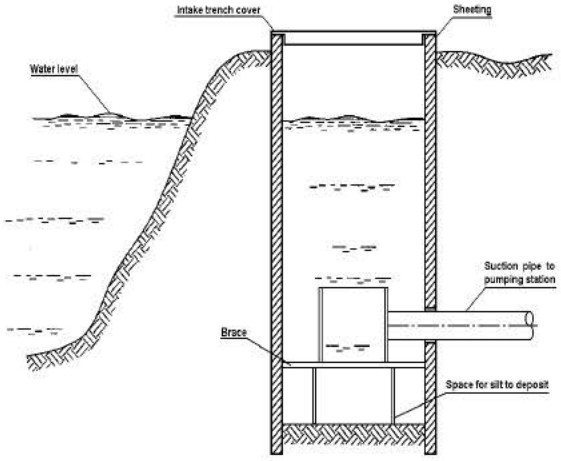
US Army Corps of Engineers®
Lakes and Rivers Division

2 May 2011

Value of the Ohio River Navigation System as a Source of Water Supplies for Municipal and Industrial Users

An intake structure for a water-supply plant on the Duck River, TN.
http://toxics.usgs.gov

Diagram of a trench-style intake.
http://www.hohusa.net



Executive Summary

The Ohio River Navigation System is used extensively as a source of water supply by municipalities and industrial facilities. The estimated benefits to water supply users are approximately $741.5 million per year, which qualifies them as major beneficiaries of the system. The water supply benefits are equal to approximately one-fourth of the approximate $3 billion per year in inland navigation benefits.

The Ohio River Navigation System measures 2,736 miles in length with an authorized depth of 9 feet and an authorized width of 300 feet. The system was created by the construction of locks and dam projects with the dams creating deep pools behind the dam and the locks allowing passage between the pools. There are currently 72 federally owned locks and dam projects in the Ohio River navigation system (Attachment 1): 56 have operational locks and 63 have pools with active water intakes.

The number of intakes totaled 394 in 2008, with 20 of the intakes inactive and 374 active. The amount of water withdrawn averaged 25.9 billion gallons a day (bgd), which represents 8 % of national fresh water usage (see Attachment 2). A breakdown of the amount of water withdrawn by river is provided in Table E-1.

Table E-1: Water supply withdrawals – volume and value

River	Navigable Length in miles	Number of active locks and dam projects	Withdrawals (mgd)	Water Supply Benefits of Navigation System ($ millions at Oct. 2010 price level)
Allegheny	72.0	8	535.5	$ 15.3
Cumberland	381.0	4	3,183.7	$ 91.0
Green	102.9	2 of 4	298.2	$ 8.5
Kanawha	90.6	3	436.1	$ 12.5
Kentucky	259.0	0 of 14	29.4	$ 0.8
Monongahela	130.1	9	1,087.2	$ 31.1
Ohio	987.0	20	10,607.5	$ 303.1
Tennessee	652.1	9	9,774.2	$ 279.3
Total:	**2,736.3**	**56**	25,951.7	$ 741.5

Note: Kentucky River has 14 lock and dam projects; none of locks is operational.
Green River has 4 lock and dam projects but two of locks are not operational.
Clinch River is a tributary of the Tennessee and is included in Tennessee data.

Nearly all the water withdrawn from the Ohio River system is for municipal and industrial uses. As shown in Table E-2, municipal users accounted for 2.4 percent of the water withdrawn and industrial users for 97.6 percent. Electric generating plants alone account for 94.9 percent of all withdrawals. Nearly the entire electric grid east of the Mississippi River would be at risk of disruptions if the electric generating plants were unable to withdraw water from the navigation pools.

Table E-2: Municipal and Industrial Withdrawals for the System			
Type	**# of intakes**	**Ave. daily withdrawals (mgd)**	**Max allowable withdrawals (mgd)**
Municipalities	170	613.4	1,009.9
Industrial – total	224	25,338.3	37,657.7
- electric power plants	75	24,635.6	36,267.0
- other industrial plants	149	702.7	1,390.7
Total:	**394**	**25,951.7**	**38,667.6**

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Attachments

Value of the Ohio River Navigation System as a Source of Water Supplies for Municipal and Industrial Users

1. Purpose of Study

The purpose of this study was to estimate the value of the Ohio River Navigation System as a source of water supply. The study built upon data compiled in 2008 that included a list of intake facilities that withdraw water from the Ohio River Navigation System. The list included the name of the owner of the intake, the location of the intake, and the volumes of water withdrawn. The 2008 study was supplemented in 2009 with additional intake information and survey information. The list of intakes was slightly modified and the value of the water withdrawn was updated to Oct 2010 price levels. The updated information is presented in this report.

2. Study Procedure

The 2008 effort proceeded in the following manner:

1. Compile a list of all water intakes withdrawing water from navigation pools in the Ohio River Basin;
2. Determine actual and maximum withdrawals amounts through each intake; and
3. Estimate the value of water in terms of:
    - 3.1 storage costs; and
    - 3.2 benefits.

Step 1 - inventory water intakes –the critical first step in the study from which all other steps followed. The inventory was obtained from U.S. Army Corps of Engineers navigation charts and permits files.

Step 2 - inventory actual and maximum withdrawals –necessary to determine the volume of water withdrawn by the intake. The withdrawal data were obtained from state regulatory agencies and responses from intake owners.

Step 3 – value the water:

Step 3.1 – obtain contract data on the cost per gallon charged by the Corps in its contracts with municipal and industrial users.

Step 3.2 – compute the difference in market price between withdrawing water from the river and from the least cost alternative source.

3. Sources of data

Five sources provided most of the data used in the 2008 study:

1. Navigation charts – water intakes
2. Permit files – water intakes
3. State permitting agencies – actual and maximum withdrawals
4. Surveys of users – actual and maximum withdrawals; effects of lost supplies
5. Harris business directory – jobs and sales by industrial facilities at risk

Navigation charts for each District are available on the Districts' web site. Permit files are maintained by each District's Regulatory Section of each permit granted by the Corps for construction along a waterway. Actual and maximum water withdrawals through each intake were obtained from State agencies, which are responsible for setting the maximum withdrawals by each user and monitoring the amounts withdrawn to ensure compliance. Withdrawal information was supplemented and verified by contacting the permit owners, who were also queried on the impact and reaction to a loss of water. The Harris business directory was used to acquire information on employment and sales for each of the waterside production facilities. Information on customers for municipal withdrawers of water was obtained from web sites and phone queries.

Table 1: Sources of Water Intake Data

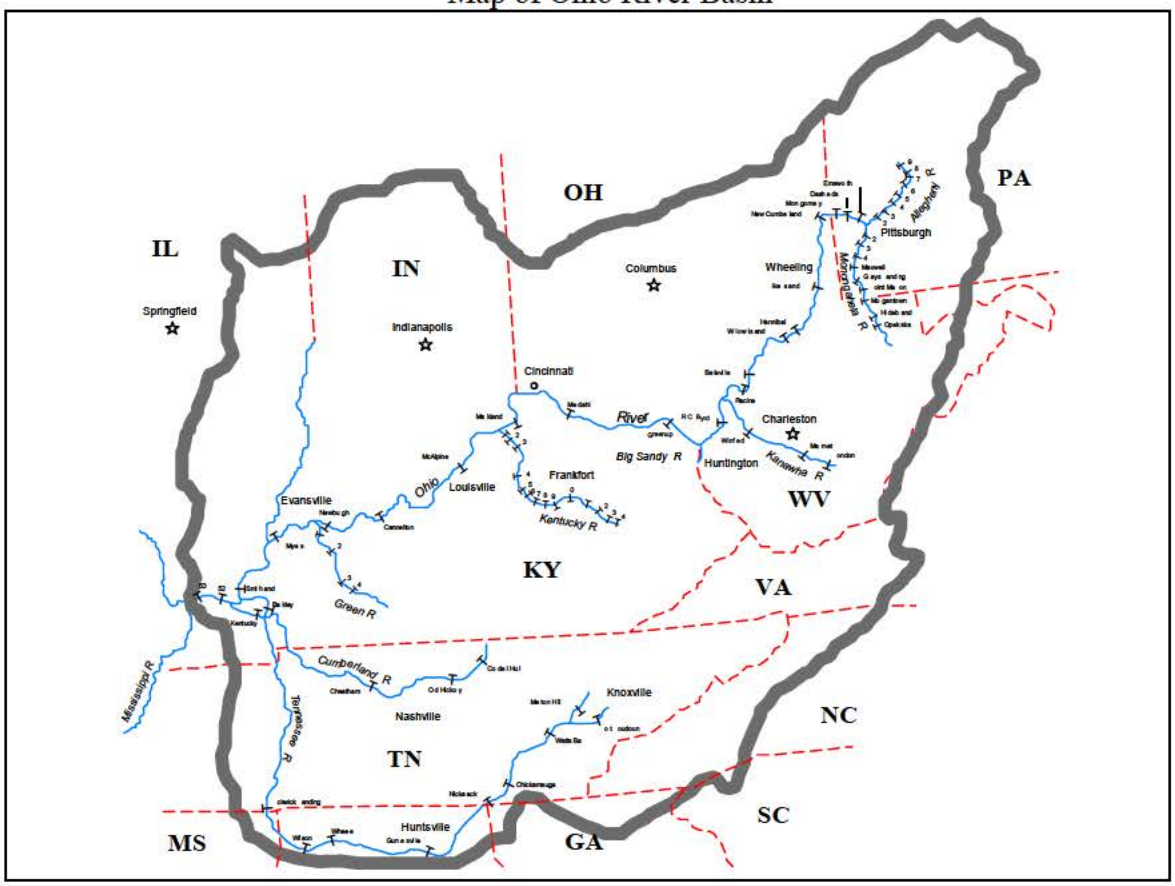
	Data		
1	Water intakes	Corps' navigation charts	http://www.lrd.usace.army.mil/navigation/navcharts/#cprPurchase%20Maps:
2	Actual and maximum allowable withdrawals	Pennsylvania Ohio TVA Tennessee	Thomas Denslinger – PADEP (717) 772-5679 Michael Hallfrisch – ODNR (614) 265-6745 Michael Eiffe, P.E – TVA (865) 632-3074 Thomas A. Moss, P.G. - TN Division of Water Supply (615) 532-0191
3	Impacts of loss of water supplies	Survey of owners of intakes	
4	Inventory of industries	Harris business directory	

4. Study Area

The study area is the area in and along the banks of the Ohio River and its navigable tributaries, which are the Monongahela, Allegheny, Kanawha, Green, Kentucky, Cumberland,

Clinch (tributary of Tennessee), and Tennessee Rivers. A list of navigation projects in the area is provided as Attachment 1 and a map of the area is provided below.

Map of Ohio River Basin



5. Inventory of Water Intakes and Withdrawals

The 2008 development of an intake inventory began with a compilation of water intakes as entered on the Corps's navigation charts. The resulting list was then verified and supplemented by records maintained in the permit files for all permits granted in the Pittsburgh, Huntington, Louisville, and Nashville District offices. Other information entered into the data base for each intake included the river, pool, river mile, bank, elevation of the intake (if available), holder of the permit, and contact information. A complete list of the intakes is provided in Attachment 2.

A summary of the water supply withdrawal information for the Ohio River and its navigable tributaries is provided in Table 2. Total withdrawals amounted to over 25.9 billion gallons a day in 2008, or about 6.4 percent of national freshwater usage (Attachment 3). Eighty-one percent of the withdrawals are from the Ohio and Tennessee Rivers.

Table 2: Ohio River Basin Water Withdrawals by River			
River	**# of intakes**	**Ave. daily withdrawals (mgd)**	**Max allowable withdrawals (mgd)**
Allegheny	19	535.5	758.3
Cumberland	49	3,183.7	3,346.7
Green	13	298.2	441.5
Kanawha	40	436.1	792.8
Kentucky	6	29.4	41.7
Monongahela	26	1,087.2	1,920.0
Ohio	137	10,607.5	16,150.4
Tennessee	104	9,774.2	15,216.1
Total:	**394**	**25,951.7**	**38,667.6**

Water withdrawal information for each navigation pool on each river is listed in Tables 3 through 11 below. The rivers are listed alphabetically. The pool with the largest volume of withdrawals is the New Cumberland pool on the Ohio River, near New Cumberland, West Virginia.

5.1 Allegheny River

The Allegheny River is located in Pennsylvania and joins with the Monongahela River at Pittsburgh, PA, to form the Ohio River. The river ranks seventh out of the nine rivers in the volume of withdrawals. There are 19 active intakes in the river with the largest volume of withdrawals from the L&D 3 pool.

Table 3: Allegheny River: Water Intakes by Pool				
River	**Pool**	**# of intakes**	**Ave. daily withdrawals (mgd)**	**Max allowable withdrawals (mgd)**
Allegheny				
	Emsworth	1	13.0	13.0
	L/D 2	4	97.2	144.0
	L/D 3	5	261.9	393.7
	L/D 4	3	2.6	5.3
	L/D 5	0	0.0	0.0
	L/D 6	1	0.6	3.0
	L/D 7	2	0.8	1.5
	L/D 8	1	154.2	191.5
	L/D 9	2	5.3	6.3
Total:		19	535.5	758.3

5.2 Cumberland River

The Cumberland River lies largely within the state of Tennessee. The river ranks third out of the nine rivers in the volume of withdrawals. There are 49 active intakes in the river with the largest volume of withdrawals from the Barkley pool.

Table 4: Cumberland River: Water Intakes by Pool				
River	**Pool**	**# of intakes**	**Ave. daily withdrawals (mgd)**	**Max allowable withdrawals (mgd)**
Cumberland				
	Ohio L/D 52	1	0.5	0.3
	Barkley	15	2,092.6	2,099.8
	Cheatham	9	109.6	219.6
	Cordell Hull	5	1.6	3.3
	Old Hickory	19	979.4	1,23.6
Total:		49	3,183.7	3,346.7

5.3 Green River

The Green River is a tributary of the Ohio River located in southwestern Kentucky. The river ranks eighth out of the nine rivers in withdrawals. There are 13 intakes on the river with the largest volume of withdrawals from the L/D 2 pool.

Table 5: Green River: Water Intakes by Pool				
River	**Pool**	**# of intakes**	**Ave. daily withdrawals (mgd)**	**Max allowable withdrawals (mgd)**
Green				
	L/D 1	7	92.2	214.5
	L/D 2	6	205.9	227.0
	L/D 3	0	0.0	0.0
Total:		**13**	**298.2**	**441.5**

5.4 Kanawha River

The Kanawha River is a tributary of the Ohio located in West Virginia. The river ranks sixth out of the nine rivers in withdrawals. There are 44 intakes on the river with the largest volume of withdrawals from the Marmet pool, near Charleston, WV.

Table 6: Kanawha River: Water Intakes by Pool				
River	**Pool**	**# of intakes**	**Ave. daily withdrawals (mgd)**	**Max allowable withdrawals (mgd)**
Kanawha				
	Winfield	20	81.6	148.3
	Marmet	13	354.5	644.5
	London	7	0.0	0.0
Total:		**44**	**436.1**	**792.8**

5.5 Kentucky River

The Kentucky River ranks ninth out of the nine rivers in terms of the amount of water withdrawn on a daily basis. There are 6 intakes on the river. The largest volume of water withdrawn from the river is from the L/D 4 pool. The sole purpose of the navigation projects is to maintain the navigation pools; the locks are not operable and there is no commercial navigation.

Table 7: Kentucky River: Water Intakes by Pool				
River	**Pool**	**# of intakes**	**Ave. daily withdrawals (mgd)**	**Max allowable withdrawals (mgd)**
Kentucky				
	L/D 1	0	0.0	0.0
	L/D 2	1	0.0	0.4
	L/D 3	0	0.0	0.0
	L/D 4	2	20.1	21.5
	L/D 5	3	9.2	19.8
Total:		**6**	**29.4**	**41.7**

5.6 Monongahela River

The Monongahela River is largely located in Pennsylvania where it flows north to Pittsburgh, Pa, where it merges with the Allegheny River to form the Ohio River. The river ranks fifth out of the nine rivers in terms of the amount of water withdrawn on a daily basis. There are 26 intakes on the river with the largest volume of withdrawals from the L/D 3 pool.

Table 8: Monongahela River: Water Intakes by Pool				
River	**Pool**	**# of intakes**	**Ave. daily withdrawals (mgd)**	**Max allowable withdrawals (mgd)**
Monongahela				
	Emsworth	1	60.0	60.0
	L/D 2	4	286.9	517.1
	L/D 3	3	558.6	935.2
	L/D 4	6	9.2	16.5
	Maxwell	5	33.7	72.7
	Grays Landing	2	0.5	0.9
	Point Marion	3	87.0	164.2
	Morgantown	1	12.0	21.8
	Hildebrand	0	0.0	0.0
	Opekiska	1	39.3	131.7
Total:		**26**	**1,087.2**	**1,920.0**

5.7 Ohio River

The Ohio River ranks first out of the nine rivers in terms of the amount of water withdrawn on a daily basis. There are 137 intakes on the river with the largest volume of withdrawals from the New Cumberland pool.

Table 9: Ohio River: Water Intakes by Pool				
River	**Pool**	**# of intakes**	**Ave. daily withdrawals (mgd)**	**Max allowable withdrawals (mgd)**
Ohio				
	Emsworth	3	50.1	91.2
	Dashields	2	6.2	20.0
	Montgomery	2	81.9	100.8
	New Cumberland	5	2,426.5	4,304.7
	Pike Island	14	1,369.3	1,533.9
	Hannibal	7	308.8	561.0
	Willows Island	10	102.5	231.6
	Belleville	8	254.5	1,520.4
	Racine	2	0.0	0.0
	R C Byrd	4	1,221.3	1,221.3
	Greeup	16	19.4	19.4
	Meldahl	6	278.3	506.8
	Markland	11	1,281.0	1,781.1
	McAlpine	12	1,276.9	1,613.9
	Cannelton	12	767.4	1,187.1

	Newburgh	8	499.7	640.3
	J.T. Meyers	8	5.7	10.4
	Smithland	2	0.0	0.0
	L/D 52	1	0.0	0.0
	L/D 53	4	658.0	806.4
Total:		**137**	**10,607.5**	**16,150.4**

5.8Tennessee River

The Tennessee River is located in Tennessee and ranks second to the Ohio in terms of navigable river miles. The river ranks second out of the nine rivers in terms of withdrawals. There are 104 intakes on the river with the largest volume of withdrawals from the Watts Bar pool. The Clinch River is a tributary of the Tennessee that has the Melton Hill project located on it. Intakes on the Clinch River above and below Melton Hill are included with the Tennessee River data.

Table 10: Tennessee River: Water Intakes by Pool

River	Pool	# of intakes	Ave. daily withdrawals (mgd)	Max allowable withdrawals (mgd)
Tennessee				
	Kentucky	21	1,243.0	2,351.8
	Pickwick	6	1,323.4	1,337.8
	Wilson	3	0.0	0.0
	Wheeler	16	2,107.3	3,837.5
	Guntersville	20	1,504.4	2,803.3
	Nickajack	5	3.6	6.7
	Chickamauga	7	1,732.0	2,993.5
	Watts Bar	9	6.8	15.7
	Ft. Loudoun	7	5.2	11.8
	Clinch - Melton Hill	8	568.7	574.8
	Clinch - Watts Bar	2	1282.1	1283.2
Total:		**104**	**9,774.2**	**15,216.1**

6. Municipal and industrial water withdrawals

The two principle users of water withdrawn from the pools created by the Ohio River navigation system dams are municipalities (cities and towns) and industrial facilities. Little is withdrawn for irrigation purposes. Of the two users, municipalities accounts for 2.4 percent of the withdrawals and industrial facilities accounts for 97.6 percent, as shown by the data in Table 11. The largest portion of industrial withdrawals at 94.9 percent is made by electric generating plants.

Table 11: Municipal and Industrial Water Withdrawals from the Ohio System			
Type	**# of intakes**	**Ave. daily withdrawals (mgd)**	**Max allowable withdrawals (mgd)**
Municipalities	170	613.4	1,009.9
Industrial – total	224	25,338.3	37,657.7
- electric power plants	75	24,635.6	36,267.0
- other industrial plants	149	702.7	1,390.7
Total:	**394**	**25,951.7**	**38,667.6**

A breakdown of water withdrawals by municipalities and industries for each river is shown in Table 12. The river with the largest amount of municipal withdrawals is the Tennessee River and the river with the largest amount of industrial withdrawals is the Ohio River.

Table 12: Municipal and Industrial Water Withdrawals by River			
Type	**# of intakes**	**Ave. daily withdrawals (mgd)**	**Max allowable withdrawals (mgd)**
Allegheny			
Municipal	13	124.6	183.8
Industrial	6	410.9	574.5
Subtotal:	**19**	**535.5**	**758.3**
Cumberland			
Municipal	33	153.7	307.4
Industrial	16	3,030.0	3,039.2
Subtotal:	**49**	**3,183.7**	**3,346.7**
Green			
Municipal	7	14.4	17.4
Industrial	6	283.8	424.1
Subtotal:	**13**	**298.2**	**441.5**
Kanawha			
Municipal	9	0.0	0.0
Industrial	31	436.1	792.8
Subtotal:	**40**	**436.1**	**792.8**
Kentucky			
Municipal	2	29.1	35.0
Industrial	4	0.3	6.7
Subtotal:	**6**	**29.4**	**41.7**
Monongahela			
Municipal	16	172.6	244.1
Industrial	10	914.6	1,676.0
Subtotal:	**26**	**1,087.2**	**1,920.0**
Ohio			

Municipal	33	44.3	82.5
Industrial	104	10,563.2	16,067.9
Subtotal:	**137**	**10,607.5**	**16,150.4**
Tennessee			
Municipal	51	74.8	139.7
Industrial	53	9,699.4	15,076.4
Subtotal:	**104**	**9,774.2**	**15,216.1**
Total:	**394**	**25,951.7**	**38,667.6**

Surveys were conducted in 2008 and 2009 to acquire information on the affects of pool draw downs and possible alternatives sources of water (Attachment 4). The results are summarized below.

6.1 Municipalities

All of the 120 owners of municipal water intakes were surveyed regarding the impact of the possible loss of water supplies. Most responded that there were no alternatives to river withdrawals that could provide all or even a significant portion of the water they require. If there was a temporary reduction in water supplies, municipalities would conserve water by implementing restriction on water usage (see Attachment 5).

6.2 Industrial plants

The industries that withdraw water from the river system were contacted to verify the water withdrawal related data and to understand how they would be affected by a potential loss of pool. Six questions were asked of each contact:

1) the average daily withdrawal rate;
2) the maximum allowable withdrawal;
3) customers served (if municipality);
4) effect of a loss of water supply;
5) contingency plan for loss of river water; and
6) the costs of alternatives for obtaining replacement water supplies.

The responses related to reduced supplies are summarized in Table 13.

Table 13: Response to potential loss or reduction in water supplies

	TOTAL
Out of business/ Closure	51
Run at lowered capacity	9
No effect	30
Large monetary cost	20

Assistance from other intakes	7
Catastrophic	13
No idea	11
Total:	**141**
* Not all owners were able to be contacted	

The response of roughly one third of the answers is they would be forced to close, which partially reflects the dependence of production on water, particularly by the electric generating plants.

The responses are skewed by the fact that the preponderance of withdrawals are by electric generating plants and that operations at these plants is almost totally dependent on large and reliable water supplies. Withdrawals by electric generating plants and river are listed in Table 14. A list of the individual electric generating plants located along the river system is provided in Attachment 6. A list of all waterside plants with intakes is provided in Attachment 7.

Table 14: Water Consumption by Electric Generating Plants

River	# of plants	withdrawals (mgd)
Allegheny	3	409.5
Cumberland	3	3,015.8
Green	4	1.2
Kanawha	4	354.5
Kentucky	0	0.0
Monongahela	7	671.5
Ohio	44	6,060.3
Tennessee	10	7,715.0
Total:	**75**	**24,635.6**

7. Benefit of navigation pools as a source of water

The major comment with regard to the 2008 study was the need to further investigate the costs and benefits of the river system as a source of water supply. The results of further investigation and the updated values are presented in this section.

The benefits of water supplies from a particular source are measured as the difference in the cost of acquiring water from the particular source (a reservoir for example) and the cost of acquiring water from the least cost alternative source. The first problem with regard to estimating the benefits of withdrawing water from navigation pools is determining a reasonable cost and approximate price. Currently, water can be withdrawn from the Ohio River and its tributaries water at no cost other than the cost of acquiring and installing pipes and pumps. All that are needed are state and Federal permits, with the state permits governing the volume of withdrawals and the Federal permits governing the construction of

facilities along and in the river. Therefore it was necessary to estimate a "market" price for water. The price was estimated based on comparable prices charged for water sold from Corps reservoirs while the benefits were estimated as the difference between the Corps reservoir price and the cost of the least cost alternative. The cost for water from the least cost alternative source is unknown, but in cases of large water users there are no reasonable alternatives so the cost is not typically a marginal difference but a quantum difference. Where respondents indicated they would close if water from the river was not available, it was conservatively assumed that the cost of the alternative was two-times the Corps reservoir cost. In essence, the benefits equal the average costs for those that withdraw water from Corps reservoirs. The estimate is conservative in the sense that the real cost of the alternative is likely to be much higher and the benefits would therefore also be much higher. The process followed to estimate the "costs" and "benefits" for this effort was as follows:

1. Acquire water price data from available sources
2. Estimate market price for water
3. Estimate cost of least cost alternative source
4. Calculate benefits as difference between market and alternative costs
    4.1 Estimate benefits foregone for short term drawdown
    4.2 Estimate benefits foregone for permanent loss of pool

7.1 Market price of navigation system water supplies

The first step in estimating a fair market price for water withdrawn from the river system was to acquire data that could be of use in the valuation effort. The effort yielded four primary sources:

1) a water supply contract dated 2010 developed by Pittsburgh District;
2) list of prices charged by the Corps for eighty-two water storage contracts managed by the Corps;
3) the cost to municipal and industrial users of a pool extending pipes further into the river to withdraw water in the event of a drawdown of the Emsworth pool; and
4) the water storage value used in the nationwide Portfolio Risk Assessment (PRA) studies.

The first two sources listed above provided "market price" estimates based on updated project construction costs, which is the approved Corps methodology for calculating the price to charge industries and municipalities that want to purchase water storage space in Corps reservoirs. The value from the Emsworth study represents the cost of extending pipes to deeper parts of the pool and the additional pumping costs if necessitated by a pool drawdown. The PRA value was developed by Corps employees in the Seattle District for estimating the water storage benefits of dams evaluated in a nationwide study of the condition of Corps dams. A more detailed description of the cost data from each source is provided in Attachment 8.

Cost data related to water storage from each source is listed in Table 15. The first item is the capital cost of constructing a dam that provides an acre foot of storage. The capital cost developed from the Corps contracts is $470 per acre foot, which is one half the cost from the PRA and Pittsburgh contract and one-twentieth the cost from the pipeline extension.

Purchasers of water storage space can either make a one-time lump sum payment or can make annual payments based upon a 30 year or less payback period and the current discount rate. For this effort the payback period was 30 years and the interest rate was 7%. The average annual equivalent construction costs are listed in column (2) of the table. For example, $38 is the payback that would be made in each of the 30 years that is the equivalent of a one-time up-front payment of $470 (Corps contracts).

One acre-foot holds 325,851.8 gallons of water and 3.069 acre-feet hold 1 million gallons. A reservoir of water with no inflows or outflows other than the withdrawal of 1 million gallons a day for 365 days would have to be 1,120 acre feet in size (3.1 acf x 365 days) to hold the required 365 million gallons of water withdrawn over the course of the year. Of course to be sustainable the reservoir has to be replenished with inflows that average at least 1 million gallons a days over 365 days, and more given evaporation and other losses of water. Without going into the math, it would require an average net inflow of 1.55 cubic feet per second (cfs) to replenish the reservoir in the amount of 1 million gallons per day. The net inflow determines the yield per acre foot measured over some time period, which largely accounts for differences in the price per gallon of water.

The average annualized cost of providing 1,120 acre feet of storage is listed in column (3). It was computed by multiplying the annualized cost per acre foot listed in column 2 by 1,120 acre feet. Different rates of inflow allow different volumes to be withdrawn from the storage space, as indicated by the yield index listed in column 4. The higher the index the greater is the volume that can be withdrawn from a given storage space. This affects the volume of storage required for the withdrawal of a given amount, in this case 1 mgd. The yield adjusted annual cost for the storage space required for 1 mgd is listed in (5) and is $28,632 compared to a cost of $42,461 with no adjustment for yield.

The costs are expressed in terms of millions of gallons and gallons in columns (6) and (7) with the approximate cost per million gallons lying between $78.4 and $1,382.3. Dividing the cost per million gallons by one million results in an annualized cost per gallon of $0.000078, as shown in column (7) on the “Corps contracts” line. Prices in the literature are often expressed as dollars per thousand gallons. The cost per thousand gallons is 7.8 cents.

Step 2 was the selection of the “cost data” in the table that was the most reasonable approximation of the “cost” of Ohio River water supplies. The “cost” listed in Table 18 for Corps contracts was selected as the best since it is an approximation of the amount the Corps would charge for water from navigation pools if it used the same pricing procedure as used to price water storage in its reservoirs. The price of a million gallons is $78.4 and the price of a gallon is $0.000078. This is somewhat less than one-tenth of a mill per gallon ($0.001). Expressed differently, one dollar buys 12,755 gallons. The “goodness of fit” of this price in terms of applicability to ORS navigation pools and water storage within the pools depends

largely on the difference between the construction cost of reservoirs and navigation dams, and in differences in yield factors. The latter difference is thought to be the larger of the two differences, since most Corps water storage reservoirs are located in areas of relatively low annual precipitation whereas the navigation dams are located in areas of relatively high annual precipitation. Higher inflows and higher yields would lower the cost below those listed in the table, in some cases by 50% to 75% based on observed flows (cfs) on the Tennessee River.

Table 15: Summary listing of costs from all sources

($ Oct 2010 price level)

Source	Capital cost per ACF	Annualized cost per ACF	Annualized cost for 1,120 acf needed for 1 mgd	Yield factor	Annualized cost for 1,120 acf needed per year for 1 mgd adjusted for yield	Cost per million gallons	Cost per gallon
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	(from data)	(7%; 30 yr)	1,120	(Productivity)		365	1000000
		(0.081 x (1))	(1,120 x (2))	(from data)	((3) / (4))	((5) / 365)	((6) / 1,000,000))
PRA	$ 755	$ 61	$ 68,142	1.5	$ 45,949	$ 125.9	$ 0.000126
Pittsburgh contract	$ 908	$ 73	$ 81,922	1.9	$ 43,026	$ 117.9	$ 0.000118
Pipe extention	$ 8,290	$ 668	$ 748,250	1.5	$ 504,553	$ 1,382.3	$ 0.001382
Corps contracts	$ 470	$ 38	$ 42,461	1.5	$ 28,632	$ 78.4	$ 0.000078
Average	$ 2,606	$ 210	$ 235,194	1.6	$ 155,540	$ 426.1	$ 0.000426

7.2 Price of water from least cost alternative source

Step 3 involved the estimation of the cost of water from the least cost alternative sources. The necessity and willingness to pay for alternative sources of water given a pool drawdown were obtained from responses to a survey. A summary of the responses is provided in Table 16. The response is keyed to the elevation of the withdrawal pipes with the "not affected" being those in the deepest part of the pool that would still contain water even with a pool drawdown. For many users the response was that there is no alternative to the navigation pools for the volumes of water they require.

Table 16: Survey response to draw down in pool

Response	Number	MGD	% of subtotal
Affected	100	11,567.7	71.8%
Not affected	30	4,534.5	28.2%
Subtotal	130	16,102.2	
No response	264	9,849.6	
Total	394	25,951.7	

A follow up question considered alternatives if there was a prohibition of withdrawals from a basically "native" river. The prohibition could be either temporary or permanent, depending largely on flow conditions. Given environmental concerns, permits often restrict withdrawals during low flow periods when water is most likely to be in high demand for weather related industries, such as the electric industry that powers air conditioners during hot weather. Thus many industries would be most vulnerable during their most critical periods of demand. The response of those "not affected" by a drawdown to a prohibition of withdrawals is summarized in Table 17. For nearly all users there are no alternatives to withdrawing from the navigation pools.

Table 17: Survey of "not affected" to drawdown to a total prohibition of withdrawals

Response	Number	MGD
Alternatives available	6	36.2
No alternatives available	33	16,888.5
Subtotal	39	16,924.7
No response	355	9,027.0
Total	394	25,951.7

The average cost of water from the least cost alternative source was then computed in the following manner with the values listed in Table 18. For a temporary loss of pool and given that most users are large power plants and the predominant response of those "affected" was that no alternative existed, the cost was set at twice the market price of $78.4 per million gallons, or $156.9. In effect this means the benefits are assumed to be equal to the average cost of water sold from Corps reservoirs. For those "unaffected" by a pool drawdown the cost of the least cost alternative was set at the existing market price, which means the benefits of maintaining the navigation pools are zero. An average cost of water for the least cost alternative was then computed as a volume weighted average of the two costs, i.e. twice the market price and zero. The cost computed for the least cost alternative source of supply for a temporary drawdown was $134.8 per million gallons. The average cost for the least cost alternative given a permanent loss of pool was $156.7 per million gallons.

Table 18: Cost of water from alternative sources
(cost per million gallons)

	Temporary draw down		Permanent loss of pool	
	Weight	Cost	Weight	Cost
Affected	71.8%	$ 156.9	99.8%	$ 156.9
Not affected	28.2%	$ 78.4	0.2%	$ 78.4
Weighted average		$ 134.8		$ 156.7
Cost of affected are twice market price, or 2 x $78.4 per million gallons.				

7.3 Benefits of navigation pools as a source of water supplies

The fourth and final step was to compute the benefits of the Ohio River system as a source of water supply. The benefits were calculated as the difference in estimated costs per gallon for water withdrawn from the navigation pools based on reservoir costs, compared to the least cost alternative source of water. The benefits are listed in the Table 19.

Table 19: Costs and Benefits of Ohio River Navigation System as a Source of Water Supply
($ per million gallons; annualized dollar values; $Oct 2010)

	Price for water from least cost alternative source	
	Temporary draw down	Permanent loss of pool
Least cost alternative source – no withdrawals allowed	$ 156.9	$ 156.9
Least cost alternative source –withdrawals allowed	$ 134.8	$ 156.7
	Price for water from navigation pools	
ORS pools	$ 78.4	$ 78.4
	Benefit of Avoiding drawdown or loss of pool	
Least cost alternative source – no withdrawals allowed	$ 78.4	$ 78.4
Least cost alternative source –withdrawals allowed	$ 56.4	$ 78.3
Note: inexact math is a result of rounding.		

The benefits foregone assuming withdrawals are allowed to continue given a drop in pool levels are $56.4 per million gallons for a temporary drawdown and $78.3 per million gallons for a permanent loss of pool. The benefits considering the actual withdrawal of 25,951.7 mgd are listed in Table 20.

Table 20: Benefits of Ohio River Navigation System as a Source of Water Supply
(annualized dollar values; $Oct 2010)

	Temporary draw down	Permanent loss of pool
Millions of gallons per day	25,951.7	25,951.7
Millions of gallons per year	9,472,372.5	9,472,372.5
	Benefits per million gallons	
Least cost alternative source – no withdrawals allowed	$ 78.4	$ 78.4
Least cost alternative source –withdrawals allowed	$ 56.4	$ 78.3
	Annual benefits of ORS as a source of water supplies	
	Temporary draw down	Permanent loss of pool
Least cost alternative source – no withdrawals allowed	$ 743,055,107	$ 743,055,107
Least cost alternative source –withdrawals allowed	$ 533,805,229	$ 741,465,797

8. Sensitivity

The estimated value and benefits of the Ohio River Navigation System as a source of water supplies is an approximation based on the best available data, but still within a probable wide range of uncertainty. Two items of known significant affects on the estimates are the interest rates used to convert construction costs into average annual costs, and the cost of the least cost alternative. The benefits of the system listed in the previous report dated in 2009 were $953.5 million, compared to $741.5 million in this paper. The reason is nearly entirely due to the interest rate used in the computations, which was 10% in the 2009 report and is 7% in this report. The higher 10% rate yields higher average annual costs of water than the lower 7% rate used in this report. The 10% rate was used in the 2009 report for convenience since all of the cost numbers were rough approximations. The use of 7% in the current report was done to be consistent with the rate recommended by OMB for computation of project economics. Neither one is right or wrong but merely different. Moreover both of the rates may be too high, given that the current rate used in water supply studies is 4 1/8%. As shown in Table 21, the annual benefits using an interest rate of 10% are $976.0 million, or nearly the same as those in the 2009 report of $953.5 million. The annual benefits using an interest rate of 4 1/8 % are $540.2 million, or 27 percent lower than those estimated using an interest rate of 7%.

A second area of high uncertainty is the cost of the least cost alternative solution in the event of the losses of the navigation pools as sources of water supplies. The simple procedure used in the report was to assume that the cost of the least cost alternative was twice the cost of water storage in the navigation pools. In effect, this makes the benefits of the system equal to the cost of water storage in the system for withdrawal purposes. The only available cost for a least cost alternative is the cost of extending the withdrawal pipes further into the river. The estimated cost was 17 times higher than the estimated cost of water storage in the navigation pools. While significantly higher, this cost may be representative of the true cost of alternatives, particularly given that coal-fired and nuclear electric generating plants are the primary withdrawers of water, and that are unlikely to shut down on a permanent basis until they exhausted every possible alternative source of water. This is true for several reasons, which include the large capital investments in the plant – on the order of $10 billion for nuclear plants and the difficulty if not impossibility of obtaining permits to build a new coal-fired or nuclear plant elsewhere. On the downside, the costs were estimated for an emergency 30 day loss of pool, so that the long term costs of a permanent alternative would likely be lower. The benefits if the costs of the pipeline extension are used as the least cost alternative are $12.3 billion, or 17 times higher than the baseline estimate.

Table 21: Sensitivity of benefits to different assumptions (Oct 2010 price level; millions of dollars)				
	Description	ORS cost	Cost of least cost alternative	Benefits
1	Baseline	$ 743.1	$ 1,484.5	$ 741.5
2	Interest rate of 10%	$ 978.1	$ 1,954.1	$ 976.0
3	Interest rate of 4 1/8%	$ 541.4	$ 1,081.5	$ 540.2
4	Pipeline extension as cost of least cost alternative	$ 743.1	$ 13,094.0	$ 12,351.0
5	Report – 2009 – 10%	$ 953.5	$ 1,907.0	$ 953.5

9. Validation and verification

Raw water prices at the source are difficult to obtain because there is generally no open market where suppliers and consumers agree on prices. The prices charged by the Corps for water withdrawn from its reservoirs is probably the best available data, but even this is somewhat flawed by differences in computational methods and interest rates. The affect of interest rates was discussed previously, but the computation of prices changed from one where the shares of construction costs to be borne by the government and the municipality/industry buying the water storage space was based on the updated construction cost at the time the contract was negotiated. At the current time the share of construction cost is updated every five years based on updated construction costs and the current interest rate.

Most municipalities have their own reservoirs or withdraw water from wells, streams, or rivers with the only costs being the costs of withdrawing the water and piping it to a treatment plant. Most industries obtain raw water from streams and rivers, which is important when the decision is first made on where to construct manufacturing plants.

A web search indicated that are a very limited number of sources to site regarding the cost of raw water. The sources that were identified along with pertinent information regarding the cost of raw water are listed in Table 22. Most of the references are related to the sale of water in Texas, where population growth and limited water supplies seemed to have converged to create more of an open market. The cost per thousand gallons range from $0.42 to $1.52, compared to the cost from a recent Corps contract of $0.12 and the shadow cost used in the report of $0.07. To some extent the difference reflects differences in yield and price levels, but the remaining difference after adjustments would still appear to be fairly large. It may reflect the willingness to pay for a scarce resource in this particular region of the country.

Table 22: Raw water prices from other sources				
Description	Price level	Cost per thousand gallons	Comment	Source
Texas – city sell water to power plant	Mar-2008	$1.00	City will transport water from reservoir to plant	http://corsicanadailysun.com/local/x212372725/Power-and-water-linked
Texas – city sell water to power plant	Mar-2008	$0.56	Power plant responsible for transport from reservoir to plant	http://corsicanadailysun.com/local/x212372725/Power-and-water-linked
Colorado – raw water for new housing developments	2011	$1.52	Cost of $9,100 per acre foot; Corps converted to cost per thsds gallons; transport not included	http://www.greeleygov.com/Water/rawwaterdedication.aspx
Texas – proposed Bedias reservoir	2005	$0.42	Annualized cost of $201 per acre foot; transport not included	http://www.twdb.state.tx.us/rwpg/2005_1PP/Region%20H/Draft%20Chapter%204/Appendix%204B%20-%20Mgt%20Strategies/4B9%20Bedias%20Reservoir%20-%20SJRA%20Interbasin%20Transfer.pdf
Pa – recent water storage contract	2010	$0.12	Transport not included	Pgh District files - confidential

10. Summary

Ohio River system navigation pools are a source of large volume water supplies that can be relied upon to be available under all but the most adverse conditions. The volumes withdrawn represent about 8 percent of total U.S. freshwater supplies. Unlike most water, which is used for irrigation, the water withdrawn from the Ohio River system is used primarily by industrial plants. Total withdrawals from the system are 25.6 billion gallons a day and the benefits of the navigation pools in providing this water are estimated at $741.5 million per year.

Table 23: Benefits of Water Withdrawn by River (Oct 2010 price level)				
River	# of intakes	ave. daily withdrawals (mgd)	Annual Benefits (mil $)	
Allegheny	19	535.5	$	15.3
Cumberland	49	3,183.7	$	91.0
Green	13	298.2	$	8.5
Kanawha	40	436.1	$	12.5
Kentucky	6	29.4	$	0.8
Monongahela	26	1,087.2	$	31.1
Ohio	137	10,607.5	$	303.1
Tennessee	104	9,774.2	$	279.3
Total:	**394**	**25,951.7**	$	741.5

The major specific beneficiaries of the use of the pools for water supplies are the electric generating plants which are located along nearly the entire length of the system. Electric generating plants withdrew nearly 95 percent of the total amount withdrawn by all industrial facilities and municipalities. The benefits to this industry alone are conservatively estimated at $704 million per year. These plants are predominantly coal-fired plants, but with a significant number of nuclear plants as well. The plants are base-load plants that generate electricity that is distributed throughout the Ohio River basin and the eastern seaboard. Water supplies are essential to their operations, but not a key component of their operating costs.

Attachment 1: Navigation Projects in the Ohio River Basin

Lock and Dam Projects in Ohio River Basin						
RIVER	LOCK NAME	RIVER MILE	POOL BELOW	POOL ABOVE	LIFT	Comment
ALLEGHENY	LOCK & DAM 2	6.7	710	721	11	
ALLEGHENY	LOCK & DAM 3	14.5	720	734	14	
ALLEGHENY	LOCK & DAM 4	24.2	734	745	11	
ALLEGHENY	LOCK & DAM 5	30.4	745	757	12	
ALLEGHENY	LOCK & DAM 6	36.3	757	769	12	
ALLEGHENY	LOCK & DAM 7	45.7	769	782	13	
ALLEGHENY	LOCK & DAM 8	52.6	782	800	18	
ALLEGHENY	LOCK & DAM 9	62.2	800	822	22	
CLINCH	MELTON HILL LOCK & DAM	23.1	737	795	58	trib of Cumberland
CUMBERLAND	BARKLEY LOCK & DAM	30.6	302	359	57	
CUMBERLAND	CHEATHAM LOCK & DAM	148.7	359	385	26	
CUMBERLAND	CORDULL HULL LOCK & DAM	313.5	445	504	59	
CUMBERLAND	OLD HICKORY LOCK & DAM	216.2	385	445	60	
GREEN	GREEN RIVER LOCK & DAM 1	9.1	341	349	8	
GREEN	GREEN RIVER LOCK & DAM 2	63.1	349	363	14	
GREEN	GREEN RIVER LOCK & DAM 3	108.5			17	inactive lock
GREEN	GREEN RIVER LOCK & DAM 4	149.0			16	inactive lock
KANAWHA	WINFIELD LOCKS & DAM	31.1	538	566	28	
KANAWHA	MARMET LOCKS & DAM	67.7	566	590	24	
KANAWHA	LONDON LOCKS & DAM	82.8	590	614	24	
KENTUCKY	KENTUCKY RIVER LOCK AND DAM 1	4.0			8	inactive lock
KENTUCKY	KENTUCKY RIVER LOCK AND DAM 2	31.0			14	inactive lock
KENTUCKY	KENTUCKY RIVER LOCK AND DAM 3	42.0			13	inactive lock
KENTUCKY	KENTUCKY RIVER LOCK AND DAM 4	65.0			13	inactive lock
KENTUCKY	KENTUCKY RIVER LOCK AND DAM 5	82.2			15	inactive lock
MONONGAHELA	LOCK & DAM 2	11.2	709	718	9	
MONONGAHELA	LOCK & DAM 3	23.8	718	726	8	
MONONGAHELA	LOCK & DAM 4	41.5	726	743	17	
MONONGAHELA	MAXWELL LOCK & DAM	61.2	743	763	20	
MONONGAHELA	GRAYS LANDING LOCK & DAM	82	763	778	15	
MONONGAHELA	POINT MARION LOCK & DAM	90.8	778	797	19	
MONONGAHELA	MORGANTOWN LOCK & DAM	102	797	814	17	
MONONGAHELA	HILDEBRAND LOCK & DAM	108	814	835	21	
MONONGAHELA	OPEKISKA LOCK & DAM	115.4	835	857	22	

RIVER	LOCK NAME	RIVER MILE	POOL BELOW	POOL ABOVE	LIFT	Comment
OHIO	EMSWORTH LOCK & DAM	6.2	692	710	18	
OHIO	DASHIELDS LOCK & DAM	13.3	682	692	10	
OHIO	MONTGOMERY LOCK & DAM	31.7	664	682	18	
OHIO	NEW CUMBERLAND LOCK & DAM	54.4	643	664	21	
OHIO	PIKE ISLAND LOCK & DAM	84.2	626	644	18	
OHIO	BELLEVILLE LOCKS & DAM	203.9	560	582	22	
OHIO	RACINE LOCKS & DAM	237.5	538	560	22	
OHIO	GREENUP LOCKS & DAM	341	485	515	30	
OHIO	CAPT ANT MELDAHL LOCK & DAM	436.2	455	485	30	
OHIO	ROBERT C. BYRD LOCKS & DAM	279.2	515	538	23	
OHIO	MARKLAND LOCKS & DAM	531.5	420	455	35	
OHIO	MCALPINE LOCKS & DAM	606.8	383	420	37	
OHIO	LOCK & DAM 52	938.9	290	302	12	
OHIO	LOCK & DAM 53	962.6	278	290	12	
OHIO	HANNIBAL LOCKS & DAM	126.4	602	623	21	
OHIO	WILLOW ISLAND LOCKS & DAM	161.7	582	602	20	
OHIO	CANNELTON LOCK & DAM	720.7	358	383	25	
OHIO	NEWBURGH LOCK & DAM	776.1	342	358	16	
OHIO	JOHN T. MYERS LOCK & DAM	846	324	342	18	
OHIO	SMITHLAND LOCK & DAM	918.5	302	324	22	
TENNESSEE	KENTUCKY LOCK	22.4	302	359	57	
TENNESSEE	PICKWICK LANDING LOCK	206.7	359	414	55	
TENNESSEE	WILSON LOCK	259.4	459	508	49	
TENNESSEE	GEN JOS WHEELER LOCK	274.9	508	556	48	
TENNESSEE	GUNTERSVILLE LOCK	349	556	595	39	
TENNESSEE	NICKAJAC LOCK	424.7	595	634	39	
TENNESSEE	CHICKAMAUGA LOCK	471	633	682	49	
TENNESSEE	WATTS BAR LOCK	529.9	683	741	58	
TENNESSEE	FORT LOUDON LOCK	602.3	741	813	72	

Note; Kentucky River has 14 lock and dam projects; none of locks are operable; intakes identified only up thru L&D 5 pool.

Attachment 2: List of Water Withdrawing Entities in Ohio River Basin

River	Facility	River Mile	Pool	Water intake (mgd)	Possible intake amount (mgd)
Allegheny	Hertz Gateway Center	0.4	Emsworth	13.0	13.0
Allegheny	City of Pittsburgh	7.3	L/D 2	30.0	50.0
Allegheny	City of Pittsburgh	7.9	L/D 2	40.0	50.0
Allegheny	Wilkinsburg-Penn Joint Water	8.8	L/D 2	22.0	34.0
Allegheny	Oakmont	13.3	L/D 2	5.2	10.0
Allegheny	Reliant Energy Inc. (Cheswick Power Station)	15.5	L/D 3	254.0	376.0
Allegheny	Allegheny Energy Inc. (Unit 3, 4, 5 Power Station-Natural Gas)	17.4	L/D 3	1.3	4.7
Allegheny	New Kensington	20.9	L/D 3	4.0	8.0
Allegheny	Tarentum	22.3	L/D 3	1.0	2.0
Allegheny	Harrison Twp.	23.3	L/D 3	1.6	3.0
Allegheny	Allegheny Ludlum Steel Corp	24.4	L/D 4	0.0	0.0
Allegheny	Braeburn Alloy Steel Co	24.4	L/D 4	1.4	2.3
Allegheny	Freeport	29.3	L/D 4	1.2	3.0
Allegheny	PA American Water	44.9	L/D 6	0.6	3.0
Allegheny	Kittanning	48	L/D 7	0.8	1.5
Allegheny	Glacial Sand & Gravel Co	49.4	L/D 7	0.0	0.0
Allegheny	Allegheny Energy Inc. (Armstrong Power Station)	55.2	L/D 8	154.2	191.5
Allegheny	PA American Water	69.3	L/D 9	5.2	6.0
Allegheny	Parker City	85	L/D 9	0.1	0.3
Cumberland	Crittendon-Livingston Co. Water	16	L/D 52-Ohio	0.5	0.3
Cumberland	Kuttawa	41	Barkley	0.0	0.0
Cumberland	Eddyville	42	Barkley	0.0	0.0
Cumberland	Commonwealth of KY	43.4	Barkley	0.0	0.0
Cumberland	Princeton	46	Barkley	2.0	0.9
Cumberland	Cadiz	59	Barkley	0.0	0.0
Cumberland	Barkley Lake Water District	62.4	Barkley	0.0	0.0
Cumberland	Dover	88.8	Barkley	0.0	0.0
Cumberland	Tennessee Valley Authority (Cumberland City Power Station)	103.4	Barkley	2,075.4	2,075.4
Cumberland	Erin	108.3	Barkley	0.0	0.0
Cumberland	Winn Materials	123.6	Barkley	0.2	1.4
Cumberland	Springfield	125.3	Barkley	2.5	4.6
Cumberland	Adairville	125.4	Barkely	0.0	0.0
Cumberland	Ft. Campbell	125.4	Barkely	0.0	0.0
Cumberland	Clarksville	132.8	Barkley	10.5	13.5
Cumberland	Cunningham-East Montgomery	142	Barkley	2.0	4.0
Cumberland	Commonwealth of Kentucky	143.4	Cheatham	0.0	0.0
Cumberland	Ashland	160	Cheatham	0.6	0.7

River	Facility	River Mile	Pool	Water intake (mgd)	Possible intake amount (mgd)
Cumberland	River Road Utility District	160.6	Cheatham	0.0	0.0
Cumberland	Harpeth Valley	172.3	Cheatham	11.0	18.0
Cumberland	Ford Motor company	182.1	Cheatham	14.0	22.0
Cumberland	Nashville Thermal Transfer Corp.	191.3	Cheatham	0.0	0.0
Cumberland	Nashville	193.7	Cheatham	34.0	90.0
Cumberland	Madison	200.3	Cheatham	11.0	18.0
Cumberland	Metro Government	205.9	Cheatham	39.0	70.9
Cumberland	White House Utility	216.5	Old Hickory	4.7	12.0
Cumberland		216.5	Old Hickory	8.0	15.8
Cumberland	Hendersonville	217	Old Hickory	2.8	8.0
Cumberland	E.I. Du Pont de Nemours and Co.	218.5	Old Hickory	0.0	0.0
Cumberland	Old Hickory Utility	218.9	Old Hickory	0.7	1.5
Cumberland		225.3	Old Hickory	2.5	8.0
Cumberland		225.75	Old Hickory	5.8	10.5
Cumberland	West Wilson Utility	226.2	Old Hickory	8.0	14.5
Cumberland	Blue Grass country Club	227.4	Old Hickory	0.0	0.0
Cumberland	Boxwell Boy scout Camp	237	Old Hickory	0.0	0.0
Cumberland	Gallatin	239.4	Old Hickory	4.5	8.3
Cumberland	Tennessee Valley Authority (Gallatin Power Station)	243.9	Old Hickory	940.4	940.4
Cumberland	Lebanon	263	Old Hickory	0.0	0.0
Cumberland	City of Hartsville	278.7	Old Hickory	0.6	1.0
Cumberland	Tennessee Valley Authority (Hartsville Nuclear Plant)	284.1	Old Hickory	0.0	0.0
Cumberland	Carthage	308.7	Old Hickory	0.5	0.6
Cumberland	New Jersey Zinc Company	309.1	Old Hickory	0.0	0.0
Cumberland	Smith Utility	309.1	Old Hickory	1.0	3.0
Cumberland	USACE	331.5	Old Hickory	0.0	0.0
Cumberland	Gainesboro	357.4	Cordell Hull	0.3	0.5
Cumberland	Northwest Clay Utility	377.4	Cordell Hull	0.2	0.6
Cumberland	Celina	380.9	Cordell Hull	0.4	1.0
Cumberland	Marrowbone	419.5	Cordell Hull	0.1	0.2
Cumberland	Burkesville	427	Cordell Hull	0.5	1.0
Green	Patriot Coal Company	31.8	L/D 1	0.3	1.2
Green	Cash Creek Generation	32.5	L/D 1	8.4	8.4
Green	Alcan Primary Metals Group	40.4	L/D 1	0.3	1.2
Green	Big Rivers Electric Corp. (Robert A. Reid Power Station)	41.1	L/D 1	73.3	193.0
Green	Allied Resources	45.6	L/D 1	0.1	0.3
Green	Webster County Water District	47.38	L/D 1	0.9	1.5
Green	Madisonville Light and Water	54	L/D 1	8.9	9.0
Green	Calhoun Water Works	63.55	L/D 2	0.6	1.0
Green	Livermore Water Works	71.28	L/D 2	0.2	0.5
Green	Big Rivers Electric Corp. (D.B. Wilson Power Station)	74	L/D 2	6.1	8.3

River	Facility	River Mile	Pool	Water intake (mgd)	Possible intake amount (mgd)
Green	E.ON U.S. (Green River Power Station)	81.8	L/D 2	194.4	211.2
Green	Central City Municipal Water Works	85.4	L/D 2	3.5	4.0
Green	Tennessee Valley Authority (Paradise Power Station)	100.56	L/D 2	1.2	2.0
Kanawha	Town of Winfiled Municiple Water	32.2	Winfield	0.0	0.0
Kanawha	Winfiled Municiple	32.2	Winfield	0.0	0.0
Kanawha	American Electric Power (John E. Amos Power Station)	39	Winfield	42.8	77.8
Kanawha	Union Boiler Co	39.9	Winfield	0.0	0.0
Kanawha	Williams Union Boiler Co.	40	Winfield	0.0	0.0
Kanawha	Arrow Concrete Company Parkersburg	41.8	Winfield	0.0	0.0
Kanawha	Ohio Apex. Inc. (Apex Pipeline Services, Inc.)	42.5	Winfield	0.0	0.0
Kanawha	Par Industrial Corp.	42.8	Winfield	0.0	0.0
Kanawha	P.B.& S. Chemical Co. Inc. Putnam Co.	43.1	Winfield	0.0	0.0
Kanawha	Horn Brother Oil Co. Putnam Co.	43.5	Winfield	0.0	0.0
Kanawha	Columbia Gas Transmission Corp. Putnam Co.	44.3	Winfield	0.0	0.0
Kanawha	Bayer CropScience LP, Institute Plant Kanawha	48	Winfield	0.0	0.0
Kanawha	Union Carbide South Charleston facility, Kanawha Co.	52.35	Winfield	38.8	70.5
Kanawha	CLEARON CORP. (Olin Chemical) Kanawha Co.	54	Winfield	0.0	0.0
Kanawha	FMC Corporation Steam Plant, Kanawha Co.	54	Winfield	0.0	0.0
Kanawha	Phone-Polulenc Ag. Co. Kanawha Co.	55	Winfield	0.0	0.0
Kanawha		55	Winfield	0.0	0.0
Kanawha	True Temper Corp.	56.3	Winfield	0.0	0.0
Kanawha	West Virginia American Water/Montgomery Plant	57.9	Winfield	0.0	0.0
Kanawha	E.I. Du Pont de Nemours and Co.	68.5	Marmet	0.0	0.0
Kanawha	N.Y.C.R.R. Co.	72.8	Marmet	0.0	0.0
Kanawha	Quincy Dock, Kanawha Co.	73	Marmet	0.0	0.0
Kanawha	Consolidated Gas Transmission Corp.	73.4	Marmet	0.0	0.0
Kanawha	Town of Chelyan	73.5	Marmet	0.0	0.0
Kanawha	AEP Co. Cabin Creek Junction	74.3	Marmet	0.0	0.0
Kanawha	Marmet Synfuel Kanawha Lens Creek Putnam Co.	74.4	Marmet	0.0	0.0
Kanawha	Cardox Corp	74.5	Marmet	0.0	0.0
Kanawha	Cedar Grove Water Works, Kanawha Co.	77.3	Marmet	0.0	0.0
Kanawha	American Electric Power (Kanawha River Power Station)	77.5	Marmet	354.5	644.5
Kanawha	AEP Co. Glasgow	78.6	Marmet	0.0	0.0

River	Facility	River Mile	Pool	Water intake (mgd)	Possible intake amount (mgd)
Kanawha	Pratt Water Works, Kanawha Co.	81.1	Marmet	0.0	0.0
Kanawha	Valley Camp Coal Co.	81.3	Marmet	0.0	0.0
Kanawha	Mammoth Coal Processing Kanawha	84.2	Winfield	0.0	0.0
Kanawha	Cannelton Coal & Coke	84.4	London	0.0	0.0
Kanawha	W.VA. Water Service Co.	85.8	London	0.0	0.0
Kanawha	Town of Boomer	88.9	London	0.0	0.0
Kanawha	Elkem Metals Alloy L.P. Fayette	89.8	London	0.0	0.0
Kanawha	Land Use Corp.	89.9	London	0.0	0.0
Kanawha	Armstrong PSD Fayette	90.4	London	0.0	0.0
Kanawha	Deep Water PSD Fayette	90.4	London	0.0	0.0
Kentucky	Liters Quarry, Inc.	30.1	L/D 2	0.0	0.4
Kentucky	Kentucky American Water Company	47.8	L/D 4	20.0	20.0
Kentucky	Buffalo Trace Distillery	64.7	L/D 4	0.1	1.5
Kentucky	Capital Powerhouse	67.8	L/D 5	0.0	4.5
Kentucky	Frankfort Electric and Water Plant Board	69.8	L/D 5	9.0	15.0
Kentucky	Harrod Concrete and Stone	70.34	L/D 5	0.2	0.3
Monongahela	PA American Water	4.4	Emsworth	60.0	60.0
Monongahela	US Steel Corp (Edgar Thompson works)	11.2	L/D 2	190.8	346.9
Monongahela	Mckeesport	16.4	L/D 2	6.7	10.0
Monongahela	US Steel Corp Clairton Works	20.1	L/D 2	52.4	95.2
Monongahela	PA American Water	23.3	L/D 2	37.0	65.0
Monongahela	Reliant Energy Inc. (Elrama Power Station)	25	L/D 3	350.0	546.5
Monongahela	PA American Water	25.3	L/D 3	45.0	65.0
Monongahela	Allegheny Energy Inc. (Mitchell Power Station)	29.5	L/D 3	163.6	323.7
Monongahela	Charleroi	42.6	L/D 4	4.0	9.0
Monongahela	Belle Vernon	44.2	L/D 4	0.5	1.0
Monongahela	Washington Twp.	46	L/D 4	0.5	1.5
Monongahela	Wheeling Pittsburgh Steel Corp	46.8	L/D 4	0.0	0.0
Monongahela	Newell	50.7	L/D 4	0.2	1.0
Monongahela	PA American Water	57.1	L/D 4	4.0	4.0
Monongahela	Tri-Coutny Municipal	64.6	Maxwell	1.1	3.0
Monongahela	Carmichaels	75.2	Maxwell	0.0	0.0
Monongahela	Duke Energy (Fayette Power Station)	77.7	Maxwell	7.1	18.5
Monongahela	Allegheny Energy Inc. (Hatfield Ferry Power Station)	79	Maxwell	25.0	50.4
Monongahela	Masontown	79.2	Maxwell	0.5	0.8
Monongahela	Dunkard Valley	85.3	Grays Landing	0.1	0.2
Monongahela	East Dunkard	88	Grays Landing	0.4	0.8
Monongahela	Alleghney Energy Inc. (Fort Martin Power Station)	92.4	Pt. Marion	12.9	29.5
Monongahela	Dominion (Morgantown Power Station)	100.5	Pt. Marion	73.5	133.6

River	Facility	River Mile	Pool	Water intake (mgd)	Possible intake amount (mgd)
Monongahela	Morgantown	101	Pt. Marion	0.6	1.1
Monongahela	Robert B. Creel Water Plant	102.6	Morgantown	12.0	21.8
Monongahela	Allegheny Energy Inc. (Rivesville Power Station)	122.2	Opekiska	39.3	131.7
Ohio	Reliant Energy Inc. (Brunot Island Power Station)	2.4	Emsworth	0.1	5.8
Ohio	West View Municipal Auth	5	Emsworth	25.0	40.0
Ohio	US Steel Corp Irving works	8.6	Emsworth	25.0	45.5
Ohio	Robinson Twp Auth	11	Dashields	2.9	12.0
Ohio	Moon Twp Auth	11.7	Dashields	3.3	8.0
Ohio	Reliant Energy Inc. (Phillips Power Station)	15.1	Montgomery	0.0	0.0
Ohio	Horsehead Corporation	28.5	Montgomery	81.9	100.8
Ohio	FirstEnergy Co. (Bruce Mansfield Power Station)	33.7	New Cumberland	70.0	70.0
Ohio	FirstEnergy Co. (Beaver Valley Nuclear Power Station)	34.6	New Cumberland	1,239.2	2,201.8
Ohio	Midland Boro	36	New Cumberland	3.0	5.4
Ohio	City of East Liverpool	40.2	New Cumberland	2.5	6.0
Ohio	FirstEnergy Co. (Sammis Power Station)	53.8	New Cumberland	1,111.8	2,021.5
Ohio	FirstEnergy Co. (Toronto Power Station)	57.5	Pike Island	0.0	0.0
Ohio	Mittal Steel USA - Weirton Plant Hancock	62.2	Pike Island	0.0	0.0
Ohio	Steubenville Water Works	65.2	Pike Island	4.5	6.0
Ohio	Weirton Water Treatment Plant Hancock	65.2	Pike Island	0.0	0.0
Ohio		68.5	Pike Island	97.1	176.6
Ohio		68.7	Pike Island	0.0	0.0
Ohio	Koppers Inc. Brooke	69.2	Pike Island	0.0	0.0
Ohio	Follansbee Hooverson Heights Water Treatmnt Plant Brooke	70.8	Pike Island	0.0	0.0
Ohio	Wheeling Pittsburgh Steel Corp	70.9	Pike Island	44.1	80.2
Ohio	Buckeye Power Inc. (Cardinal Power Station 2/3)	77.3	Pike Island	54.9	99.8
Ohio	American Electric Power (Tidd Power Station)	77.4	Pike Island	0.0	0.0
Ohio	American Electric Power (Cardinal Power Station)	79.9	Pike Island	1,165.4	1,165.4
Ohio	Wheeling Pittsburgh Steel Corp	83.25	Pike Island	0.0	0.0
Ohio	Wheeling Pittsburgh Steel Corp	83.6	Pike Island	3.3	6.0
Ohio	Wheeling Pittsburgh Steel Corp	87.9	Hannibal	0.0	0.0
Ohio	Bellaire Water Works	94	Hannibal	0.9	1.1
Ohio	FirstEnergy Co. (R.E. Burger Power Stationf)	102.4	Hannibal	307.9	559.9

River	Facility	River Mile	Pool	Water intake (mgd)	Possible intake amount (mgd)
Ohio	American Electric Power (Kammer Power Station)	111.1	Hannibal	0.0	0.0
Ohio	American Electric Power (Mitchell Power Station)	112.4	Hannibal	0.0	0.0
Ohio	PPG (Natrium) Marshall	119	Hannibal	0.0	0.0
Ohio	Bayer Material Science LLC Marshall	121.3	Hannibal	0.0	0.0
Ohio	City Of New Martinsville Municiple	128.2	Willow Island	0.0	0.0
Ohio	City Of Sistersville Municiple	137.2	Willow Island	0.0	0.0
Ohio	Sistersville Water Plant, Tyler Co.	137.2	Willow Island	0.0	0.0
Ohio	Union Carbide Corp. (Ranney Water Collection)	144.8	Willow Island	0.0	0.0
Ohio	SISTERSVILLE PLANT	146	Willow Island	0.0	0.0
Ohio	Allegheny Energy Inc. (Willow Island Power Station)	160.5	Willow Island	80.8	203.0
Ohio	Allegheny Energy Inc. (Pleaseants Power Station)	160.6	Willow Island	18.7	21.1
Ohio	American Cynamid Co.	160.9	Willow Island	0.0	0.0
Ohio	Cytec Industries Willow Island	162	Willow Island	0.0	0.0
Ohio	Willow Island Power Station, Pleasants Co.	162	Willow Island	3.0	7.5
Ohio	Cabot Corporation	164.1	Belleville	0.0	0.0
Ohio	American Municipal Power-Ohio (Richard H. Gorsuch Power Station)	176.6	Belleville	254.5	1,520.4
Ohio	Henderson Water Utility - South	177.8	Belleville	0.0	0.0
Ohio	City of Parkersburg Municipal	182.1	Belleville	0.0	0.0
Ohio	E.I. Du Pont de Nemours and Co.	190.2	Belleville	0.0	0.0
Ohio	Dupont Washington Works	190.9	Belleville	0.0	0.0
Ohio	NORTHWEST PIPE CO.	191	Belleville	0.0	0.0
Ohio	GE CO.	191.5	Belleville	0.0	0.0
Ohio	Century Aluminum of WV	227	Racine	0.0	0.0
Ohio	Pechiney Rolled Products, LLC.[a]	227	Racine	0.0	0.0
Ohio	American Electric Power (Phillip Sporn Power Station)	241.6	Robert C. Byrd	0.0	0.0
Ohio	American Electric Power (Mountaineer Power Station)	242.9	Robert C. Byrd	0.0	0.0
Ohio	American Electric Power (James M. Gavin Power Station)	258.5	Robert C. Byrd	43.3	43.3
Ohio	Ohio Valley Electric Corp. (Kyger Creek Power Station)	259.6	Robert C. Byrd	1,178.0	1,178.0
Ohio	WV American Water-Huntington water Corp., Cabell Co.	306.8	Greenup	0.0	0.0
Ohio	Ceredo Dock, Wayne Co.	314.4	Greenup	0.0	0.0
Ohio	KANAWHA RIVER TERMINALS INC.	314.6	Greenup	0.0	0.0
Ohio	Sunoco Chemicals - Neal, Wayne Co.	316	Greenup	0.0	0.0
Ohio	Sandy River Synfuel, Wayne Co.	316.6	Greenup	0.0	0.0
Ohio	Marathon Ashland Petroleum Co.	316.9	Greenup	0.0	0.0

River	Facility	River Mile	Pool	Water intake (mgd)	Possible intake amount (mgd)
Ohio	American Electric Power (Big Sandy Power Station)	317	Greenup	19.4	19.4
Ohio	Aristech Corp.	317	Greenup	0.0	0.0
Ohio	Asland Oil, Inc.	317	Greenup	0.0	0.0
Ohio	Calgon Carbon Corp.	317	Greenup	0.0	0.0
Ohio	Columbia Gas Transmission	317	Greenup	0.0	0.0
Ohio	Kenova Municipal Water, Wayne Co.	317	Greenup	0.0	0.0
Ohio	Special Metals Co.	317	Greenup	0.0	0.0
Ohio	USS Chemicals	317	Greenup	0.0	0.0
Ohio	Hilltop Basic Resources Inc - Big Bend Quarry	321.4	Greenup	0.0	0.0
Ohio	Russell Water Co	327.7	Greenup	0.0	0.0
Ohio	Dayton Power & Light (Killen Power Station)	390.7	Meldahl	20.0	36.4
Ohio	TGM Constructors	400	Meldahl	0.0	0.1
Ohio	Duke Energy (J.M. Stuart Power Station)	404.7	Meldahl	252.0	458.2
Ohio	City of Maysville Municipal	407.9	Meldahl	1.8	3.3
Ohio	Inland Container Industrial	413.8	Meldahl	0.0	0.0
Ohio	East Kentucky Power Cooperative (Spurlock Power Station)	414.1	Meldahl	4.5	8.9
Ohio	North American Stainless	442.2	Markland	0.0	0.0
Ohio	Duke Energy (Zimmer Power Station)	443.2	Markland	42.5	42.5
Ohio	Duke Energy (Beckjord Power Station)	452.9	Markland	617.0	617.0
Ohio	Cold Stream Country Club	456.3	Markland	0.4	0.7
Ohio	City of Cincinnati Municipal	462.9	Markland	0.0	0.0
Ohio	Northern Kentucky Water Service District - Newport Plant	462.9	Markland	0.0	0.0
Ohio	City of Covington Municipal	463	Markland	0.0	0.0
Ohio	Duke Energy (Miami Fort Power Station)	490.1	Markland	166.0	166.0
Ohio	American Electric Power (Tanners Creek Power Station)	494.1	Markland	437.0	922.0
Ohio	Duke Energy (East Bend Power Station)	511.4	Markland	18.1	32.9
Ohio	Gallatin Steel Co	533	Markland	0.0	0.0
Ohio	E.ON U.S. (Ghent Power Station)	536.4	McAlpine	70.0	127.3
Ohio	Carmeuse Lime Inc	539.9	McAlpine	0.0	0.0
Ohio	Ohio Valley Electric Corp. (Clifty Creek Power Station)	560	McAlpine	1,178.0	1,434.0
Ohio	TIN Inc - Temple-Inland	568.1	McAlpine	0.0	0.0
Ohio	E.ON U.S. (Trimble Power Station)	572	McAlpine	21.3	38.7
Ohio	Maysville Utility Commission	573.45	McAlpine	0.0	0.0
Ohio	City of Charleston Municipal	591.2	McAlpine	0.0	0.0
Ohio	Charleston Ammo Depot Industrial	591.4	McAlpine	0.0	0.0
Ohio	River Sand & Gravel LLC	598.5	McAlpine	0.4	0.8

River	Facility	River Mile	Pool	Water intake (mgd)	Possible intake amount (mgd)
Ohio	Louisville Water Co	600.1	McAlpine	0.0	0.0
Ohio	Colgate Palmolive Co.	603.6	McAlpine	0.0	0.0
Ohio	E.ON U.S. (Ohio Falls Hydroelectric Power Station)	605	McAlpine	7.2	13.1
Ohio	Duke Energy (Gallagher Power Station)	610.3	Cannelton	150.0	260.0
Ohio	Air Products and Chemicals (formerly Airco Carbide)	612.7	Cannelton	0.0	0.0
Ohio	E.ON U.S. (Cane Run Power Station)	613	Cannelton	333.0	410.0
Ohio	Publicker and DuPont	613.4	Cannelton	0.0	0.0
Ohio	Rohm & Haas - Louisville Plant	613.5	Cannelton	0.0	0.0
Ohio	E.ON U.S. (Mill Creek Power Station)	626	Cannelton	284.4	517.1
Ohio	Kosmos Cement Industrial	626.9	Cannelton	0.0	0.0
Ohio	E I Dupont Inc	648.3	Cannelton	0.0	0.0
Ohio	AK Steel Corp - West Works	656.8	Cannelton	0.0	0.0
Ohio	Ashland Water Works	661.72	Cannelton	0.0	0.0
Ohio	Mulzer Crushed Stone Inc	674	Cannelton	0.0	0.0
Ohio	Colgate Palmolive Co	692	Cannelton	0.0	0.0
Ohio	Can-Tex Industrial	724.5	Newburgh	0.0	0.0
Ohio	Big Rivers Electric Corp. (Kenneth C. Coleman Power Station)	728.6	Newburgh	240.5	356.7
Ohio	American Electric Power (Rockport Power Station)	744.8	Newburgh	12.1	11.5
Ohio	Owensboro Municipal Utilities (Elmer Smith Power Station)	755.5	Newburgh	247.1	272.1
Ohio	Aluminum Company of America, Warrick Operations	773	Newburgh	0.0	0.0
Ohio	Vectren Corp. (F.B. Culley Power Station)	773.8	Newburgh	0.0	0.0
Ohio	ALCOA Industrial	773.9	Newburgh	0.0	0.0
Ohio	City of Evansville Municipal Intake	791.5	J.T. Meyers	0.0	0.0
Ohio	Vectren Corp. / Alcoa Inc. (Warrick Power Station)	793.9	Newburgh	0.0	0.0
Ohio	Henderson Municipal Power & Light (Henderson Power Station)	803.9	J.T. Meyers	0.0	0.0
Ohio	Vectren Corp. (A.B. Brown Power Station)	817	J.T. Meyers	5.7	10.4
Ohio	City of Mount Vernon	829.5	J.T. Meyers	0.0	0.0
Ohio	GE Industrial	831.1	J.T. Meyers	0.0	0.0
Ohio	GE Plastics Mt. Vernon, Inc.	831.2	J.T. Meyers	0.0	0.0
Ohio	City of Morganfield	839.9	J.T. Meyers	0.0	0.0
Ohio	Peabody Coal Co - Camp 9 Coal Prep Plant	841.5	J.T. Meyers	0.0	0.0
Ohio	City of Mulfordtown	870.8	Smithland	0.0	0.0
Ohio	City of Sturgis	871.5	Smithland	0.0	0.0
Ohio	City of Paducah	935.5	L/D 52	0.0	0.0

River	Facility	River Mile	Pool	Water intake (mgd)	Possible intake amount (mgd)
Ohio	Tennessee Valley Authority (Shawnee Power Station)	945.9	L/D 53	60.0	80.6
Ohio	US Enrichment Corp	945.9	L/D 53	0.0	0.0
Ohio	Ameren Corp. (Joppa Power Station)	952.3	L/D 53	598.0	725.8
Ohio	Ballard Wildlife Management Area	965.6	L/D 53	0.0	0.0
Tennessee	Paducah	0.3	Kentucky	0.0	0.0
Tennessee	North Star Steel	13.8	Kentucky	0.0	0.2
Tennessee	Elf Atochiem Co.	15.2	Kentucky	0.0	0.0
Tennessee	Arkema	15.9	Kentucky	6.1	21.0
Tennessee	West Lake Chemical Co.	18	Kentucky	0.0	0.0
Tennessee	Lake City Water	23.4	Kentucky	0.0	0.0
Tennessee	North Marshall Water	28.5	Kentucky	0.0	0.0
Tennessee	Jonathan Creek Water	39	Kentucky	0.6	0.9
Tennessee	Inland Container Corp.	94.4	Kentucky	4.0	8.0
Tennessee	Consolidated Aluminum Corp.	95.5	Kentucky	3.0	12.0
Tennessee	E.I. Du Pont de Nemours and Co.	98.6	Kentucky	0.1	76.8
Tennessee	Tennessee Valley Authority (Johnsonville Power Station)	100	Kentucky	1,226.9	2,230.7
Tennessee	Camden	100.4	Kentucky	1.5	0.0
Tennessee	New Johnsonvile	100.7	Kentucky	0.4	1.0
Tennessee	Waverly	110.5	Kentucky	0.3	1.2
Tennessee	Union Carbide Corp.*****	128.9	Kentucky-Duck	0.0	0.0
Tennessee	Koch Asphalt Co.	134.8	Kentucky	0.0	0.1
Tennessee	Parsons	155.1	Kentucky	0.0	0.0
Tennessee	Clifon	158	Kentucky	0.0	0.0
Tennessee	Adamsdale	192.2	Kentucky	0.0	0.0
Tennessee	Clyde Owen Sand and Gravel Co. Inc.	197.4	Kentucky	0.0	0.0
Tennessee	TN River Pulp and Paper	205.4	Pickwick	27.0	40.0
Tennessee	Hardin County	206.7	Pickwick	0.4	0.7
Tennessee	Cherokee	239	Pickwick	0.0	0.0
Tennessee	Tennessee Valley Authority (Colbert Power Station)	245.3	Pickwick	1,294.1	1,294.1
Tennessee	Tristates Limestone Co.	249.5	Pickwick	0.0	0.0
Tennessee	Sheffield	254.3	Pickwick	1.9	3.0
Tennessee	Muscle Shoals Utility	259.4	Wilson	0.0	0.0
Tennessee	Florence Water Board	259.8	Wilson	0.0	0.0
Tennessee	Renyolds Metal Company	261	Wilson	0.0	0.0
Tennessee	AL Dept. of Conservation	278.1	Wheeler	0.0	0.0
Tennessee	U.S. Plywood-Champion Paper Inc.	282	Wheeler	55.8	60.0
Tennessee	Athens******	285	Wheeler	7.0	9.0
Tennessee	Eagle Snacks******	285	Wheeler	0.0	0.0
Tennessee	Frito Lay******	285	Wheeler	0.1	0.8

River	Facility	River Mile	Pool	Water intake (mgd)	Possible intake amount (mgd)
Tennessee	Limestone County******	285	Wheeler	2.0	4.0
Tennessee	West Morgan-East Lawrence Water	286.5	Wheeler	3.0	16.0
Tennessee	Tennessee Valley Authority (Browns Ferry Nuclear Plant)	294.2	Wheeler	1,990.2	3,618.6
Tennessee	AMOCO Chemicals Corp.	299.4	Wheeler	3.2	23.9
Tennessee	Minnesota Manufacture and Mine Inc.	299.7	Wheeler	11.5	16.6
Tennessee	Decatur Ice and Coal Co.	304.8	Wheeler	0.0	0.0
Tennessee	Decatur Water	306	Wheeler	20.0	30.0
Tennessee	Hartselle	308.2	Wheeler	2.3	4.6
Tennessee	Huntsville	320	Wheeler	0.0	0.0
Tennessee	Redstone Arsenal	323.9	Wheeler	0.0	18.0
Tennessee	Huntsville Arsenal	330.2	Wheeler	12.2	36.0
Tennessee	Northeast Morgan County	334.7	Guntersville	0.0	0.0
Tennessee	Grant	351.8	Guntersville	0.8	1.0
Tennessee	Arab	356	Guntersville	3.0	4.0
Tennessee	Guntersville	356	Guntersville	0.0	2.0
Tennessee	Butler Rubber Co. Inc.	358.2	Guntersville	0.0	0.0
Tennessee	Top Flite Rubber Inc.	358.5	Guntersville	0.0	0.5
Tennessee	Yokohama Rubber Inc.	358.9	Guntersville	0.0	0.0
Tennessee	Albertsville	360.5	Guntersville	12.0	17.0
Tennessee	Monsanto Textiles Co.	364.3	Guntersville	0.0	72.0
Tennessee	Anderson County	367.8	Melton Hill	1.0	2.0
Tennessee	Clinton	367.8	Melton Hill	1.4	4.5
Tennessee	E.A. Wright	367.8	Melton Hill	0.0	0.0
Tennessee	Modine Manufacturing Co.	367.8	Melton Hill	0.0	0.4
Tennessee	North Anderson County	367.8	Melton Hill	0.6	0.7
Tennessee	Tennessee Valley Authority (Bull Run Power Station)	367.8	Melton Hill	563.2	563.2
Tennessee	U.S. Atomic Energy Commision (Clinch River Breeder Reactor Project)	367.8	Melton Hill	0.0	0.0
Tennessee	West Knoxville Utility	367.8	Melton Hill	2.5	4.0
Tennessee	Tennessee Valley Authority (Kingston Power Station)	367.8	Watts Bar	1,280.0	1,280.0
Tennessee	Scottsboro	377.4	Guntersville	0.0	0.0
Tennessee	AL Water Works Board	382	Guntersville	0.0	0.0

River	Facility	River Mile	Pool	Water intake (mgd)	Possible intake amount (mgd)
Tennessee	Fort Payne	387.6	Guntersville	5.0	10.0
Tennessee	Tennessee Valley Authority (Bellefonte Nuclear Plant)	391.2	Guntersville	0.0	0.0
Tennessee	Mead Paperboard	405.2	Guntersville	4.0	6.0
Tennessee	Tennessee Valley Authority (Widows Creek Power Station)	407.6	Guntersville	1,476.3	2,684.2
Tennessee	North Jackson	409.7	Guntersville	2.0	3.0
Tennessee	Bridgeport	413.4	Guntersville	0.5	1.0
Tennessee	Vulcan Construction Materials	417	Guntersville	0.0	0.0
Tennessee	South Pittsburg	418	Guntersville	0.8	2.0
Tennessee	Jasper	422.6	Guntersville	0.0	0.6
Tennessee	Tennessee Paper Mills Ind.	437.5	Nickajack	0.0	0.0
Tennessee	Tennessee Valley Authority (Yellow Creek Nuclear Plant)	448.5	Nickajack	0.0	0.0
Tennessee	Signal Mountain Cement	454.2	Nickajack	2.9	2.9
Tennessee	Chattanooga	463.4	Nickajack	0.0	0.3
Tennessee	Rock-Tenn Co.	463.5	Nickajack	0.7	3.5
Tennessee	Eastside Utility	478.6	Chickamauga	0.0	0.0
Tennessee	Savannah Valley Utility	483.6	Chickamauga	0.0	0.0
Tennessee	Tennessee Valley Authority (Sequoyah Nuclear Plant)	484.9	Chickamauga	1,539.3	2,798.7
Tennessee	Soddy-Daisy Falling Water Utility	487.5	Chickamauga	1.0	2.0
Tennessee	Etowah	500.5	Chickamauga	1.9	2.6
Tennessee	Dayton	503.7	Chickamauga	1.6	2.0
Tennessee	Tennessee Valley Authority (Watts Bar Nuclear Plant)	529.1	Chickamauga	188.2	188.2
Tennessee	Town of Spring City	532.4	Watts Bar	0.3	0.3
Tennessee	Rock Wood	553	Watts Bar	1.3	6.0
Tennessee	Cumberland Utility	567.8	Watts Bar	0.0	0.0
Tennessee	Harriman utility	567.8	Watts Bar	2.1	3.2
Tennessee	Kingston	568.2	Watts Bar	0.0	0.0
Tennessee	Loudon	584.8	Watts Bar	0.1	0.6
Tennessee	Kimberly Clark Corp.	589.5	Watts Bar	0.0	0.0

River	Facility	River Mile	Pool	Water intake (mgd)	Possible intake amount (mgd)
Tennessee	Union Carbide Corp.	591.8	Watts Bar	2.0	5.8
Tennessee	Lenoir	601.3	Watts Bar	1.0	3.0
Tennessee	Knoxville	617	Ft Loudon	4.0	7.5
Tennessee	Robert Shaw Controls Co.	617.2	Ft Loudon	0.0	0.0
Tennessee	American Limestone Co.	632	Ft Loudon	0.1	0.6
Tennessee	Modine Manufacturing Co.	632	Ft Loudon	0.1	0.2
Tennessee	Newport Utilities	632	Ft Loudon	0.0	0.0
Tennessee	Northeast Knox Utility	632	Ft Loudon	1.0	2.0
Tennessee	Holliston Mill Inc.	632	Ft Loudon	0.0	1.5
Tennessee	Univ. of Tennessee	647.4	Watts Bar	0.0	0.0
Total				**25,951.7**	**38,667.6**

River Key

Barren Fork, a tributary of The Cumberland.
Beech River, a tributary of the Tennessee
Caney Fork, a tributary of the Cumberland
Collins River, a tributary of the Cumberland
Duck River, a tributary of the Tennessee.
Elk River, a tributary of the Tennessee.
Emory River, a tributary of the Tennessee.
French Broad, a tributary of the Tennessee.
Hiawasee River, a tributary of the Tennessee.
Little River, a tributary of the Tennessee.
Piney River, a tributary of the Tennessee.
Red River, a tributary of the Cumberland.
Sequathchie, a tributary of the Tennessee.
Coal River, a tributary of the Kanawha.
Holston River, a tributary of the Tennessee.
Guyandotte River, a tributary of the Ohio.
Big Sandy River, a tributary of the Ohio.

Attachment 3: Water use in the U.S.

Table 2-1: Main water users in U.S.		
Sector	bgd	Percent of total
Thermoelectric power industry	195	48
Irrigation	137	34
Public supply	45	11
Industrial	20	5
Other	8	2
Total	405	100

In the U.S., water is used for a number of activities such as irrigating cropland and recreation. Billions of gallons of water are withdrawn from rivers, lakes, and underground sources each day for things taken for granted like electric power generation. According the USGS *Estimated Water Use in the United States in 2000*, around 405 billion gallons per day (bgd) are withdrawn for all types of uses. Of these withdrawals, about 85 percent are fresh water and the other 15 percent are from saline sources. Surface water withdrawals, which include lakes, reservoirs, and rivers, amount to 323 bgd. The most total water withdrawn, including fresh and saline, is used for the thermoelectric power industry. This water is used to generate electricity using steam-driven turbines. The water used is taken in for use in plant's cooling systems. It is estimated that almost half of total withdrawals, 195 bgd or 48%, are made for this reason.

Irrigation is the next largest consumer of water, all of which is fresh. At 34% of total withdrawals, 137 bgd are used to irrigate cropland. With an increasing amount of arid land due to the build up of greenhouse gases in Earth's atmosphere, and more land being utilized for farming of biofuel components, such as soy, the amount of water needed for irrigation is on the rise. According the USGS, between 1995 and 2000 the amount rose about 2%. This number is expected to increase further in the future.

Public supply accounts for 11% of total water withdrawals in the U.S. These withdrawals are used for things such as public swimming pools and firefighting. The USGS estimates that about 85% of the U.S.'s population relies on public-supply water, with its majority coming from surface water withdrawals. The use of public-supply water is on the rise as well and only expected to keep increasing with the population.

Water used to produce food, paper, chemicals, and other commodities is on a decline. Self-supplied industrial water usage now accounts for 19.7 bgd, and declined about 12% in the period from 1995 to 2000. Surface water is the primary source for this category. This pattern of decline may be a result of job-loss and industry decline and continue, or a result of increased environmental standards and begin to steady.

The USGS lumps together self-supply domestic, livestock, aquaculture, and mining. These withdrawals only comprise 2% of the total. These categories are also highly variable.

Self-supply domestic however, is expected to decline as more municipal water facilities become available.

However the breakdown of water withdrawals trends, the one thing that is certain is that the overall water needs of this country will increase with an increasing population. Whether the withdrawals are from rivers, lakes, groundwater, or even the oceans, billions of gallons a day will continue to be necessary for the U.S. to run smoothly.

United States Geological Survey. (2004). *Estimated water use in the United States in 2000* (USGS Circular 1268). Reston, Virginia.

The Water Intake Survey for Navigation Pools on the Ohio River is approved, subject to the terms of clearance for OMB control number 0710-0001

Attachment 4: Water Intake Survey; OMB 0710-0001

Interviewer: _____ Date: _____

Respondent: _____ Title: _____

Company: _____ Intake River: _____ Mile: _____ Bank: _____

As you probably know, the Corps of Engineers is responsible for maintaining water levels to facilitate barge transport and to assure water supply on the rivers. The Corps of Engineers is conducting a study that is assessing effects on the economy and employment that might result from the unlikely event of failure of one of the locks or dams, resulting in drop in water levels, so that withdrawal of water from the rivers would have to be restricted for some period of time, such as:

Short Duration (up to 30 days)

Intermediate Duration (30 to 180 days), or

Long Duration (180 days or more)

Section I General

Question #1 I have information that your company draws water from the river at River Mile _____. Is this correct? _____

Question #2 If so, how much water do you draw on an average day? _____

Question #3 What is your company's Water Intake Elevation, in feet? _____ (WIE)

Note: Interviewer estimates Lowered River Surface Elevation (LRSE), in feet, at the respondent's location: _____. If WIE < (LRSE - 2 feet) then Stop!, and report "No Effect". If WIE > (LRSE - 2 feet), then proceed to Section II.

Section II -- Short Duration Drop in Water Level -- up-to 30 days

In the event of a *short duration drop in river water level*, to elevation _____ (LRSE) at your location, so that your water intake would be above or close to the surface --

Question #4 Would your company obtain water from an alternate source? _____ At what capital cost? _____ At what ongoing cost per week

(operating cost) _____? Note: If respondent is unable to estimate costs, obtain description of work required, so contractor can estimate costs.

Question #5 Would you modify your intake equipment to continue to draw river water? _____ At what capital cost? _____ At what ongoing cost per week (operating cost) _____? Note: If respondent is unable to estimate costs, obtain description of work required, so contractor can estimate costs.

Question #6 Would you have to curtail operations?_____ What would be the value of lost sales (per week)? _____ How many jobs would be lost? _____

If you and other users of river water were *completely prohibited* from drawing river water from the same river pool --

Question #7 Do you have an alternate source of water that does not involve the same river pool? _____ Would that require capital investment? How much?_____ At what ongoing cost per week (operating cost) _____? Note: If respondent is unable to estimate costs, obtain description of work required, so contractor can estimate costs.

Question #8 Would you have to curtail operations in this case? _____ What would be the value of lost sales (per week)? _____ How many jobs would be lost? _____

Question #9 Can you name any particular customers of yours that may have to reduce their own production if this were to happen? _____

Section III -- Intermediate Duration Drop in Water Level -- 30 days to 180 days

In the event of an *intermediate duration drop in river water level*, to elevation _____ (LRSE) at your location, so that your water intake would be above or close to the surface --

Question #10 Would your company obtain water from an alternate source? _____ At what capital cost? _____ At what ongoing cost per week (operating cost) _____? Note: If respondent is unable to estimate costs, obtain description of work required, so contractor can estimate costs.

Question #11 Would you modify your intake equipment to continue to draw river water? _____ At what capital cost? _____ At what ongoing cost per week (operating cost) _____? Note: If respondent is unable to estimate costs, obtain description of work required, so contractor can estimate costs.

Question #12 Would you have to curtail operations?_____ What would be the value of lost sales (per week)? _____ How many jobs would be lost? _____

If you and other users of river water were *completely prohibited* from drawing river water from the same river pool --

Question #13 Do you have an alternate source of water that does not involve the same river pool? _____ Would that require capital investment? How much?_____ At what ongoing cost per week (operating cost) _____? Note: If respondent is unable to estimate costs, obtain description of work required, so contractor can estimate costs.

Question #14 Would you have to curtail operations in this case? _____ What would be the value of lost sales (per week)? _____ How many jobs would be lost? _____

Question #15 Can you name any particular customers of yours that may have to reduce their own production if this were to happen? _____

Section IV -- Long Duration Drop in Water Level -- Two Years or More

In the event of an *long duration drop in river water level,* to elevation _____ (LRSE) at your location, so that your water intake would be above or close to the surface --

Question #16 Would your company obtain water from an alternate source? _____ At what capital cost? _____ At what ongoing cost per week (operating cost) _____? Note: If respondent is unable to estimate costs, obtain description of work required, so contractor can estimate costs.

Question #17 Would you modify your intake equipment to continue to draw river water? _____ At what capital cost? _____ At what ongoing cost per week (operating cost) _____? Note: If respondent is unable to estimate costs, obtain description of work required, so contractor can estimate costs.

Question #18 Would you have to curtail operations?_____ What would be the value of lost sales (per week)? _____ How many jobs would be lost? _____

If you and other users of river water were *completely prohibited* from drawing river water from the same river pool --

Question #19 Do you have an alternate source of water that does not involve the same river pool? _____ Would that require capital investment? How much?_____ At what ongoing cost per week

(operating cost) _____? Note: If respondent is unable to estimate costs, obtain description of work required, so contractor can estimate costs.

Question #20 Would you have to curtail operations in this case? _____ What would be the value of lost sales (per week)? _____ How many jobs would be lost? _____

Question #21 Can you name any particular customers of yours that may have to reduce their own production if this were to happen? _____

Section V -- Do you have any comments for the Corps of Engineers on this subject? _____

_____

_____

_____

_____

Attachment 5: Municipal Plans in the Event of a Water Shortage

All of the 120 owners of municipal water intakes were surveyed regarding the impact of the possible loss of water supplies. Most responded that there were no alternatives to river withdrawals that could provide all or even a significant portion of the water they require. If there was a temporary reduction in water supplies, municipalities would conserve water by implementing restriction on water usage. A typical water plan of a municipality is shown in the table below. The loss of supplies below normal levels would result in a "watch" situation. Generally, the area will remain in a watch situation as long as 75 percent of its normal volume of water supplies is available. When available supplies fall to 56 to 75 percent of normal the area will be designated in a "warning" situation with mandatory restrictions on water use. An "emergency" situation is declared when water supplies are between 38 and 56 percent of normal. There are no official plans for situations when water supplies are below 38 percent of normal but the situation would become untenable. At its most critical level the municipality would trend towards becoming a temporary ghost town. Long term or permanent loss of water supplies would not allow an eventual recovery.

Table 14: Typical Municipal Water Supply Plan

	Action	Supply in MGD	Pool Elevation in reservoir
Normal	None	27.7	905.2
Watch	Voluntary conservation	21.2	899.8
Warning	No watering lawns, etc.	15.5	895.3
Emergency	Close car washes, etc.	10.6	891.0

Attachment 6: Electric Generating Facilities in the Ohio Basin

River	Facility	River Mile	Pool	Water intake (mgd)	Possible intake amount (mgd)
Allegheny	Reliant Energy Inc. (Cheswick Power Station)	15.5	L/D 3	254.0	376.0
Allegheny	Allegheny Energy Inc. (Unit 3, 4, 5 Power Station-Natural Gas)	17.4	L/D 3	1.3	4.7
Allegheny	Allegheny Energy Inc. (Armstrong Power Station)	55.2	L/D 8	154.2	191.5
Clinch	Tennessee Valley Authority (Cumberland City Power Station)	103.4	Barkley	2,075.4	2,075.4
Clinch	Tennessee Valley Authority (Gallatin Power Station)	243.9	Old Hickory	940.4	940.4
Clinch	Tennessee Valley Authority (Hartsville Nuclear Plant)	284.1	Old Hickory	0.0	0.0
Cumberland	Big Rivers Electric Corp. (Robert A. Reid Power Station)	41.1	L/D 1	73.3	193.0
Cumberland	Big Rivers Electric Corp. (D.B. Wilson Power Station)	74	L/D 2	6.1	8.3
Cumberland	E.ON U.S. (Green River Power Station)	81.8	L/D 2	194.4	211.2
Green	Tennessee Valley Authority (Paradise Power Station)	100.56	L/D 2	1.2	2.0
Green	American Electric Power (John E. Amos Power Station)	39	Winfield	42.8	77.8
Green	AEP Co. Cabin Creek Junction	74.3	Marmet	0.0	0.0
Green	American Electric Power (Kanawha River Power Station)	77.5	Marmet	354.5	644.5
Kanawha	AEP Co. Glasgow	78.6	Marmet	0.0	0.0
Monongahela	Reliant Energy Inc. (Elrama Power Station)	25	L/D 3	350.0	546.5
Monongahela	Allegheny Energy Inc. (Mitchell Power Station)	29.5	L/D 3	163.6	323.7
Monongahela	Duke Energy (Fayette Power Station)	77.7	Maxwell	7.1	18.5
Monongahela	Allegheny Energy Inc. (Hatfield Ferry Power Station)	79	Maxwell	25.0	50.4
Monongahela	Alleghney Energy Inc. (Fort Martin Power Station)	92.4	Pt. Marion	12.9	29.5
Monongahela	Dominion (Morgantown Power Station)	100.5	Pt. Marion	73.5	133.6
Monongahela	Allegheny Energy Inc. (Rivesville Power Station)	122.2	Opekiska	39.3	131.7
Ohio	Reliant Energy Inc. (Brunot Island Power Station)	2.4	Emsworth	0.1	5.8
Ohio	Reliant Energy Inc. (Phillips Power Station)	15.1	Montgomery	0.0	0.0
Ohio	FirstEnergy Co. (Bruce Mansfield Power Station)	33.7	New Cumberland	70.0	70.0
Ohio	FirstEnergy Co. (Beaver Valley Nuclear Power Station)	34.6	New Cumberland	1,239.2	2,201.8

River	Facility	River Mile	Pool	Water intake (mgd)	Possible intake amount (mgd)
Ohio	FirstEnergy Co. (Sammis Power Station)	53.8	New Cumberland	1,111.8	2,021.5
Ohio	FirstEnergy Co. (Toronto Power Station)	57.5	Pike Island	0.0	0.0
Ohio	Buckeye Power Inc. (Cardinal Power Station 2/3)	77.3	Pike Island	54.9	99.8
Ohio	American Electric Power (Tidd Power Station)	77.4	Pike Island	0.0	0.0
Ohio	American Electric Power (Cardinal Power Station)	79.9	Pike Island	1,165.4	1,165.4
Ohio	FirstEnergy Co. (R.E. Burger Power Stationf)	102.4	Hannibal	307.9	559.9
Ohio	American Electric Power (Kammer Power Station)	111.1	Hannibal	0.0	0.0
Ohio	American Electric Power (Mitchell Power Station)	112.4	Hannibal	0.0	0.0
Ohio	Allegheny Energy Inc. (Willow Island Power Station)	160.5	Willow Island	80.8	203.0
Ohio	Allegheny Energy Inc. (Pleaseants Power Station)	160.6	Willow Island	18.7	21.1
Ohio	American Municipal Power-Ohio (Richard H. Gorsuch Power Station)	176.6	Belleville	254.5	1,520.4
Ohio	American Electric Power (Phillip Sporn Power Station)	241.6	Robert C. Byrd	0.0	0.0
Ohio	American Electric Power (Mountaineer Power Station)	242.9	Robert C. Byrd	0.0	0.0
Ohio	American Electric Power (James M. Gavin Power Station)	258.5	Robert C. Byrd	43.3	43.3
Ohio	Ohio Valley Electric Corp. (Kyger Creek Power Station)	259.6	Robert C. Byrd	1,178.0	1,178.0
Ohio	American Electric Power (Big Sandy Power Station)	317	Greenup	19.4	19.4
Ohio	Dayton Power & Light (Killen Power Station)	390.7	Meldahl	20.0	36.4
Ohio	Duke Energy (J.M. Stuart Power Station)	404.7	Meldahl	252.0	458.2
Ohio	East Kentucky Power Cooperative (Spurlock Power Station)	414.1	Meldahl	4.5	8.9
Ohio	Duke Energy (Zimmer Power Station)	443.2	Markland	42.5	42.5
Ohio	Duke Energy (Beckjord Power Station)	452.9	Markland	617.0	617.0
Ohio	Duke Energy (Miami Fort Power Station)	490.1	Markland	166.0	166.0
Ohio	American Electric Power (Tanners Creek Power Station)	494.1	Markland	437.0	922.0
Ohio	Duke Energy (East Bend Power Station)	511.4	Markland	18.1	32.9
Ohio	E.ON U.S. (Ghent Power Station)	536.4	McAlpine	70.0	127.3

River	Facility	River Mile	Pool	Water intake (mgd)	Possible intake amount (mgd)
Ohio	Ohio Valley Electric Corp. (Clifty Creek Power Station)	560	McAlpine	1,178.0	1,434.0
Ohio	E.ON U.S. (Trimble Power Station)	572	McAlpine	21.3	38.7
Ohio	E.ON U.S. (Ohio Falls Hydroelectric Power Station)	605	McAlpine	7.2	13.1
Ohio	Duke Energy (Gallagher Power Station)	610.3	Cannelton	150.0	260.0
Ohio	E.ON U.S. (Cane Run Power Station)	613	Cannelton	333.0	410.0
Ohio	E.ON U.S. (Mill Creek Power Station)	626	Cannelton	284.4	517.1
Ohio	Big Rivers Electric Corp. (Kenneth C. Coleman Power Station)	728.6	Newburgh	240.5	356.7
Ohio	American Electric Power (Rockport Power Station)	744.8	Newburgh	12.1	11.5
Ohio	Owensboro Municipal Utilities (Elmer Smith Power Station)	755.5	Newburgh	247.1	272.1
Ohio	Vectren Corp. (F.B. Culley Power Station)	773.8	Newburgh	0.0	0.0
Ohio	Vectren Corp. / Alcoa Inc. (Warrick Power Station)	793.9	Newburgh	0.0	0.0
Ohio	Henderson Municipal Power & Light (Henderson Power Station)	803.9	J.T. Meyers	0.0	0.0
Ohio	Vectren Corp. (A.B. Brown Power Station)	817	J.T. Meyers	5.7	10.4
Ohio	Tennessee Valley Authority (Shawnee Power Station)	945.9	L/D 53	60.0	80.6
Ohio	Ameren Corp. (Joppa Power Station)	952.3	L/D 53	598.0	725.8
Tennessee	Tennessee Valley Authority (Johnsonville Power Station)	100	Kentucky	1,226.9	2,230.7
Tennessee	Tennessee Valley Authority (Colbert Power Station)	245.3	Pickwick	1,294.1	1,294.1
Tennessee	Tennessee Valley Authority (Browns Ferry Nuclear Plant)	294.2	Wheeler	1,990.2	3,618.6
Tennessee	Tennessee Valley Authority (Bull Run Power Station)	367.8	Melton Hill	563.2	563.2
Tennessee	Tennessee Valley Authority (Kingston Power Station)	367.8	Watts Bar	1,280.0	1,280.0
Tennessee	Tennessee Valley Authority (Bellefonte Nuclear Plant)	391.2	Guntersville	0.0	0.0
Tennessee	Tennessee Valley Authority (Widows Creek Power Station)	407.6	Guntersville	1,476.3	2,684.2
Tennessee	Tennessee Valley Authority (Yellow Creek Nuclear Plant)	448.5	Nickajack	0.0	0.0
Tennessee	Tennessee Valley Authority (Sequoyah Nuclear Plant)	484.9	Chickamauga	1,539.3	2,798.7
Tennessee	Tennessee Valley Authority (Watts Bar Nuclear Plant)	529.1	Chickamauga	188.2	188.2
Total:				**24,635.6**	**36,267.0**

Attachment 7: List of Industrial Facilities

The numbers of jobs at risk along with salaries and earnings was compiled from the owners list of intakes and the Harris directory of plants in the eight state area. There are 215 industrial facilities along the navigation system that extract water for industrial production purposes. These facilities provide 38,439 jobs and have annual sales of $13.2 trillion, as shown in Table 15. They are the core of the region's manufacturing sector.

Table 15: Companies dependent on Ohio River water supplies by river

River	Number	Ave. daily withdrawals (mgd)	Employment	Sales (billion US $)
Allegheny	6	412.4	1,506	$634.3
Clinch	4	1,283.5	0	
Cumberland	5	14.0	16	$7.9
Green	8	89.3	9,079	$448.8
Kanawha	34	570.1	334	$99.7
Kentucky	5	20.3	576	$124.9
Monongahela	9	868.2	3,678	$999.4
Ohio	96	11,044.9	16,367	$7,317.7
Tennessee	48	2,061.2	6,883	$3,603.6
Total:	**215**	**16,363.9**	**38,439**	**$13,236.4**

River	Facility	River Mile	Pool	Water intake (mgd)	Employees	Sales
Allegheny	Reliant Energy Inc. (Cheswick Power Station)	15.5	L/D 3	254.0	80	51,619,680
Allegheny	Allegheny Energy Inc. (Unit 3, 4, 5 Power Station-Natural Gas)	17.4	L/D 3	1.3	0	0
Allegheny	Allegheny Ludlum Steel Corp	24.4	L/D 4	0.0	500	194,368,500
Allegheny	Braeburn Alloy Steel Co	24.4	L/D 4	1.4	0	0
Allegheny	Glacial Sand & Gravel Co	49.4	L/D 7	0.0	0	0
Allegheny	Allegheny Energy Inc. (Armstrong Power Station)	55.2	L/D 8	154.2	72	46,457,712
Cumberland	Tennessee Valley Authority (Cumberland City Power Station)	103.4	Barkley	2,075.4	15	7,490,535
Cumberland	Winn Materials	123.6	Barkley	0.2	0	0
Cumberland	Ford Motor company	182.1	Cheatham	14.0	0	0
Cumberland	Nashville Thermal Transfer Corp.	191.3	Cheatham	0.0	0	0

River	Facility	River Mile	Pool	Water intake (mgd)	Employees	Sales
Cumberland	E.I. Du Pont de Nemours and Co.	218.5	Old Hickory	0.0	50	36,914,650
Cumberland	Blue Grass country Club	227.4	Old Hickory	0.0	0	0
Cumberland	Boxwell Boy scout Camp	237.0	Old Hickory	0.0	0	0
Cumberland	Tennessee Valley Authority (Gallatin Power Station)	243.9	Old Hickory	940.4	150	74,905,350
Cumberland	Tennessee Valley Authority (Hartsville Nuclear Plant)	284.1	Old Hickory	0.0	0	0
Cumberland	New Jersey Zinc Company	309.1	Old Hickory	0.0	0	0
Cumberland	USACE	331.5	Old Hickory	0.0	0	0
Green	Cash Creek Generation	32.5	L/D 1	8.4	0	0
Green	Alcan Primary Metals Group	40.4	L/D 1	0.3	0	0
Green	Big Rivers Electric Corp. (Robert A. Reid Power Station)	41.1	L/D 1	73.3	0	0
Green	Big Rivers Electric Corp. (D.B. Wilson Power Station)	74.0	L/D 2	6.1	0	0
Green	E.ON U.S. (Green River Power Station)	81.8	L/D 2	194.4	0	0
Green	Tennessee Valley Authority (Paradise Power Station)	100.56	L/D 2	1.2	0	0
Kanawha	American Electric Power (John E. Amos Power Station)	39.0	Winfield	42.8	12	7,742,952
Kanawha	Union Boiler Co	39.9	Winfield	0.0	20	6,911,160
Kanawha	Williams Union Boiler Co.	40.0	Winfield	0.0	20	6,911,160
Kanawha	Arrow Concrete Company Parkersburg	41.8	Winfield	0.0	35	36,100,000
Kanawha	Ohio Apex. Inc. (Apex Pipeline Services, Inc.)	42.5	Winfield	0.0	50	6,500,000
Kanawha	Par Industrial Corp.	42.8	Winfield	0.0	0	0
Kanawha	P.B.& S. Chemical Co. Inc. Putnam Co.	43.1	Winfield	0.0	0	0
Kanawha	Horn Brother Oil Co. Putnam Co.	43.5	Winfield	0.0	0	0
Kanawha	Columbia Gas Transmission Corp. Putnam Co.	44.3	Winfield	0.0	4	5,646,108
Kanawha	Bayer CropScience LP, Institute Plant Kanawha	48	Winfield	0.0	500	408,040,500
Kanawha	Union Carbide South Charleston facility, Kanawha Co.	52.35	Winfield	38.8	800	258,452,800

River	Facility	River Mile	Pool	Water intake (mgd)	Employees	Sales
Kanawha	CLEARON CORP. (Olin Chemical) Kanawha Co.	54.0	Winfield	0.0	0	0
Kanawha	FMC Corporation Steam Plant, Kanawha Co.	54.0	Winfield	0.0	94	30,368,204
Kanawha	Phone-Polulenc Ag. Co. Kanawha Co.	55.0	Winfield	0.0	0	0
Kanawha	True Temper Corp.	56.3	Winfield	0.0	0	0
Kanawha	E.I. Du Pont de Nemours and Co.	68.5	Marmet	0.0	50	16,153,300
Kanawha	N.Y.C.R.R. Co.	72.8	Marmet	0.0	0	0
Kanawha	Consolidated Gas Transmission Corp.	73.4	Marmet	0.0	0	0
Kanawha	AEP Co. Cabin Creek Junction	74.3	Marmet	0.0	50	24,968,450
Kanawha	Marmet Synfuel Kanawha Lens Creek Putnam Co.	74.4	Marmet	0.0	0	0
Kanawha	Cardox Corp	74.5	Marmet	0.0	0	0
Kanawha	American Electric Power (Kanawha River Power Station)	77.5	Marmet	354.5	0	0
Kanawha	AEP Co. Glasgow	78.6	Marmet	0.0	100	9,329,100
Kanawha	Valley Camp Coal Co.	81.3	Marmet	0.0	0	0
Kanawha	Mammoth Coal Processing Kanawha	84.2	Winfield	0.0	0	0
Kanawha	Cannelton Coal & Coke	84.4	London	0.0	200	72,111,000
Kanawha	Town of Boomer	88.9	London	0.0	0	0
Kanawha	Elkem Metals Alloy L.P. Fayette	89.8	London	0.0	0	0
Kanawha	Land Use Corp.	89.9	London	0.0	0	0
Kanawha	Armstrong PSD Fayette	90.4	London	0.0	0	0
Kanawha	Deep Water PSD Fayette	90.4	London	0.0	0	0
Kentucky	Liters Quarry, Inc.	30.1	L/D 2	0.0	0	0
Kentucky	Buffalo Trace Distillery	64.7	L/D 4	0.1	200	27,950,600
Kentucky	Capital Powerhouse	67.8	L/D 5	0.0	0	0
Kentucky	Harrod Concrete and Stone	70.3	L/D 5	0.2	0	0
Monongahela	US Steel Corp (Edgar Thompson works)	11.2	L/D 2	190.8	600	233,242,200
Monongahela	US Steel Corp Clairton Works	20.1	L/D 2	52.4	1,300	505,358,100
Monongahela	Reliant Energy Inc. (Elrama Power Station)	25.0	L/D 3	350.0	20	12,904,920

River	Facility	River Mile	Pool	Water intake (mgd)	Employees	Sales
Monongahela	Allegheny Energy Inc. (Mitchell Power Station)	29.5	L/D 3	163.6	80	9,500,000
Monongahela	Wheeling Pittsburgh Steel Corp	46.8	L/D 4	0.0	350	136,057,950
Monongahela	Duke Energy (Fayette Power Station)	77.7	Maxwell	7.1	11	5,493,059
Monongahela	Allegheny Energy Inc. (Hatfield Ferry Power Station)	79.0	Maxwell	25.0	22	14,195,412
Monongahela	Alleghney Energy Inc. (Fort Martin Power Station)	92.4	Pt. Marion	12.9	1,000	789,886,000
Monongahela	Dominion (Morgantown Power Station)	100.5	Pt. Marion	73.5	0	0
Monongahela	Allegheny Energy Inc. (Rivesville Power Station)	122.2	Opekiska	39.3	0	0
Ohio	Reliant Energy Inc. (Brunot Island Power Station)	2.4	Emsworth	0.1	14	9,033,444
Ohio	US Steel Corp Irving works	8.6	Emsworth	25.0	0	0
Ohio	Reliant Energy Inc. (Phillips Power Station)	15.1	Montgomery	0.0	0	0
Ohio	Horsehead Corporation	28.5	Montgomery	81.9	1,500	67,143,000
Ohio	FirstEnergy Co. (Bruce Mansfield Power Station)	33.7	New Cumberland	70.0	220	12,556,280
Ohio	FirstEnergy Co. (Beaver Valley Nuclear Power Station)	34.6	New Cumberland	1,239.2	0	0
Ohio	FirstEnergy Co. (Sammis Power Station)	53.8	New Cumberland	1,111.8	60	38,714,760
Ohio	FirstEnergy Co. (Toronto Power Station)	57.5	Pike Island	0.0	0	0
Ohio	Mittal Steel USA - Weirton Plant Hancock	62.2	Pike Island	0.0	2,100	468,300,000
Ohio		68.5	Pike Island	97.1	500	194,368,500
Ohio	Koppers Inc. Brooke	69.2	Pike Island	0.0	90	72,271,530
Ohio	Follansbee Hooverson Heights Water Treatmnt Plant Brooke	70.8	Pike Island	0.0	0	0
Ohio	Wheeling Pittsburgh Steel Corp	70.9	Pike Island	44.1	0	0
Ohio	Buckeye Power Inc. (Cardinal Power Station 2/3)	77.3	Pike Island	54.9	300	193,573,800
Ohio	American Electric Power (Tidd Power Station)	77.4	Pike Island	0.0	0	0

River	Facility	River Mile	Pool	Water intake (mgd)	Employees	Sales
Ohio	American Electric Power (Cardinal Power Station)	79.9	Pike Island	1,165.4	0	0
Ohio	Wheeling Pittsburgh Steel Corp	83.3	Pike Island	0.0	825	337,915,800
Ohio	Wheeling Pittsburgh Steel Corp	83.6	Pike Island	3.3	0	0
Ohio	Wheeling Pittsburgh Steel Corp	87.9	Hannibal	0.0	350	136,057,950
Ohio	FirstEnergy Co. (R.E. Burger Power Stationf)	102.4	Hannibal	307.9	140	90,334,440
Ohio	American Electric Power (Kammer Power Station)	111.1	Hannibal	0.0	0	0
Ohio	American Electric Power (Mitchell Power Station)	112.4	Hannibal	0.0	100	64,524,600
Ohio	PPG (Natrium) Marshall	119.0	Hannibal	0.0	0	0
Ohio	Bayer Material Science LLC Marshall	121.3	Hannibal	0.0	500	161,533,000
Ohio	Union Carbide Corp. (Ranney Water Collection)	144.8	Willow Island	0.0	0	0
Ohio	Allegheny Energy Inc. (Willow Island Power Station)	160.5	Willow Island	80.8	0	0
Ohio	Allegheny Energy Inc. (Pleaseants Power Station)	160.6	Willow Island	18.7	0	0
Ohio	American Cynamid Co.	160.9	Willow Island	0.0	400	179,771,100
Ohio	Cytec Industries Willow Island	162.0	Willow Island	0.0	400	142,812,000
Ohio	Willow Island Power Station, Pleasants Co.	162.0	Willow Island	3.0	250	161,311,500
Ohio	Cabot Corporation	164.1	Belleville	0.0	53	29,672,527
Ohio	American Municipal Power-Ohio (Richard H. Gorsuch Power Station)	176.6	Belleville	254.5	0	0
Ohio	E.I. Du Pont de Nemours and Co.	190.2	Belleville	0.0	50	6,273,850
Ohio	Dupont Washington Works	190.9	Belleville	0.0	0	0
Ohio	NORTHWEST PIPE CO.	191.0	Belleville	0.0	0	0
Ohio	GE CO.	191.5	Belleville	0.0	0	0
Ohio	Century Aluminum of WV	227.0	Racine	0.0	0	0
Ohio	Pechiney Rolled Products, LLC.[a]	227.0	Racine	0.0	1,200	133,300,000
Ohio	American Electric Power (Phillip Sporn Power Station)	241.6	Robert C. Byrd	0.0	0	0
Ohio	American Electric Power (Mountaineer Power Station)	242.9	Robert C. Byrd	0.0	0	0
Ohio	American Electric Power (James M. Gavin Power Station)	258.5	Robert C. Byrd	43.3	0	0

River	Facility	River Mile	Pool	Water intake (mgd)	Employees	Sales
Ohio	Ohio Valley Electric Corp. (Kyger Creek Power Station)	259.6	Robert C. Byrd	1,178.0	0	0
Ohio	Ceredo Dock, Wayne Co.	314.4	Greenup	0.0	0	0
Ohio	KANAWHA RIVER TERMINALS INC.	314.6	Greenup	0.0	10	29,264,710
Ohio	Sunoco Chemicals - Neal, Wayne Co.	316.0	Greenup	0.0	0	0
Ohio	Sandy River Synfuel, Wayne Co.	316.6	Greenup	0.0	60	290,000
Ohio	Marathon Ashland Petroleum Co.	316.9	Greenup	0.0	0	0
Ohio	American Electric Power (Big Sandy Power Station)	317.0	Greenup	19.4	0	0
Ohio	Aristech Corp.	317.0	Greenup	0.0	190	139,077,340
Ohio	Asland Oil, Inc.	317.0	Greenup	0.0	0	0
Ohio	Calgon Carbon Corp.	317.0	Greenup	0.0	0	0
Ohio	Columbia Gas Transmission	317.0	Greenup	0.0	10	5,813,080
Ohio	Kenova Municipal Water, Wayne Co.	317.0	Greenup	0.0	0	0
Ohio	Special Metals Co.	317.0	Greenup	0.0	1,000	282,747,000
Ohio	USS Chemicals	317.0	Greenup	0.0	0	0
Ohio	Hilltop Basic Resources Inc - Big Bend Quarry	321.4	Greenup	0.0	0	0
Ohio	Dayton Power & Light (Killen Power Station)	390.7	Meldahl	20.0	0	0
Ohio	TGM Constructors	400.0	Meldahl	0.0	0	0
Ohio	Duke Energy (J.M. Stuart Power Station)	404.7	Meldahl	252.0	0	0
Ohio	Inland Container Industrial	413.8	Meldahl	0.0	0	0
Ohio	East Kentucky Power Cooperative (Spurlock Power Station)	414.1	Meldahl	4.5	0	0
Ohio	North American Stainless	442.2	Markland	0.0	575	266,000,000
Ohio	Duke Energy (Zimmer Power Station)	443.2	Markland	42.5	0	0
Ohio	Duke Energy (Beckjord Power Station)	452.9	Markland	617.0	5	3,226,230
Ohio	Duke Energy (Miami Fort Power Station)	490.1	Markland	166.0	0	0
Ohio	American Electric Power (Tanners Creek Power Station)	494.1	Markland	437.0	100	10,595,300
Ohio	Duke Energy (East Bend Power Station)	511.4	Markland	18.1	0	0
Ohio	Gallatin Steel Co	533.0	Markland	0.0	380	71,300,000

River	Facility	River Mile	Pool	Water intake (mgd)	Employees	Sales
Ohio	E.ON U.S. (Ghent Power Station)	536.4	McAlpine	70.0	175	112,918,050
Ohio	Carmeuse Lime Inc	539.9	McAlpine	0.0	244	53,813,712
Ohio	Ohio Valley Electric Corp. (Clifty Creek Power Station)	560.0	McAlpine	1,178.0	362	233,579,052
Ohio	TIN Inc - Temple-Inland	568.1	McAlpine	0.0	144	29,521,584
Ohio	E.ON U.S. (Trimble Power Station)	572.0	McAlpine	21.3	6	3,871,476
Ohio	Charleston Ammo Depot Industrial	591.4	McAlpine	0.0	0	0
Ohio	River Sand & Gravel LLC	598.5	McAlpine	0.4	0	0
Ohio	Colgate Palmolive Co.	603.6	McAlpine	0.0	400	228,656,800
Ohio	E.ON U.S. (Ohio Falls Hydroelectric Power Station)	605.0	McAlpine	7.2	6	3,871,476
Ohio	Duke Energy (Gallagher Power Station)	610.3	Cannelton	150.0	5	3,226,230
Ohio	Air Products and Chemicals (formerly Airco Carbide)	612.7	Cannelton	0.0	5	2,093,925
Ohio	E.ON U.S. (Cane Run Power Station)	613.0	Cannelton	333.0	0	0
Ohio	Publicker and DuPont	613.4	Cannelton	0.0	0	0
Ohio	Rohm & Haas - Louisville Plant	613.5	Cannelton	0.0	700	512,390,200
Ohio	E.ON U.S. (Mill Creek Power Station)	626.0	Cannelton	284.4	6	3,871,476
Ohio	Kosmos Cement Industrial	626.9	Cannelton	0.0	0	0
Ohio	E I Dupont Inc	648.3	Cannelton	0.0	0	0
Ohio	AK Steel Corp - West Works	656.8	Cannelton	0.0	800	310,989,600
Ohio	Mulzer Crushed Stone Inc	674.0	Cannelton	0.0	0	0
Ohio	Colgate Palmolive Co	692.0	Cannelton	0.0	400	228,656,800
Ohio	Can-Tex Industrial	724.5	Newburgh	0.0	0	0
Ohio	Big Rivers Electric Corp. (Kenneth C. Coleman Power Station)	728.6	Newburgh	240.5	98	248,955,000
Ohio	American Electric Power (Rockport Power Station)	744.8	Newburgh	12.1	10	6,452,460
Ohio	Owensboro Municipal Utilities (Elmer Smith Power Station)	755.5	Newburgh	247.1	0	0
Ohio	Aluminum Company of America, Warrick Operations	773.0	Newburgh	0.0	0	0

River	Facility	River Mile	Pool	Water intake (mgd)	Employees	Sales
Ohio	Vectren Corp. (F.B. Culley Power Station)	773.8	Newburgh	0.0	0	0
Ohio	ALCOA Industrial	773.9	Newburgh	0.0	2,800	1,105,683,600
Ohio	Vectren Corp. / Alcoa Inc. (Warrick Power Station)	793.9	Newburgh	0.0	0	0
Ohio	Vectren Corp. (A.B. Brown Power Station)	817.0	J.T. Meyers	5.7	0	0
Ohio	GE Industrial	831.1	J.T. Meyers	0.0	0	0
Ohio	GE Plastics Mt. Vernon, Inc.	831.2	J.T. Meyers	0.0	0	0
Ohio	Peabody Coal Co - Camp 9 Coal Prep Plant	841.5	J.T. Meyers	0.0	23	1,300,000
Ohio	Tennessee Valley Authority (Shawnee Power Station)	945.9	L/D 53	60.0	275	15,100,000
Ohio	US Enrichment Corp	945.9	L/D 53	0.0	1,510	219,037,580
Ohio	Ameren Corp. (Joppa Power Station)	952.3	L/D 53	598.0	0	0
Ohio	Ballard Wildlife Management Area	965.6	L/D 53	0.0	0	0
Tennessee	North Star Steel	13.8	Kentucky	0.0	0	0
Tennessee	Elf Atochiem Co.	15.2	Kentucky	0.0	0	0
Tennessee	Arkema	15.9	Kentucky	6.1	395	127,611,070
Tennessee	West Lake Chemical Co.	18.0	Kentucky	0.0	0	0
Tennessee	Inland Container Corp.	94.4	Kentucky	4.0	0	0
Tennessee	Consolidated Aluminum Corp.	95.5	Kentucky	3.0	0	0
Tennessee	E.I. Du Pont de Nemours and Co.	98.6	Kentucky	0.1	50	21,692,000
Tennessee	Tennessee Valley Authority (Johnsonville Power Station)	100.0	Kentucky	1,226.9	280	180,668,880
Tennessee	New Johnsonvile	100.7	Kentucky	0.4	0	0
Tennessee	Union Carbide Corp.*****	128.9	Kentucky-Duck	0.0	0	0
Tennessee	Koch Asphalt Co.	134.8	Kentucky	0.0	0	0
Tennessee	Clyde Owen Sand and Gravel Co. Inc.	197.4	Kentucky	0.0	0	0
Tennessee	TN River Pulp and Paper	205.4	Pickwick	27.0	0	0
Tennessee	Tennessee Valley Authority (Colbert Power Station)	245.3	Pickwick	1,294.1	0	0
Tennessee	Tristates Limestone Co.	249.5	Pickwick	0.0	0	0
Tennessee	Renyolds Metal Company	261.0	Wilson	0.0	1	394,887
Tennessee	U.S. Plywood-Champion Paper Inc.	282.0	Wheeler	55.8	0	0
Tennessee	Athens******	285.0	Wheeler	7.0	0	0

River	Facility	River Mile	Pool	Water intake (mgd)	Employees	Sales
Tennessee	Eagle Snacks******	285.0	Wheeler	0.0	0	0
Tennessee	Frito Lay******	285.0	Wheeler	0.1	57	27,355,554
Tennessee	Tennessee Valley Authority (Browns Ferry Nuclear Plant)	294.2	Wheeler	1,990.2	4,000	1,997,476,000
Tennessee	AMOCO Chemicals Corp.	299.4	Wheeler	3.2	0	0
Tennessee	Minnesota Manufacture and Mine Inc.	299.7	Wheeler	11.5	22	1,938,302
Tennessee	Decatur Ice and Coal Co.	304.8	Wheeler	0.0	0	0
Tennessee	Redstone Arsenal	323.9	Wheeler	0.0	10	1,100,000
Tennessee	Huntsville Arsenal	330.2	Wheeler	12.2	0	0
Tennessee	Butler Rubber Co. Inc.	358.2	Guntersville	0.0	7	524,000
Tennessee	Top Flite Rubber Inc.	358.5	Guntersville	0.0	0	0
Tennessee	Yokohama Rubber Inc.	358.9	Guntersville	0.0	0	0
Tennessee	Monsanto Textiles Co.	364.3	Guntersville	0.0	0	0
Tennessee	E.A. Wright	367.8	Melton Hill	0.0	0	0
Tennessee	Modine Manufacturing Co.	367.8	Melton Hill	0.0	0	0
Tennessee	Tennessee Valley Authority (Bull Run Power Station)	367.8	Melton Hill	563.2	0	0
Tennessee	U.S. Atomic Energy Commision (Clinch River Breeder Reactor Project)	367.8	Melton Hill	0.0	0	0
Tennessee	Tennessee Valley Authority (Kingston Power Station)	367.8	Watts Bar	1,280.0	0	0
Tennessee	Tennessee Valley Authority (Bellefonte Nuclear Plant)	391.2	Guntersville	0.0	0	0
Tennessee	Mead Paperboard	405.2	Guntersville	4.0	0	0
Tennessee	Tennessee Valley Authority (Widows Creek Power Station)	407.6	Guntersville	1,476.3	550	354,885,300
Tennessee	Vulcan Construction Materials	417.0	Guntersville	0.0	9	1,239,831
Tennessee	Tennessee Paper Mills Ind.	437.5	Nickajack	0.0	0	0
Tennessee	Tennessee Valley Authority (Yellow Creek Nuclear Plant)	448.5	Nickajack	0.0	0	0
Tennessee	Signal Mountain Cement	454.2	Nickajack	2.9	13	990,000
Tennessee	Rock-Tenn Co.	463.5	Nickajack	0.7	154	55,883,058

River	Facility	River Mile	Pool	Water intake (mgd)	Employees	Sales
Tennessee	Tennessee Valley Authority (Sequoyah Nuclear Plant)	484.9	Chickamauga	1,539.3	3,000	1,935,738,000
Tennessee	Tennessee Valley Authority (Watts Bar Nuclear Plant)	529.1	Chickamauga	188.2	200	129,049,200
Tennessee	Kimberly Clark Corp.	589.5	Watts Bar	0.0	360	120,375,360
Tennessee	Union Carbide Corp.	591.8	Watts Bar	2.0	0	0
Tennessee	Robert Shaw Controls Co.	617.2	Ft Loudon	0.0	49	6,706,238
Tennessee	American Limestone Co.	632.0	Ft Loudon	0.1	0	0
Tennessee	Modine Manufacturing Co.	632.0	Ft Loudon	0.1	0	0
Tennessee	Newport Utilities	632.0	Ft Loudon	0.0	0	0
Tennessee	Northeast Knox Utility	632.0	Ft Loudon	1.0	0	0
Tennessee	Holliston Mill Inc.	632.0	Ft Loudon	0.0	0	0
TOTAL:				**25,338.3**	**34,893.0**	**$14,630,977,844**

Attachment 8: Source of Water Pricing Data

1. General: The inland navigation system is an important source of water for communities and businesses as well as an efficient mode of transportation. There are two principle methods of estimating the value of water using economic principles as identified in ER 1105-2-100, page E-208: 1) determine the alternative cost of providing the water; and 2) estimate the cost based on the cost of constructing the facility or portion of the facility that stores the water. Both methods were considered in this evaluation.

2. Sources of information: Five sources of information were referenced to obtain water pricing data as listed in Table 8-1:

1) a current water supply contract developed by Pittsburgh District;
2) an inventory of prices about 25% of the water supply contracts managed by the Corps of Engineers;
3) the value used in the nationwide Portfolio Risk Assessment (PRA); and
4) the cost used in the Emsworth dam rehabilitation study.

The first three sources provide costs based on updated construction costs while the fourth is a combination of the one and two.

Table 8-1: Sources for Water Supply Storage Pricing Information

1	Portfolio Risk Assessment of Corps Dams	Estimate of water supply storage value
2	Pittsburgh contract	Amount charges for water storage in 2010 contract
3	Emsworth Rehab Study	Estimated cost of extending pipeline into river if necessitated by a pool draw down
4	Corps water supply contracts	Amounts charge for water storage in Corps reservoirs

Water supply storage costs from each source are summarized in Table 8-2. The derivation of the data from each source is explained in the sections that follow. All annualized values are based on a 30 year payback period, a 7 % interest rate, and are listed at October 2010 price levels.

Table 8-2: Water supply storage pricing data

($ Oct 2010 price level)							
Source	Capital cost per ACF	Annualized cost per ACF	Cost for 1 mgd unadjusted for yield	Yield factor	Cost for 1 mgd adjusted for yield	Cost per million gallons	Cost per gallon
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	(from data)	(7%; 30 yr)	1,120	(Productivity)		365	1000000
		(0.081 x (1))	(1,120 x (2))	(from data)	((3) / (4))	((5) / 365)	((6) / 1,000,000))
PRA	$ 755	$ 61	$ 68,142	1.5	$ 45,949	$ 125.9	$ 0.000126
Pittsburgh contract	$ 908	$ 73	$ 81,922	1.9	$ 43,026	$ 117.9	$ 0.000118
Pipe extention	$ 8,290	$ 668	$ 748,250	1.5	$ 504,553	$ 1,382.3	$ 0.001382
Corps contracts	$ 470	$ 38	$ 42,461	1.5	$ 28,632	$ 78.4	$ 0.000078
Average	$ 2,606	$ 210	$ 235,194	1.6	$ 155,540	$ 426.1	$ 0.000426

3. PRA costs: The portfolio risk assessment team was tasked with performing a reconnaissance study of each Corps dam in terms of reliability and consequences of failure. One possible consequence of failure was loss of water supply storage. The cost they arrived at based largely on experience with water storage in the northwest was an annualized $60 per acre-foot updated in this study to $61 per acre-foot. They did not develop a yield factor or convert the cost per acf into a cost per mgd.

$61 per acf

The other numbers listed on the PRA line were back calculated from this single number. For example, the cost per acre foot was computed by capitalizing the annualized value:

$61 x (1/.081) = $755

The yield factor was the average yield from water storage projects under Corps contracts.

4. Pittsburgh District contract: A draft contract for water storage in a Pittsburgh District Reservoir was prepared by the Pittsburgh District in 2008 using updated construction costs and current O&M costs to compute the costs to the potential buyer of storage. Selected data used in the computation are listed in Table 8-3. The cost of providing storage for 10,000 acre feet was $9,076,564, or $908 per acre-foot. The annual equivalent payment amount based on a 30 year payback period and a discount rate of 7 % is $73 per acre-foot. The yield factor at the project is higher than average, which lowers the cost per gallon nearer to the overall average.

Table 8-3: Storage and cost data used in actual contract computations

MGD	Acre-feet	Pro-rated construction cost
1	588	$533,916
5	2,941	$ 2,669,578
10	5,882	$ 5,339,155
17	10,000	$ 9,076,564

5. Pipe extension - cost used in Emsworth Dam Rehab Study: Emsworth is a locks and dam project on the Ohio River 6.7 miles downstream of the City of Pittsburgh. A rehabilitation study was performed for the project in the year 2000. One of the potential consequences of failure was the loss of water supply. The cost attributable to the loss of water supply was based on the cost of extending the intake piping further into the river and the additional electricity cost for pumping. The duration of pool loss was 30 days. The estimated cost to extend the withdrawal pipe and the additional power to pump water was the equivalent of $0.032 per million gallons, which was updated to $0.041 at October 2010 price levels. Expressed in terms of millions of gallons per day, the cost is $0.00137. The average withdrawal is 329 mgd and so the total cost is $164 million.

$0.00137 mgd x 329 mgd x 365 days = $164,000,000 per year

The other numbers in the table were back calculated from these costs and volumes as follows. First, the equivalent of 1 mgd of withdrawals requires 1,120 acre feet of storage. Therefore 329 mgd requires 368,203 acre-feet. Assuming a yield factor of 1.5, the required storage space is reduced to 245,468 acre-feet. The annualized cost per acre-foot is $670 assuming a yield factor of 1 and $445 assuming a yield factor of 1.5. The equivalent capitalized costs per acre-foot are $8,290 and $5,527 respectively. These values are significantly higher than the others, possibly due to the emergency nature of the costs.

6. Corps contracts: The Corps maintains a data base of all contract prices for storage that the Corps' sells out of its reservoir. This data base consists of 316 water supply storage agreements in 134 Corps operated reservoir projects. The prices in about 25% of these contracts were updated to October 2010 price levels using the ENR index and totaled; the acre feet in these agreements were likewise totaled. Dividing the total updated price by the total acre feet resulted in a price per acre foot of $445. This was converted to an annualized value using a payback period of 30 years and a discount rate of 7% which resulted in a cost per acf of $38. The average yield factor was 1.5 and the remainders of the computations were performed in the identical manner as used for the other scenarios/alternatives.

7. Annual Operation and Maintenance Costs: The cost data discussed to this point are, in most cases, the updated construction costs which are the result of pro-rating total project construction costs by the percent that contract storage in acre feet represents of total storage in the project. In addition to this cost, water purveyors are also responsible for a share of the projects annual O&M costs. These are only available for the Pittsburgh project agreement. This value was used to calculate the total cost per acf and the cost per million gallons a day for all four case studies. The costs are:

$4 per acf
$2,280 per mgd

It was assumed that these costs would net out to zero in the calculations, i.e. the cost per acf was the same for all alternatives, and so are not included in the total or in further calculations.

8. Summary: The cost of water for the pipeline extension is nearly ten times higher than for the other situations. This probably reflects the emergency and temporary nature of the scenario but it also reflects the range of costs associated with alternatives to the status quo. This cost does not reflect the shadow price of river water. The other situations/data sources are likewise flawed, albeit to a lesser extent. Construction costs, discount rates, and yield factors all significantly affect the computed costs. To minimize errors, the decision was to use the average cost computed from Corps contracts as a proxy for the cost (or price) that users of Ohio River system water would be willing to pay. The costs are listed in Table 8-4.

Table 8-4: Estimated market price of Ohio River System Water

($ Oct 2010 price level)							
	Capital cost per ACF	Annualized cost per ACF	Cost for 1 mgd unadjusted for yield	Yield factor	Cost for 1 mgd adjusted for yield	Cost per million gallons	Cost per gallon
Estimated market price	$ 470	$ 38	$ 42,461	1.5	$ 28,632	$ 78	$ 0.000078