Waterway Traffic Forecasts for the Upper Mississippi River Basin

Volume III: Agricultural Chemicals

Contract No. DACW72-90-D-003

Final Report

April 4, 1997

Submitted to:
Institute for Water Resources
U.S. Army Corps of Engineers

Submitted by:
Jack Faucett Associates

In Cooperation with:
Criton Corporation

JACK FAUCETT ASSOCIATES

4550 MONTGOMERY AVENUE • SUITE 300 NORTH

BETHESDA, MARYLAND 20814

(301) 961-8800

Waterway Traffic Forecasts for the Upper Mississippi River Basin: Agricultural Chemicals

Report Prepared by

Criton Corporation

April 4, 1997

I. Introduction

The Criton Corporation has developed this analysis to evaluate past, present and prospective agricultural chemical (fertilizer) supply and demand relationships in geographic regions served by the Upper Mississippi River Basin waterway transportation network. These analyses were undertaken to develop insight into the major determinants of riverborne fertilizer shipments along the targeted waterways. These analyses were then used to derive relevant fertilizer demand estimates, which in turn were used to generate riverborne fertilizer traffic forecasts through 2050 for the Upper Mississippi River Basin waterways. Specifically, traffic levels were forecast for the Upper Mississippi River between Minneapolis/St. Paul and the mouth of the Missouri River; the Upper Mississippi River between the mouth of the Missouri River and the Mouth of the Ohio River, and the entire length of the Illinois Waterway.

This report is divided into seven sections including this introduction. Section II discusses the basic types and uses of agricultural chemicals as well as historic traffic levels on the Upper Mississippi Basin waterways. Section III identifies and evaluates the relevant fertilizer supply regions which feed the five-state Upper Mississippi study area. Section IV evaluates historical fertilizer use trends by crop and state. Section V presents the methodology and assumptions used to generate the fertilizer demand and waterway traffic forecasts. Section VI summarizes the results of Criton's regional fertilizer demand forecast, and Section VII present's Criton's waterway traffic forecasts for agricultural chemicals.

II. Agricultural Chemicals: Types Uses, and Historic River Traffic Levels

Given the massive presence of agricultural activities in the Upper Mississippi Basin, agricultural chemicals represent a significant commodity base for the Upper Mississippi River and its tributaries.

Agricultural chemicals are directly applied to crop lands in the spring and fall. Some agricultural chemicals, notably anhydrous ammonia, also are used as feedstocks for other agricultural chemicals. In addition to being applied directly to crops lands, anhydrous ammonia also is used to manufacture urea and liquid UAN solutions.

In general, agricultural chemicals fall into three main categories, each centered on a specific crop nutrient: nitrogen, phosphates, and potash. Nitrogen fertilizers primarily consist of anhydrous ammonia, urea, liquid UAN solutions, and to a lesser degree, ammonium nitrate and ammonium sulfate. Within these groups, anhydrous ammonia and UAN solutions are transported and used as liquids, while urea, ammonium nitrate and ammonium sulfate are dry bulk materials. Phosphate fertilizers are produced by converting raw phosphate rock into phosphoric acids. These acids are then further refined and mixed with small amounts of nitrogen chemicals to produce well-known phosphate-based fertilizers such a monoammonia phosphate (MAP), diammonia phosphate (DAP), and various superphosphates. The vast majority of potash-based fertilizer consists of potassium chloride.

Because of the intensity of agricultural activities in the five-state study area (Minnesota, Wisconsin, Iowa, Illinois and Missouri) this region represents one of the largest fertilizer demand areas in the United States. Combined, farmers in these five states applied 12.5 million tons of fertilizer material to their crops in 1994. This represents almost 25 percent of total U.S. fertilizer use that year.

In gross terms, Illinois is the largest market for fertilizer in the five-state area, accounting for 4.1 million tons of fertilizer demand in 1994. Illinois was followed by Iowa, Minnesota, Missouri and Wisconsin (see Table 1.)

Table 1.
Upper Mississippi Fertilizer Use by State: 1994
(000s of short tons of material)

State	Use
Illinois	4,143.9
Iowa	3,325,9
Minnesota	2,155.0
Missouri	1,692.2
Wisconsin	1,215.5
Total	**12,532.1**

Source: Association of American Plant Food Control Officials, Commercial Fertilizers 1995.

Total fertilizer demand is determined by several factors, including the number of acres planted, geographic location, and most importantly, the specific crop being cultivated. For example, corn is an extremely fertilizer intensive crop, requiring roughly 43 percent more nitrogen than wheat and 42 percent more potash than wheat (see Table 2). Fertilizer usage on soybeans, meanwhile, is minuscule when compared to either corn or wheat.

Table 2.
Fertilizer Use by Crop and State: 1992
(Pounds of Nutrient per planted acre)

	Nitrogen			Phosphate			Potash		
State	**Corn**	**Wheat**	**Soy**	**Corn**	**Wheat**	**Soy**	**Corn**	**Wheat**	**Soy**
Illinois	153	84	2	65	63	10	88	60	22
Iowa	113	-	2	44	-	7	50	-	10
Minnesota	107	83	4	42	31	7	54	26	7
Missouri	119	74	2	39	40	9	54	44	13
Wisconsin	85	-	-	42	-	-	59	-	-
Average*	**115**	**80**	**3**	**46**	**45**	**8**	**61**	**43**	**13**

*The average calculated represents the average of the fertilizer application rates in each of the states. It does not represent a regional average of the application rates on all acres planted in the five-state region.

Source: U.S. Dept. of Agriculture, Fertilizer Use and Price Statistics: 1960-1993, USDA Statistical Bulletin No. 893.

It is also apparent from Table 2, that farmers in Illinois rely most heavily on chemical fertilizers for their crops, using significantly higher quantities of all three types of chemical fertilizers on all Illinois crops than other states in the five-state study area. While fertilizer application rates can and do vary from year-to-year, the general relationship for fertilizer application rates between crops and states generally holds for all years.

The Upper Mississippi and Illinois River systems represent a critical link in the fertilizer supply chain feeding the five-state Upper Mississippi study region. In 1994, for example, the Upper Mississippi between the Twin Cities and the mouth of the Missouri River handled a total of 5.2 million tons of agricultural chemicals (see Table 3). In that year, nitrogen fertilizers accounted for approximately 45 percent of the total and phosphate fertilizers accounted for 40 percent of the total. Potash fertilizer accounted for the remaining 15 percent. As will be discussed later, potash fertilizer represents a relatively small share of Upper Mississippi fertilizer traffic because the vast majority of the potash consumed in the five-state study area originates in western Canada and moves into the region by rail.

Table 3.
Fertilizer Traffic: Upper Mississippi from the Twin Cities to the Missouri River
(000s of Tons)

Year	Inbound	Outbound	Through	Intra	Total
Nitrogen Fertilizer*					
1990	462	79	759	82	1382
1991	529	61	790	70	1450
1992	583	61	853	130	1627\
1993	721	107	802	120	1750
1994	981	218	999	153	2351
Phosphate Fertilizer**					
Year	**Inbound**	**Outbound**	**Through**	**Intra**	**Total**
1990	1213	7	691	2	1913
1991	1130	-	675	12	1817
1992	1278	5	724	1	2008
1993	1193	-	707	-	1900
1994	1314	14	690	82	2100
Potash Fertilizer					
Year	**Inbound**	**Outbound**	**Through**	**Intra**	**Total**
1990	54	149	102	81	386
1991	58	165	104	123	450
1992	62	346	93	165	666
1993	52	212	116	135	515
1994	44	366	152	221	783

* Includes ammonia
** Waterborne Commerce data show relatively small volumes of material classified as "phosphate fertilizer" Volumes in the "Fertilizers & Mixes NEC" category, however, are substantial. Criton's research indicates that the vast majority of this material constitutes MAP and DAP, both of which are phosphate fertilizers. Their classification in the NEC category probably results from the fact that both MAP and DAP have a small nitrogen content. For this table and all future analyses, Criton will combine tonnage in the "Fertilizers & Mixes NEC" category with tonnage classified as Phosphate fertilizer.

Source: Waterborne Commerce of the U.S. 1990-1994

Substantial volumes of fertilizer also move by barge on the Illinois Waterway (see Table 4). Nitrogen fertilizers historically have accounted for the largest share, representing 59 percent of all Illinois Waterway fertilizer traffic in 1994. Phosphate fertilizers, meanwhile accounted for 28 percent of the total while potassic fertilizers accounted for the remaining 13 percent.

Table 4.
Fertilizer Traffic: Illinois Waterway
(000s of Tons)

Nitrogen Fertilizer*

Year	Inbound	Outbound	Through	Intra	Total
1990	635	55	120	10	823
1991	638	39	136	13	826
1992	651	49	171	4	875
1993	675	40	92	14	836
1994	934	38	105	1	1078

Phosphate Fertilizer

Year	Inbound	Outbound	Through	Intra	Total
1990	545	-	34	-	581
1991	487	23	21	-	531
1992	451	5	14	-	470
1993	498	2	15	-	515
1994	474	13	11	4	502

Potash Fertilizer

Year	Inbound	Outbound	Through	Intra	Total
1990	126	-	6	9	141
1991	127	-	4	1	131
1992	157	1	3	5	166
1993	171	2	9	-	182
1994	159	50	-	26	235

* Includes ammonia

Source: Waterborne Commerce of the U.S. 1990-1994

III. Fertilizer Supply Sources

Because of their disparate chemistries and raw material requirements, the three major agricultural chemical groups are sourced in widely disparate areas. Nitrogen fertilizers, the most widely used fertilizer in the U.S. as well as in the five-state Upper Mississippi region, are produced throughout the U.S. This is because the primary raw material used in making nitrogen fertilizer is natural gas. As a result, nitrogen fertilizer production facilities have been built wherever there is an abundant supply of natural gas, either through direct access to major gas fields, or via the U.S.'s interstate gas transmission pipeline network. Among the three fertilizer groups, nitrogen fertilizers are the only chemical fertilizers produced in significant quantities within the five-state study area. These facilities are listed in Table 5.

Table. 5
Nitrogen Fertilizer Production Facilities Within the Five-State Upper Mississippi River Study Region

		Capacity (000s of Tons)			
Operator	**Location**	**Ammonia**	**Urea**	**Nitrogen Solutions**	**Ammonia Nitrate**
Famland Industries	Ft. Dodge, IA	210	-	-	-
Green Valley Chem	Creston, IA	35	-	-	-
Arcadian Chemical	Clinton, IA	180	66	180	167
Terra Industries	Port Neal, IA*	350	255	350	160
Phoenix Chemical	E. Dubuque, IL	-	125	230	90
ICI Explosives	Joplin, MO	-	-	-	168
LaRoche	Crystal City, MO	-	-	-	220

*Terra's Port Neal plant was completely destroyed by a massive explosion in late 1994. The future status of this plant is unknown.

Source: TVA, North American Fertilizer Capacity Data.

Presently, the nitrogen fertilizer capacity in the five-state study region represents only a small fraction of total fertilizer demand in the area. The shortfall is especially pronounced since a significant proportion of the ammonia production in the region is used as a feedstock for other nitrogen fertilizers and a significant proportion of the ammonia nitrate production is used to manufacture explosives for the mining industry.

The gap between local nitrogen fertilizer production and demand for this product is filled by shipments of nitrogen fertilizer products from outside sources. Most of the nitrogen fertilizer shipped to this region is produced at nitrogen fertilizer plants along the U.S. Gulf Coast. Significant nitrogen fertilizer production capacity also exists in Oklahoma and Arkansas. A substantial volume of nitrogen fertilizer, especially urea, is imported through New Orleans and barged up the Mississippi River. Nitrogen fertilizer also is shipped into the region by rail from western Canada.

All phosphate fertilizers consumed in the five-state study region are produced outside of the region. U.S. phosphate fertilizer production is concentrated in Florida's "Bone Valley," which has dozens of large phosphate rock mining operations. Phosphate rock is generally processed near these locations into finished phosphate fertilizers or shipped to the lower Mississippi, where there are at least two additional phosphate fertilizer manufacturing plants. Imports via the lower Mississippi also supplements this domestic production.

Like phosphates, all potassic fertilizers consumed in the five-state study region originate from outside supply sources. The vast majority is shipped by rail from western Canada. Smaller volumes originate from U.S. potash mines located in the vicinity of Carlsbad, NM. This potash is moved by rail to either Houston or St. Louis, where it is transloaded to barge for shipment to river-served fertilizer distribution facilities. Overseas imports via New Orleans also represent a significant source of fertilizer-grade potash in the five-state Upper Mississippi study region.

IV. Fertilizer Utilization Trends

Trends in fertilizer usage have experienced significant variations depending on the type of fertilizer and specific crop. Tables A-1 through A-3, which are contained in Appendix A to this report, track historic nitrogen fertilizer application rates for the three major field crops grown in the five-state Upper Mississippi study region. Nitrogen fertilizer application rates for corn (Appendix A, Table A-1) experienced a dramatic increase during the 1960s and early 1970s. Application rates appear to have peaked during the mid- to late-1980s and now appear to be leveling. While data represented in Figure 1 suggests a downward trend in nitrogen fertilizer application rates since 1988, this appearance is exaggerated by the sharp decline in 1993 rates. This decline was most likely due to the extremely wet spring and summer (which contributed to the great 1993 summer floods) which prevented many farmers from adequately fertilizing their land. Preliminary data for 1994 and 1995 indicate that nitrogen fertilizer application rates were substantially higher in those years than in 1993. These data, however, are not sufficiently refined to determine specific application rates by state or crop. Given these events it appears that nitrogen fertilizer application rates are leveling with no apparent upward or downward trend.

Nitrogen fertilizer application rates for wheat, meanwhile, have been generally increasing through the 1960s and 1970s, peaking in 1988 (see Appendix A, Table A-2). Among the three major region field crops, nitrogen fertilizer use on soybeans is minuscule when compared to wheat and corn and extremely erratic. Overall nitrogen application rates for soybeans peaked in 1991 and have fallen in 1992 and 1993 (see Appendix A, Table A-3). We do not believe that this is an indication of any long-term trend as similar peaks were experienced in previous years. In addition, as with corn, nitrogen application rates for soybeans in 1993 were likely to be adversely affected by the extremely wet spring.

Phosphate fertilizer application rates for corn in recent years have been considerably lower than application rates during the late 1970s and early 1980s. Since 1988 the data represented in Appendix A, Table A-4 appears to indicate a moderate downward trend. As with nitrogen fertilizers, it is our belief that 1993 application rates were held below typical levels due to the unusually wet spring that year and the application rates rebounded in 1994 and 1995.

Phosphate fertilizer application rates for wheat, meanwhile, have been relatively flat since the early 1980s (see Appendix A, Table A-5) No statistically significant upward or downward trend in phosphate fertilizer usage for wheat is apparent

Phosphate fertilizer application rates for soybeans are summarized in Appendix A, Table A-6. As with nitrogen fertilizers, phosphate use on soybeans tends to fluctuate widely from year-to-year. No statistically significant upward or downward trend is apparent.

Potash fertilizer application rates for corn are presented in Appendix A, Table A-7. Overall potash application rates for corn peaked during the early 1980s, and have leveled at slightly lower levels since that time..

Potash application rates for wheat (Appendix A, Table A-8), experienced steady growth through the early 1980s. Application rates since that period have been fluctuating with no apparent general trend pointing to either increases or decreases on overall application rates.

Application rates of potash on soybean crops in the five-state study region have generally been rising through the late 1980s, especially in Illinois. As with other crop nutrients used in soybean production, potash application rates tend to vary quite dramatically from year-to-year (Appendix A, Table A-9). Again, there is no apparent trend pointing to either increased or decreased potash use in soybeans based on data during the 1988-1993 period.

V. Forecast Methodology and Assumptions

To forecast riverborne fertilizer traffic, it was first necessary to develop estimates of total fertilizer demand by state, crop and primary nutrient for the five-state study region

These projections are based upon two important variables: acreage planted by crop, and the rate of nutrient application per acre per crop.

Criton relied on crop acreage forecasts for corn, wheat, and soybeans developed by Sparks Companies, Inc. (SCI) in developing its fertilizer demand forecast. These forecasts were used so that there would be overall consistency not only for the specific commodity (fertilizer) forecasts, but also between related commodities (fertilizer and grain). *For a more detailed discussion on the derivation of the crop acreage forecasts, see **Waterway Traffic Forecasts for the Upper Mississippi River Basin, Volume II: Grain**, prepared by Jack Faucett Associates (JFA).* These acreage forecasts are presented in Appendix B of the JFA report.

It was necessary to make minor adjustments to SCI's acreage forecasts before they could be used to generate fertilizer demand forecasts. Specifically, the forecasts represent harvested acreage for each of the main field crops by state. Fertilizer use, meanwhile, is determined by planted acreage. To account for any differences between planted and harvest acreage, Criton multiplied each harvest acreage forecast by an adjustment factor which represents the average ratio of planted acres to harvested acres for the latest five-year period for which data were available. These factors are shown in Table 6.

Table 6.
Ratio of Planted Acres to Harvested Acres by State and Crop

Crop	Illinois	Wisconsin	Minnesota	Iowa	Missouri
Corn	1.038	1.322	1.143	1.038	1.073
Soybeans	1.012	1.049	1.028	1.010	1.033
Wheat	1.160	NA	1.062	NA	1.068

In evaluating prospective fertilizer application rates for the five-state study region, historical fertilizer application rates for the 1988-1993 period were analyzed. These rates for nitrogen fertilizers are summarized in Table 7. Application rates for phosphate fertilizers are summarized in Table 8, while application rates for potassic fertilizer are summarized in Table 7.

Some year-to-year fluctuations in fertilizer application rates are apparent among both individual nutrients and crops. However, based on the data contained in Tables 7 through 9 did not provide evidence of any sustained long-term trend towards either increased or decreased fertilizer use for any individual crop or nutrient. Consequently,

Table 7.
Nitrogen Fertilizer Application Rates: 1988-1993
(lbs. of nutrient per acre)

State / Crop	1988	1989	1990	1991	1992	1993	Average
Illinois							
Corn	163	158	164	157	153	147	157
Wheat	96	88	85	84	84	86	87
Soybeans	2	2	4	3	2	3	3
Wisconsin							
Corn	85	87	79	82	85	78	83
Wheat	na	na	na	na	na	na	na
Soybeans	na	na	na	na	na	na	na
Minnesota							
Corn	113	112	108	107	107	100	108
Wheat	103	71	81	83	83	92	86
Soybeans	3	3	2	5	4	2	3
Iowa							
Corn	138	127	122	118	113	112	121.7
Wheat	na	na	na	na	na	na	na
Soybeans	2	1	3	4	2	1	2
Missouri							
Corn	129	136	126	132	132	131	131
Wheat	89	83	81	88	74	81	83
Soybeans	3	3	2	3	2	3	3

Source: USDA, Fertilizer Use and Price Statistics: 1960-1993

Table 8.
Phosphate Fertilizer Application Rates: 1988-1993
(lbs. of nutrient per acre)

State / Crop	1988	1989	1990	1991	1992	1993	Average
Illinois							
Corn	89	85	89	85	84	81	86
Wheat	73	56	67	61	63	57	63
Soybeans	17	12	16	13	10	11	13
Wisconsin							
Corn	97	95	95	93	95	93	95
Wheat	na	na	na	na	na	na	na
Soybeans	na	na	na	na	na	na	na
Minnesota							
Corn	87	85	86	83	84	83	85
Wheat	38	33	37	33	31	32	34
Soybeans	11	6	4	4	7	4	6
Iowa							
Corn	87	83	80	77	73	77	79
Wheat	na	na	na	na	na	na	na
Soybeans	3	8	4	5	7	6	6
Missouri							
Corn	87	82	80	79	77	77	80
Wheat	40	41	40	40	40	40	40
Soybeans	10	8	6	8	9	7	8

Source: USDA, Fertilizer Use and Price Statistics: 1960-1993

Table 9.
Potash Fertilizer Application Rates: 1988-1993
(lbs. of nutrient per acre)

State / Crop	1988	1989	1990	1991	1992	1993	Average
Illinois							
Corn	97	86	95	88	88	86	90
Wheat	76	52	72	69	60	56	64
Soybeans	34	28	33	25	22	23	28
Wisconsin							
Corn	75	69	70	64	59	56	66
Wheat	na	na	na	na	na	na	na
Soybeans	na	na	na	na	na	na	na
Minnesota							
Corn	57	54	59	52	54	56	55
Wheat	26	18	24	20	26	17	22
Soybeans	10	8	8	5	7	9	8
Iowa							
Corn	64	57	59	52	50	49	55
Wheat	na	na	na	na	na	na	na
Soybeans	8	12	8	7	10	10	9
Missouri							
Corn	60	59	64	57	54	51	57
Wheat	57	47	59	49	44	46	50
Soybeans	20	16	10	12	13	13	14

Source: USDA, Fertilizer Use and Price Statistics: 1960-1993

it was assumed that prospective fertilizer application rates would be equal to the average application rates over the 1988 through 1993 period by state, crop, and nutrient.

Criton projected total fertilizer demand for each of the five states in the study region by multiplying the projected acreage forecasts (after adjusting them by the factors presented in Table 6) by the average 1988-1993 fertilizer application rates summarized in Tables 7 through 9. Because of the relatively wide range of potential outcomes encompassed by SCI's upper and lower bound crop acreage estimates, it is likely that any variability in prospective annual fertilizer application rates will be sufficiently accounted for by this variability alone. As a result, upper and lower bound estimates for prospective fertilizer application rates were not calculated.

Since the data in Tables 7 through 9 reflect application rates based on pounds of nutrient per acre, one additional adjustment was necessary: Converting pounds of nutrient to pounds of material. Based on the historical ratio of nutrient to material weights, it was assumed that 1.84 pounds of nitrogen fertilizer would be required to yield one pound of nitrogen nutrient, 1.71 pounds of phosphate fertilizer would be required to yield one pound of phosphate nutrient, while 1.12 pounds of potassic fertilizer would be required to yield one pound of potash nutrient. It was also assumed that these ratios would remain fixed during the forecast period. In practical terms, this implies that for nitrogen

fertilizers, for example, the proportions of fertilizer applied as anhydrous ammonia, urea, UAN solutions, etc. would remain fixed through the forecast period.

With respect to the barge traffic forecast, it was assumed that practically all phosphate and potash fertilizers consumed in the five state study region would continue to originate from sources outside the region. It was also assumed that the proportion of these fertilizers moving by barge into the region would remain at historical levels. With respect to nitrogen fertilizers, Criton assumed that local production would increase at a higher rate than local demand, implying a decrease in the proportion of nitrogen fertilizers moved by barge to the region. This assumption is driven by one specific development: plans by COGA Industries to build a one million ton-per-year granulized urea plant near Girard, IL. Construction on the new project is expected to begin in late 1996, with production expected to begin in mid-1998. Completion of this project is expected to displace some of the barged nitrogen fertilizers currently moving into the region.

VI. Projected Fertilizer Demand

To develop riverborne forecasts for agricultural chemicals, total demand forecasts for agricultural chemicals were developed for the five-state study region. Individual forecasts were developed for each state and crop utilizing the crop acreage forecasts and the fertilizer application rate assumptions discussed in the previous section.

Criton's forecast for total nitrogen fertilizer demand for the five-state study region for the three major field crops grown in the area are presented in Table 10. High and low estimates, based on SCI's different acreage forecasts, are presented in Appendix A.

Overall, relatively little growth is predicted for nitrogen fertilizer demand during the study period as small increases in projected demand in Minnesota and Wisconsin are tempered by gradually falling demand in Illinois, Iowa and Missouri *(note the data indicate a major jump in fertilizer use between 1995 and 1996. This jump is due to the fact that 1995 crop plantings were substantially below prior year levels due to a 7.5 percent ARP set-aside for corn. Plantings and fertilization rates also were hampered by unusually wet weather in the Spring on 1995. Thus, 1995 data are significantly below the long-term trend line and it should be considered an "outlier" year. This also will be evident in the phosphate and Potash fertilizer sectors.)*

Extremely limited growth also is expected for phosphate fertilizers (Table 11) and potash fertilizers (Table 12.). High and low forecasts for both of these commodities also are contained in Appendix B.

Table 10. Base Case Projected Demand for Nitrogen Fertilizer by State and Crop (000s of Tons of Material)

	Illinois			Wisconsin			Minnesota			Iowa			Missouri			Grand
	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Total
1995	1495	126	22	291	0	2	692	182	15	721	0	21	187	89	11	3854
1996	1712	136	21	316	0	2	749	210	15	835	0	19	297	108	11	4429
1997	1704	136	21	311	0	2	737	212	15	828	0	20	291	96	11	4386
1998	1712	136	21	316	0	2	760	214	15	844	0	20	291	96	11	4438
1999	1712	136	21	316	0	2	760	216	15	847	0	20	291	99	11	4445
2000	1712	136	21	316	0	2	760	216	15	847	0	20	291	99	11	4445
2001	1711	136	21	317	0	2	761	217	15	847	0	20	290	99	11	4447
2002	1711	136	21	318	0	2	761	217	15	847	0	20	290	99	11	4450
2003	1711	135	21	320	0	2	762	218	15	847	0	20	290	99	11	4452
2004	1711	135	21	321	0	2	763	218	15	847	0	20	290	100	11	4454
2005	1711	135	21	322	0	2	763	219	15	847	0	20	290	100	11	4456
2006	1711	134	21	324	0	2	764	219	15	846	0	20	290	100	11	4458
2007	1711	134	21	325	0	2	765	220	15	846	0	20	290	101	11	4460
2008	1710	134	21	326	0	2	765	220	15	846	0	20	290	101	11	4462
2009	1710	134	21	328	0	2	766	221	15	846	0	20	289	101	11	4465
2010	1710	133	21	329	0	2	767	221	15	846	0	20	289	102	11	4467
2015	1709	132	21	335	0	2	770	224	15	845	0	20	289	103	12	4477
2020	1709	131	21	342	0	2	774	226	15	845	0	20	288	104	12	4488
2025	1708	129	21	348	0	2	777	229	15	844	0	20	287	106	12	4499
2030	1707	128	21	355	0	2	780	231	15	843	0	20	287	107	12	4509
2035	1706	127	21	362	0	2	784	234	15	843	0	20	286	109	12	4520
2040	1706	125	21	368	0	2	787	236	15	842	0	20	285	110	12	4531
2045	1705	124	21	375	0	2	791	239	15	842	0	20	285	112	12	4541
2050	1704	123	21	379	0	2	794	241	15	841	0	20	284	114	12	4550

Table 11. Base Case Projected Demand for Phosphate Fertilizer by State and Crop (000s of Tons of Material)

	Illinois			Wisconsin			Minnesota			Iowa			Missouri			Grand
	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Total
1995	604	11	107	153	0	7	263	68	46	467	0	43	58	44	32	1903
1996	691	11	103	166	0	6	285	68	44	540	0	40	92	53	32	2132
1997	688	11	106	163	0	7	280	68	47	536	0	42	90	47	33	2118
1998	691	11	106	166	0	7	289	68	46	547	0	41	90	47	32	2141
1999	691	11	105	166	0	7	289	68	46	549	0	41	90	49	32	2143
2000	691	11	105	166	0	7	289	68	46	549	0	41	90	49	32	2142
2001	691	11	105	167	0	7	289	68	46	549	0	41	90	49	32	2143
2002	691	11	105	167	0	7	290	68	46	549	0	41	90	49	32	2144
2003	691	11	105	168	0	7	290	68	46	548	0	41	90	49	32	2145
2004	691	11	105	169	0	7	290	68	46	548	0	41	90	49	33	2146
2005	691	11	105	169	0	7	290	68	46	548	0	41	90	49	33	2147
2006	691	11	105	170	0	7	291	68	46	548	0	41	90	50	33	2148
2007	691	11	105	171	0	7	291	68	46	548	0	41	90	50	33	2149
2008	691	11	105	171	0	7	291	68	46	548	0	41	90	50	33	2150
2009	691	11	104	172	0	7	291	68	46	548	0	41	90	50	33	2151
2010	691	11	104	173	0	7	292	68	46	548	0	41	90	50	33	2152
2015	690	11	104	176	0	7	293	68	46	547	0	41	89	51	33	2157
2020	690	11	104	180	0	7	294	68	46	547	0	41	89	52	34	2162
2025	690	11	104	183	0	7	295	68	46	547	0	41	89	52	34	2167
2030	689	11	104	187	0	7	297	68	46	546	0	41	89	53	35	2172
2035	689	11	104	190	0	7	298	68	46	546	0	41	89	54	35	2177
2040	689	11	104	193	0	7	299	68	46	545	0	41	88	55	35	2182
2045	688	11	104	197	0	7	301	68	46	545	0	41	88	55	36	2187
2050	688	11	104	199	0	7	302	68	46	545	0	42	88	56	36	2191

Table 12. Base Case Projected Demand for Potassic Fertilizer by State and Crop (000s of Tons of Material)

	Illinois			Wisconsin			Minnesota			Iowa			Missouri			Grand
	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Total
1995	467	13	146	146	0	8	215	28	54	369	0	48	50	36	37	1618
1996	535	14	140	159	0	7	233	33	52	427	0	44	79	44	37	1803
1997	533	14	144	156	0	8	229	33	55	424	0	46	77	39	39	1796
1998	535	14	144	159	0	8	236	33	54	432	0	45	77	39	38	1814
1999	535	14	143	159	0	8	236	33	54	434	0	45	77	40	37	1815
2000	535	14	142	159	0	8	236	33	54	434	0	45	77	40	38	1815
2001	535	14	142	159	0	8	236	34	54	434	0	45	77	40	38	1816
2002	535	14	142	160	0	8	237	34	54	433	0	45	77	40	38	1817
2003	535	14	142	161	0	8	237	34	54	433	0	45	77	40	38	1818
2004	535	14	142	161	0	8	237	34	54	433	0	45	77	40	38	1819
2005	535	14	142	162	0	8	237	34	54	433	0	45	77	40	38	1820
2006	535	14	142	163	0	8	237	34	54	433	0	45	77	41	38	1821
2007	535	14	142	163	0	8	238	34	54	433	0	45	77	41	38	1822
2008	535	14	142	164	0	8	238	34	54	433	0	45	77	41	38	1823
2009	535	14	142	165	0	8	238	34	54	433	0	45	77	41	39	1824
2010	535	14	142	165	0	8	238	34	54	433	0	45	77	41	39	1825
2015	534	13	142	169	0	8	239	35	54	433	0	45	77	42	39	1830
2020	534	13	142	172	0	8	240	35	54	432	0	46	77	42	40	1835
2025	534	13	142	175	0	8	241	35	54	432	0	46	77	43	40	1839
2030	534	13	141	178	0	8	243	36	54	432	0	46	76	43	40	1844
2035	533	13	141	182	0	8	244	36	54	431	0	46	76	44	41	1849
2040	533	13	141	185	0	8	245	37	54	431	0	46	76	45	41	1854
2045	533	13	141	188	0	8	246	37	54	431	0	46	76	45	42	1859
2050	533	12	141	190	0	8	247	37	54	430	0	46	76	46	42	1863

VII. Projected Riverborne Fertilizer Shipments

Criton generated riverborne fertilizer projections for two major waterway segments targeted by the Upper Mississippi Basin Study: The Upper Mississippi River between the Twin Cities and the mouth of the Missouri River, and the Illinois Waterway. For each of these segments, separate forecasts were developed for each of the three major fertilizer types: nitrogen, phosphate, and potash. For each major nutrient, three separate waterway traffic forecasts are presented: Base, High, and Low. Each forecast was developed using the "Base", "High" and "Low" fertilizer demand forecasts generated from the corresponding SCI crop acreage forecasts.

Forecasts of nitrogen fertilizer traffic on the Upper Mississippi between the Twin Cities and the mouth of the Missouri River are presented in Table 13. Waterway tonnage forecasts for the Upper Mississippi for phosphate and potash traffic are presented in Tables 14 and 15, respectively.

Among the major fertilizers moving on the Upper Mississippi River, Criton does not anticipate any significant changes in riverborne traffic with the exception of the nitrogen fertilizer sector. After an exceptional 1994 season and a marginal 1995 season, nitrogen fertilizer shipments should return to more "normal" levels by 1996 or 1997. Nitrogen fertilizer shipments are expected to begin falling in 1998, however, due to the completion of COGA's new one million ton-per-year urea plant currently under development near Girard, IL. The full impact of the COGA project on riverborne shipments should be realized by 2000.

Riverborne shipments of phosphate and potash fertilizers are not expected to be influenced by new local production facilities. As a result, while no significant long-term decreases in traffic are expected in riverborne phosphate and potash fertilizers, traffic growth in these commodities is expected to be extremely limited.

Table 13. Projected Riverborne Shipments of Nitrogen Fertilizer: Twin Cities to the Missouri River
(000s of Tons of Material)

	Low	Base	High
1992		1627	
1993		1750	
1994		2351	
1995	1518	1518	1518
1996	1420	1730	2039
1997	1419	1719	2018
1998	1274	1576	1879
1999	1114	1422	1730
2000	1115	1422	1730
2001	1115	1422	1730
2002	1121	1423	1724
2003	1122	1423	1723
2004	1118	1423	1727
2005	1117	1423	1729
2006	1116	1423	1731
2007	1119	1423	1728
2008	1117	1424	1731
2009	1121	1425	1729
2010	1123	1426	1729
2015	1122	1427	1732
2020	1122	1428	1733
2025	1120	1428	1737
2030	1122	1429	1736
2035	1123	1430	1737
2040	1123	1430	1738
2045	1123	1430	1738
2050	1124	1430	1737

Table 14. Projected Riverborne Shipments of Phosphate Fertilizer: Twin Cities to the Missouri River

(000s of Tons of Material)

	Low	Base	High
1992		2008	
1993		1900	
1994		2100	
1995	1795	1795	1795
1996	1625	1996	2391
1997	1627	1987	2373
1998	1642	2006	2399
1999	1639	2007	2405
2000	1638	2007	2404
2001	1640	2007	2405
2002	1646	2008	2400
2003	1648	2009	2400
2004	1645	2009	2405
2005	1646	2010	2405
2006	1644	2011	2408
2007	1647	2011	2407
2008	1648	2012	2408
2009	1648	2013	2410
2010	1650	2013	2409
2015	1653	2017	2415
2020	1655	2020	2421
2025	1660	2023	2425
2030	1659	2027	2434
2035	1663	2030	2438
2040	1669	2033	2441
2045	1674	2037	2444
2050	1672	2039	2454

Table 15. Projected Riverborne Shipments of Potash Fertilizer: Twin Cities to the Missouri River
(000s of Tons of Material)

	Low	Base	High
1992		666	
1993		515	
1994		783	
1995	511	511	511
1996	515	567	663
1997	518	566	660
1998	519	569	664
1999	517	569	665
2000	516	569	665
2001	517	569	664
2002	518	569	663
2003	519	569	662
2004	517	569	664
2005	517	569	664
2006	516	569	665
2007	517	569	664
2008	517	569	664
2009	517	569	664
2010	519	569	664
2015	519	570	664
2020	516	570	666
2025	517	570	665
2030	516	571	667
2035	516	571	667
2040	517	571	667
2045	517	572	667
2050	516	572	668

Riverborne shipments of fertilizer on the Illinois Waterway are expected to mirror overall fertilizer demand for the state of Illinois (see Section VI). The one exception to this expectation is in the nitrogen fertilizer trade. As with the Upper Mississippi, the completion of COGA's one million ton-per-year granulated urea plant near Girard, IL is expected exert significant downward pressure on riverborne nitrogen, which should become evident during the 1998-2000 period (see Table 16). Riverborne nitrogen shipments on the Illinois Waterway are expected to track total changes in demand for nitrogen fertilizers within the state of Illinois for the remainder of the forecast period.

Illinois Waterway traffic in phosphate and potassic fertilizers, meanwhile, are expected to be essentially flat to moderately declining in the base case forecast, due primarily to a gradual loss of planted crop acreage due to increased urbanization. Forecasts for Illinois Waterway shipments of phosphate fertilizers are summarized in Table 17, while forecasts of Illinois Waterway potash fertilizer traffic are summarized in Table 18.

Table 16. Projected Riverborne Shipments of Nitrogen Fertilizer: Illinois Waterway
(000s of Tons of Material)

	Low	Base	High
1992		875	
1993		836	
1994		1078	
1995	805	805	805
1996	773	916	1058
1997	775	912	1050
1998	659	798	937
1999	537	680	822
2000	538	680	821
2001	537	679	822
2002	541	679	817
2003	542	679	816
2004	539	679	819
2005	537	679	820
2006	536	678	820
2007	538	678	819
2008	535	677	819
2009	537	676	815
2010	537	675	813
2015	535	674	813
2020	534	673	812
2025	531	672	813
2030	531	671	811
2035	530	670	809
2040	530	670	809
2045	530	669	809
2050	531	669	808

Table 17. Projected Riverborne Shipments of Phosphate Fertilizer: Illinois Waterway

(000s of Tons of Material)

	Low	Base	High
1992		470	
1993		515	
1994		502	
1995	469	469	469
1996	452	523	594
1997	454	522	592
1998	455	524	595
1999	453	524	596
2000	453	524	596
2001	453	524	596
2002	455	524	594
2003	455	524	593
2004	453	523	595
2005	453	523	595
2006	452	523	595
2007	453	523	594
2008	453	523	594
2009	453	523	594
2010	455	523	593
2015	454	523	592
2020	452	523	594
2025	452	522	593
2030	450	522	594
2035	450	522	593
2040	451	522	592
2045	452	521	591
2050	450	521	592

Table 18. Projected Riverborne Shipments of Potash Fertilizer: Illinois Waterway

(000s of Tons of Material)

	Low	Base	High
1992		166	
1993		182	
1994		235	
1995	158	158	158
1996	150	174	198
1997	151	174	198
1998	151	175	199
1999	150	175	199
2000	150	175	199
2001	150	175	199
2002	151	175	198
2003	151	175	198
2004	150	175	199
2005	150	175	199
2006	150	175	199
2007	150	174	199
2008	150	174	198
2009	150	174	198
2010	151	174	198
2015	151	174	198
2020	150	174	198
2025	150	174	198
2030	149	174	198
2035	149	174	198
2040	150	174	198
2045	150	173	197
2050	149	173	198

Appendix A

Historic Fertilizer Application Rates for Corn, Wheat and Soybeans in the Five-State Upper Mississippi Study Region

Table A-1. Nitrogen Fertilizer Application Rates for Corn: Lbs. of Nutrient per Acre

State	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Minnesota	22	35	46	63	81	85	91	90	84	91	78	85	101	102	85	101	99
Wisconsin	26	32	42	48	62	78	68	59	77	74	61	72	86	80	91	92	107
Illinois	64	77	98	101	108	115	112	107	123	116	108	112	140	127	136	145	144
Iowa	36	56	74	79	90	98	101	95	103	101	92	95	123	125	121	135	127
Missouri	69	70	89	79	100	103	115	124	114	121	109	100	114	126	118	111	115

State	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Minnesota	103	107	97	110	106	102	115	113	112	108	107	107	100
Wisconsin	109	92	94	102	95	83	88	85	87	79	82	85	78
Illinois	149	151	153	147	155	151	158	163	158	164	157	153	147
Iowa	138	130	134	139	144	128	129	138	127	122	118	113	112
Missouri	125	121	128	118	125	129	127	129	136	126	132	132	131

Source: U.S. Dept. of Agriculture, Fertilizer Use and Price Statistics: 1960-1993, USDA Statistical Bulletin No. 893

Table A-2. Nitrogen Fertilizer Application Rates for Wheat: Lbs. of Nutrient per Acre

State	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Minnesota	12	12	12	21	30	29	31	21	56	49	48	49	59	57	67	70	64
Illinois	29	27	37	39	36	36	42	58	52	39	55	44	51	51	52	51	66
Missouri	34	38	40	47	40	49	55	46	71	64	52	48	60	57	51	49	65

State	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Minnesota	55	62	68	57	63	75	73	103	71	81	83	83	92
Illinois	61	71	62	66	77	63	85	96	88	85	84	84	86
Missouri	67	65	71	63	66	58	84	89	83	81	88	74	81

Source: U.S. Dept. of Agriculture, Fertilizer Use and Price Statistics: 1960-1993, USDA Statistical Bulletin No. 893

Table A-3. Nitrogen Fertilizer Application Rates for Soybeans: Lbs. of Nutrient per Acre

State	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Minnesota	0	1	1	1	2	1	3	1	3	3	3	5	1	1	2	2	1
Illinois	0	0	2	2	1	1	2	4	1	3	1	1	1	3	1	2	2
Iowa	0	1	1	1	2	0	1	1	1	1	1	1	1	2	1	1	1
Missouri	0	1	1	3	2	2	2	2	4	2	2	2	1	1	4	3	4

State	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Minnesota	3	1	3	4	3	1	2	3	3	2	5	4	2
Illinois	2	1	2	3	1	1	4	2	2	4	3	2	3
Iowa	1	2	1	3	1	1	1	2	1	3	4	2	1
Missouri	2	3	3	2	0	1	4	3	3	2	3	2	3

Source: U.S. Dept. of Agriculture, Fertilizer Use and Price Statistics: 1960-1993, USDA Statistical Bulletin No. 893

Table A-4. Phosphate Fertilizer Application Rates for Corn: Lbs. of Nutrient per Acres

State	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Minnesota	28	36	39	50	60	52	56	55	58	58	54	53	58	52	45	56	46
Wisconsin	42	47	55	47	74	62	67	62	59	59	54	53	58	58	70	56	55
Illinois	36	49	62	60	72	69	86	60	67	62	71	59	75	80	81	83	77
Iowa	28	34	45	48	54	59	60	52	54	50	50	50	56	58	56	62	59
Missouri	27	33	43	42	42	46	51	47	50	48	49	43	46	50	52	53	50

State	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Minnesota	50	46	43	46	41	43	43	47	44	46	43	42	45
Wisconsin	59	55	54	56	48	51	54	53	52	50	41	42	41
Illinois	86	80	76	86	72	68	72	77	61	74	69	65	62
Iowa	57	59	52	54	48	47	49	52	48	48	46	44	41
Missouri	54	50	49	44	41	45	46	49	46	46	41	39	40

Source: U.S. Dept. of Agriculture, Fertilizer Use and Price Statistics: 1960-1993, USDA Statistical Bulletin No. 893

Table A-5. Phosphate Fertilizer Application Rates for Wheat: Lbs. of Nutrient per Acre

State	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Minnesota	19	25	18	22	28	32	34	27	36	29	34	31	33	31	36	32	25
Illinois	37	34	42	48	50	48	45	61	62	47	61	45	50	57	52	60	77
Missouri	21	22	22	24	24	31	27	25	25	30	38	29	33	37	35	36	43

State	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Minnesota	26	29	31	30	28	36	26	38	33	37	33	31	32
Illinois	56	64	62	63	54	62	60	73	56	67	61	63	57
Missouri	41	36	39	34	34	31	24	40	41	40	40	40	40

Source: U.S. Dept. of Agriculture, Fertilizer Use and Price Statistics: 1960-1993, USDA Statistical Bulletin No. 893

Table A-6. Phosphate Fertilizer Application Rates for Soybeans: Lbs. of Nutrient per Acre

State	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Minnesota	1	3	2	3	8	5	8	3	5	8	5	4	3	3	4	8	3
Illinois	1	3	10	7	6	6	4	7	9	15	7	6	11	11	9	11	14
Iowa	2	3	4	5	9	6	6	4	5	7	4	3	3	6	4	4	3
Missouri	1	4	5	6	6	7	5	5	10	8	6	4	4	6	12	12	12

State	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Minnesota	1	3	2	3	8	5	8	3	5	8	5	4	3	3	4	8	3	3
Illinois	1	3	10	7	6	6	4	7	9	15	7	6	11	11	9	11	14	11
Iowa	2	3	4	5	9	6	6	4	5	7	4	3	3	6	4	4	3	5
Missouri	1	4	5	6	6	7	5	5	10	8	6	4	4	6	12	12	12	11

Source: U.S. Dept. of Agriculture, Fertilizer Use and Price Statistics: 1960-1993, USDA Statistical Bulletin No. 893

Table A-7. Potash Fertilizer Application Rates for Corn: Lbs. of Nutrient per Acre

State	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Minnesota	21	26	33	40	58	51	64	56	52	65	59	56	64	69	57	68	69
Wisconsin	41	45	62	67	74	73	80	68	76	83	86	81	102	84	85	90	82
Illinois	33	43	61	62	71	70	86	56	73	73	78	69	86	96	90	99	100
Iowa	16	22	30	35	43	48	55	44	48	44	51	51	57	65	60	66	63
Missouri	24	30	37	39	39	45	50	43	54	52	54	51	52	56	62	63	60

State	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Minnesota	71	62	59	62	56	53	55	57	54	59	52	54	56
Wisconsin	87	87	83	81	66	67	79	75	69	70	64	59	60
Illinois	102	105	104	105	100	86	94	97	86	95	88	88	86
Iowa	64	67	65	69	61	53	60	68	57	59	52	50	49
Missouri	62	60	65	51	53	50	60	60	59	64	57	54	51

Source: U.S. Dept. of Agriculture, Fertilizer Use and Price Statistics: 1960-1993, USDA Statistical Bulletin No. 893

Table A-8. Potash Fertilizer Application Rates for Wheat: Lbs. of Nutrient per Acre

State	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Minnesota	6	6	3	10	11	12	12	11	12	12	19	14	14	16	20	17	13
Illinois	25	27	30	42	35	39	35	46	43	50	39	41	41	47	35	52	52
Missouri	20	19	22	23	22	30	27	25	26	29	34	30	37	37	41	44	52

State	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Minnesota	18	20	22	20	20	20	17	25	18	24	20	26	17
Illinois	53	62	65	67	50	60	71	76	52	72	69	60	56
Missouri	48	45	43	38	40	49	29	57	47	59	49	44	46

Source: U.S. Dept. of Agriculture, Fertilizer Use and Price Statistics: 1960-1993, USDA Statistical Bulletin No. 893

Table A-9. Potash Fertilizer Application Rates for Soybeans: Lbs. of Nutrient per Acre

State	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Minnesota	3	3	3	4	9	7	18	4	7	9	8	5	8	6	5	12	7
Illinois	3	8	12	11	11	8	12	10	14	19	12	10	22	17	16	21	20
Iowa	1	2	3	3	7	6	6	5	5	8	5	4	5	7	5	6	5
Missouri	2	4	7	7	7	8	6	7	12	12	8	8	7	10	19	22	24

State	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Minnesota	10	6	11	16	12	4	6	10	8	8	5	7	9
Illinois	24	16	31	22	20	19	27	34	28	33	25	22	23
Iowa	6	6	5	12	6	6	9	8	12	8	7	10	9
Missouri	16	16	12	11	14	16	17	20	16	9	14	13	13

Source: U.S. Dept. of Agriculture, Fertilizer Use and Price Statistics: 1960-1993, USDA Statistical Bulletin No. 893

Appendix B

"High" and "Low" Estimates of Total Fertilizer Demand for the Five-State Study Area

Table B-1. Projected Demand for Nitrogen Fertilizer by State and Crop

High Case

	Illinois			Wisconsin			Minnesota			Iowa			Missouri			Grand
	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Total
1995	1495	126	22	291	0	2	692	182	15	721	0	21	187	89	11	3854
1996	1932	203	24	396	0	4	888	302	20	960	0	23	434	179	14	5377
1997	1915	203	24	390	0	4	874	303	21	951	0	24	423	158	14	5305
1998	1926	202	24	396	0	4	900	308	21	967	0	24	421	158	14	5367
1999	1933	202	24	395	0	4	901	311	20	971	0	24	423	162	14	5385
2000	1932	202	24	396	0	4	900	311	20	972	0	24	425	163	14	5388
2001	1932	202	24	397	0	4	903	312	20	970	0	24	422	162	14	5388
2002	1924	202	24	398	0	4	902	310	20	970	0	24	421	163	14	5377
2003	1922	201	24	398	0	4	902	312	20	970	0	24	424	163	14	5380
2004	1928	201	24	399	0	4	905	311	20	970	0	24	420	166	14	5387
2005	1930	201	24	402	0	4	901	314	20	969	0	24	421	165	14	5390
2006	1931	201	24	403	0	4	907	314	20	969	0	24	422	166	14	5398
2007	1929	199	24	406	0	4	903	313	20	971	0	24	421	166	14	5394
2008	1926	199	24	408	0	4	906	316	20	968	0	24	420	167	14	5396
2009	1927	199	24	408	0	4	909	316	20	969	0	24	420	167	14	5401
2010	1922	197	24	409	0	4	909	319	20	970	0	24	420	168	14	5400
2015	1922	197	24	417	0	4	915	321	20	969	0	24	416	169	14	5413
2020	1929	195	24	424	0	4	914	323	20	967	0	24	418	173	14	5429
2025	1925	192	24	430	0	4	920	326	20	966	0	24	415	174	15	5435
2030	1929	191	24	438	0	4	926	330	20	968	0	24	413	176	15	5459
2035	1928	188	24	446	0	4	925	335	21	965	0	24	415	179	15	5468
2040	1922	186	24	453	0	4	930	338	20	964	0	24	411	181	15	5474
2045	1919	185	24	460	0	4	933	341	20	964	0	24	413	183	15	5485
2050	1924	182	24	465	0	4	939	346	20	966	0	24	408	187	15	5505

Table B-2. Projected Demand for Phosphatic Fertilizer by State and Crop

High Case

	Illinois			Wisconsin			Minnesota			Iowa			Missouri			Grand
	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Total
1995	604	11	107	153	0	7	263	68	46	467	0	43	58	44	32	1903
1996	780	18	118	208	0	12	338	112	60	621	0	49	134	88	40	2578
1997	773	18	121	205	0	13	332	112	63	616	0	51	131	78	41	2555
1998	778	18	121	208	0	13	342	114	63	627	0	49	130	78	41	2582
1999	781	18	121	207	0	13	343	116	62	629	0	50	131	80	40	2589
2000	780	18	120	208	0	13	342	115	62	630	0	50	132	81	40	2590
2001	780	18	120	209	0	13	343	116	62	628	0	49	131	80	41	2589
2002	777	18	120	209	0	13	343	115	62	628	0	50	130	81	41	2586
2003	776	17	120	209	0	13	343	116	62	628	0	50	131	81	41	2587
2004	779	17	120	210	0	13	344	115	62	628	0	49	130	82	41	2591
2005	779	17	120	211	0	13	343	116	62	628	0	50	130	82	41	2591
2006	780	17	120	211	0	13	345	117	62	627	0	49	131	82	41	2595
2007	779	17	120	213	0	13	344	116	62	629	0	50	130	82	41	2595
2008	778	17	120	214	0	13	345	117	62	627	0	50	130	83	41	2595
2009	778	17	120	214	0	13	346	117	62	627	0	50	130	82	41	2598
2010	776	17	120	215	0	13	346	118	62	628	0	50	130	83	41	2599
2015	776	17	119	219	0	13	348	119	62	628	0	50	129	84	42	2606
2020	779	17	120	223	0	13	347	120	62	626	0	50	129	85	42	2613
2025	777	17	119	226	0	13	350	121	62	625	0	50	128	86	43	2618
2030	779	17	119	230	0	13	352	122	62	627	0	50	128	87	43	2629
2035	779	16	119	234	0	13	352	124	62	625	0	50	128	88	43	2635
2040	776	16	119	238	0	13	354	125	62	625	0	50	127	89	44	2640
2045	775	16	119	241	0	14	355	126	62	624	0	50	128	91	44	2646
2050	777	16	119	244	0	14	357	128	62	625	0	50	126	93	45	2656

Table B-3. Projected Demand for Potassic Fertilizer by State and Crop

High Case

	Illinois			Wisconsin			Minnesota			Iowa			Missouri			Grand
	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Total
1995	467	13	146	146	0	0	215	28	54	369	0	48	50	36	37	1610
1996	604	21	160	199	0	15	276	47	71	491	0	54	116	72	46	2171
1997	599	21	164	196	0	15	272	47	74	487	0	56	113	64	48	2155
1998	602	21	165	199	0	16	280	48	73	495	0	55	112	64	48	2176
1999	604	21	164	198	0	15	280	48	72	497	0	55	113	66	47	2180
2000	604	21	163	199	0	15	280	48	72	498	0	55	113	66	47	2181
2001	604	21	163	199	0	15	281	48	73	496	0	55	112	66	47	2180
2002	601	21	163	200	0	15	280	48	72	496	0	55	112	66	47	2178
2003	601	20	163	200	0	15	280	48	73	497	0	55	113	66	48	2178
2004	603	20	163	201	0	15	281	48	73	497	0	55	112	67	48	2182
2005	603	20	163	202	0	16	280	49	72	496	0	55	112	67	48	2182
2006	604	20	163	202	0	16	282	49	72	496	0	55	112	67	48	2185
2007	603	20	163	204	0	15	281	48	73	497	0	55	112	67	48	2186
2008	602	20	163	205	0	15	282	49	72	495	0	55	112	67	48	2186
2009	602	20	163	205	0	15	282	49	73	496	0	55	112	67	48	2188
2010	601	20	163	205	0	16	282	49	73	496	0	55	112	68	48	2188
2015	601	20	162	210	0	16	284	50	73	496	0	55	111	68	49	2194
2020	603	20	163	213	0	15	284	50	72	495	0	55	111	70	49	2201
2025	602	20	162	216	0	15	286	50	73	494	0	55	110	70	50	2204
2030	603	19	162	220	0	15	288	51	72	495	0	55	110	71	50	2214
2035	603	19	162	224	0	16	288	52	73	494	0	55	110	72	51	2219
2040	601	19	162	228	0	16	289	52	73	494	0	56	110	73	51	2223
2045	600	19	162	231	0	16	290	53	73	493	0	56	110	74	52	2228
2050	601	19	162	234	0	16	292	54	73	494	0	56	109	76	52	2236

Table B-4. Projected Demand for Nitrogen Fertilizer by State and Crop

Low Case

	Illinois			Wisconsin			Minnesota			Iowa			Missouri			Grand
	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Total
1995	1495	126	22	291	0	2	692	182	15	721	0	21	187	89	11	3854
1996	1491	69	18	236	0	0	610	118	9	710	0	15	160	37	8	3481
1997	1493	69	18	232	0	0	601	121	10	705	0	16	158	34	8	3466
1998	1497	70	18	236	0	0	620	121	10	721	0	15	160	34	8	3509
1999	1490	70	18	237	0	0	619	121	10	723	0	15	158	35	8	3506
2000	1491	70	18	236	0	0	620	121	10	722	0	15	156	34	8	3503
2001	1491	69	18	237	0	0	618	121	10	724	0	16	159	35	8	3507
2002	1499	69	18	239	0	0	621	124	10	724	0	15	159	35	8	3522
2003	1500	69	18	241	0	0	622	123	10	723	0	15	157	36	8	3524
2004	1494	69	18	243	0	0	620	125	10	723	0	16	160	33	8	3520
2005	1491	68	18	243	0	0	626	124	10	724	0	16	159	35	8	3523
2006	1490	68	18	245	0	0	621	124	10	724	0	16	158	35	8	3518
2007	1492	70	18	244	0	0	626	126	10	722	0	16	158	36	8	3526
2008	1495	69	18	245	0	0	625	124	10	725	0	16	159	35	8	3528
2009	1493	69	18	247	0	0	624	126	10	724	0	16	159	36	8	3528
2010	1498	70	18	249	0	0	625	124	10	722	0	15	158	35	9	3533
2015	1497	67	18	254	0	0	626	126	10	722	0	16	161	37	9	3541
2020	1489	67	18	260	0	0	634	130	10	722	0	16	158	36	9	3547
2025	1491	66	18	267	0	0	634	131	10	722	0	16	160	38	9	3562
2030	1485	65	18	272	0	0	634	133	10	719	0	16	160	39	9	3560
2035	1485	66	18	277	0	0	642	132	10	721	0	16	158	39	9	3572
2040	1489	65	18	283	0	0	644	134	10	720	0	16	159	40	9	3588
2045	1491	63	18	290	0	0	648	136	10	719	0	16	157	41	9	3598
2050	1485	63	18	292	0	0	649	137	10	716	0	16	160	40	10	3595

Table B-5. Projected Demand for Phosphatic Fertilizer by State and Crop

Low Case

	Illinois			Wisconsin			Minnesota			Iowa			Missouri			Grand
	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Total
1995	604	11	107	153	0	7	263	68	46	467	0	43	58	44	32	1903
1996	602	6	88	124	0	0	232	44	28	460	0	31	50	18	24	1707
1997	603	6	91	122	0	0	229	45	31	457	0	33	49	17	25	1706
1998	604	6	90	124	0	0	236	45	30	467	0	32	49	17	24	1724
1999	602	6	90	125	0	0	235	45	30	469	0	32	49	17	24	1723
2000	602	6	89	124	0	0	236	45	30	468	0	32	48	17	24	1722
2001	602	6	90	125	0	0	235	45	30	469	0	32	49	18	24	1725
2002	605	6	89	126	0	0	236	46	30	469	0	32	49	17	24	1731
2003	606	6	90	127	0	0	237	46	30	468	0	32	49	18	24	1732
2004	603	6	89	128	0	0	236	46	30	468	0	32	50	17	24	1730
2005	602	6	89	128	0	0	238	46	31	469	0	32	49	17	24	1732
2006	602	6	89	129	0	0	236	46	31	469	0	32	49	17	24	1731
2007	602	6	90	128	0	0	238	47	30	467	0	32	49	18	25	1733
2008	604	6	89	129	0	0	237	46	31	469	0	32	49	17	25	1735
2009	603	6	89	130	0	0	237	47	30	469	0	32	49	18	25	1734
2010	605	6	89	131	0	0	238	46	30	468	0	32	49	17	25	1736
2015	604	6	89	133	0	0	238	47	30	467	0	32	50	18	25	1741
2020	601	6	89	136	0	0	241	48	31	468	0	32	49	18	26	1744
2025	602	6	89	140	0	0	241	49	31	468	0	33	50	19	26	1751
2030	600	6	89	143	0	0	241	49	31	466	0	33	50	19	26	1751
2035	600	6	89	145	0	0	244	49	30	467	0	33	49	19	26	1757
2040	601	6	88	149	0	0	245	50	31	466	0	33	49	20	27	1764
2045	602	5	88	152	0	0	246	51	31	466	0	33	49	20	27	1770
2050	599	5	88	154	0	0	247	51	31	464	0	33	50	20	28	1768

Table B-6. Projected Demand for Potassic Fertilizer by State and Crop

Low Case

	Illinois			Wisconsin			Minnesota			Iowa			Missouri			Grand
	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Corn	Wheat	Soy	Total
1995	467	13	146	146	0	8	215	28	54	369	0	48	50	36	37	1618
1996	466	7	120	119	0	0	189	18	33	363	0	35	43	15	28	1436
1997	467	7	123	117	0	0	187	19	36	361	0	37	42	14	29	1437
1998	468	7	123	118	0	0	193	19	36	369	0	36	43	14	28	1452
1999	466	7	122	119	0	0	192	19	35	370	0	36	42	14	28	1451
2000	466	7	121	119	0	0	193	19	35	370	0	35	42	14	28	1449
2001	466	7	122	119	0	0	192	19	35	371	0	36	42	14	28	1452
2002	469	7	121	120	0	0	193	19	36	371	0	35	42	14	28	1456
2003	469	7	122	121	0	0	193	19	35	370	0	36	42	15	28	1458
2004	467	7	122	122	0	0	193	19	35	370	0	36	43	14	29	1456
2005	466	7	122	122	0	0	195	19	36	371	0	36	42	14	28	1458
2006	466	7	122	123	0	0	193	19	36	371	0	36	42	14	29	1457
2007	466	7	122	123	0	0	195	20	35	369	0	36	42	14	29	1458
2008	467	7	121	123	0	0	194	19	36	371	0	36	42	14	29	1460
2009	467	7	121	124	0	0	194	19	35	370	0	36	42	14	29	1459
2010	468	7	121	125	0	0	194	19	35	369	0	36	42	14	29	1461
2015	468	7	121	127	0	0	194	20	36	369	0	36	43	15	29	1465
2020	465	7	121	130	0	0	197	20	36	370	0	36	42	15	30	1468
2025	466	7	121	134	0	0	197	20	36	370	0	36	43	16	30	1474
2030	464	7	121	137	0	0	197	21	36	368	0	36	43	16	30	1475
2035	464	7	121	139	0	0	200	21	36	369	0	36	42	16	31	1480
2040	466	7	120	142	0	0	200	21	36	368	0	36	42	16	31	1486
2045	466	6	120	145	0	0	201	21	36	368	0	36	42	16	32	1491
2050	464	6	120	147	0	0	202	21	36	367	0	36	43	16	32	1490