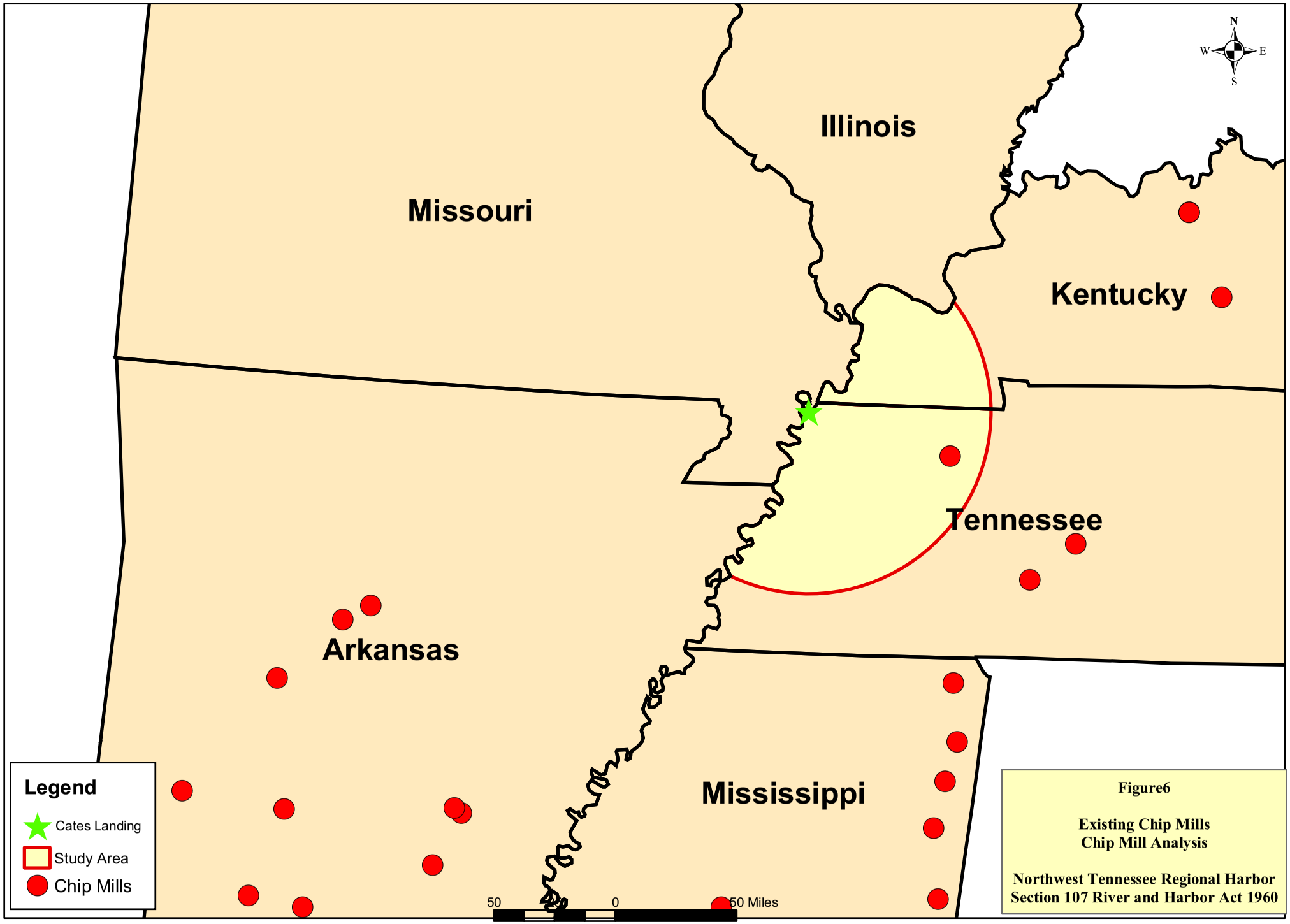


Figure 5

Watersheds (SFRA, 2002)
Chip Mill Analysis

Northwest Tennessee Regional Harbor
Section 107 River and Harbor Act 1960


Missouri
Illinois
Kentucky
Tennessee
Arkansas
Mississippi
N
W
E
S
Legend
Cates Landing
Study Area
Chip Mills
50
0
50 Miles
Figure6
Existing Chip Mills
Chip Mill Analysis
Northwest Tennessee Regional Harbor
Section 107 River and Harbor Act 1960