

# Economic Value of the Christina Basin

June 2013

*Prepared for*

The Christina Basin Clean Water Partnership

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# 1. Executive Summary

The water, natural resources, and ecosystems in the Christina River Basin contribute an economic value of \$908.6 million to \$485 billion annually to the Pennsylvania, Delaware, and Maryland economies. This report examines that economic value in three different ways:

- 1. Economic value directly related to Christina Basin water resources and habitats.** The Christina Basin contributes over \$1.5 billion in annual economic activity from water quality, water supply, fish/wildlife, recreation, agriculture, forests, and public parks benefits. When accounting for the Port of Wilmington, the Basin contributes over \$4.7 billion
- 2. Value of goods and services provided by Christina Basin ecosystems.** Using natural capital as a measure of value, habitat in the Christina Basin provides \$908.6 million annually in ecosystem goods and services in 2010 dollars, with a net present value (NPV) of \$29.5 billion calculated over a 100-year period.
- 3. Employment related to Christina Basin resources and habitats.** Using employment as a measure of value, natural resources within the Christina Basin directly and indirectly supports over 122,000 jobs with over \$485 billion in annual wages.

The purpose of these estimates is to demonstrate that the Christina Basin provides real and significant economic benefits to Pennsylvania, Delaware, and Maryland, benefits that are worthy of investment to keep these natural resources healthy and productive. Estimates were made by taking values from existing literature and studies and applying them to the Christina Basin using ecological economics and benefits-transfer techniques described in this report. Values are converted to 2010 dollars based on the change in the Northeast Region Consumer Price Index except where noted.

Note that the values in the three categories are not summed because there is some overlap between certain values within each category that could result in double counting. For example, the jobs of fishermen that contribute to employment and wages are also a factor in the economic activity generated from fishing, and the ecosystem values of forests for water-quality benefits may be at least partially captured in the economic value of water supply. Accurately determining (and eliminating) this overlap is difficult within the scope of this analysis.

The estimates presented in this report are as inclusive as could be due to a lack of data for some economic sectors, nor are they meant to be used to compare and contrast uses of the Christina Basin's water resources for their value. Some values were not included in these estimates because the data to assess them either are not readily available or do not exist. For example, the full amount of economic activity and jobs associated with the industries that rely on the Christina Basin for their processes is not included here, because identifying those companies and gathering information on their economic activity is beyond the scope of this analysis.

## 2. The Basin

The Christina River Basin is part of the larger 13,000 mi<sup>2</sup> Delaware River Basin. The Basin is a distinctive natural resource in Delaware and Pennsylvania and occupies 565 sq. mi. Its headwaters and 2/3 of its land area are in Pennsylvania, and its lower third is located within Delaware and a small slice of Maryland. The Basin includes four major watersheds—Brandywine, Red Clay, and White Clay Creeks, and the Christina River.

The Christina River Basin requires significant inter-governmental coordination, because it spans:

- Three states: Delaware, Pennsylvania, and Maryland.
- Five counties: Chester, Lancaster, and Delaware counties in Pennsylvania, New Castle County in Delaware, and Cecil County in Maryland.
- Over 60 townships, boroughs, and cities such as Elsmere, Newark, Newport, and Wilmington in Delaware and Avondale, Coatesville, Downingtown, Kennett Square, West Chester, and West Grove in Pennsylvania.

The Basin is home to more than 0.5 million people in three states (U.S. Census, 2010) and the land use is generally divided among three sectors – urban/suburban (1/3), agriculture (1/3), and open space/forests (1/3).

The Christina Basin provides many ecological and natural functions:

- *Parks*: Brandywine Creek State Park, White Clay Creek State Park, and White Clay Creek Preserve and Marsh Creek State Park are located in the Christina Basin.
- *Conservation Areas*: Large, privately owned conservation areas in the basin include Woodlawn Trustees land along the Brandywine Creek, Delaware Nature Society land along the Red Clay Creek in Delaware, and Brandywine Conservancy, Red Clay Valley Association, and Brandywine Valley Association holdings in Pennsylvania.
- *Habitat*: Contiguous forests and wetlands provide habitat for several federal or state-listed endangered or threatened species:
  - Bog Turtle (*Glyptemys muhlenbergii*)
  - Cerulean Warbler (*Dendroica cerulea*)
  - Long-tailed Salamander (*Eurycea longicauda*)
  - Bald Eagle (*Haliaeetus leucocephalus*)
- *Exceptional Value Waters*: The Brandywine Creek above Wilmington and the White Clay Creek above Newark have more protective water quality standards through their designation by the Delaware DNREC as waters of Exceptional Recreational and Ecological Significance (ERES waters).
- *Wild and Scenic Status*: President Clinton and the U.S. Congress designated the White Clay Creek and its tributaries as federal Wild and Scenic River. The White Clay Creek is the only wild and scenic river in Delaware, and it is the first river nationally to be protected on a watershed basis.
- *Recreation*: The streams and parks throughout the Basin provide a variety of primary and secondary recreational opportunities such as canoeing, hiking/biking, boating, trout fishing, and warm water fishing.

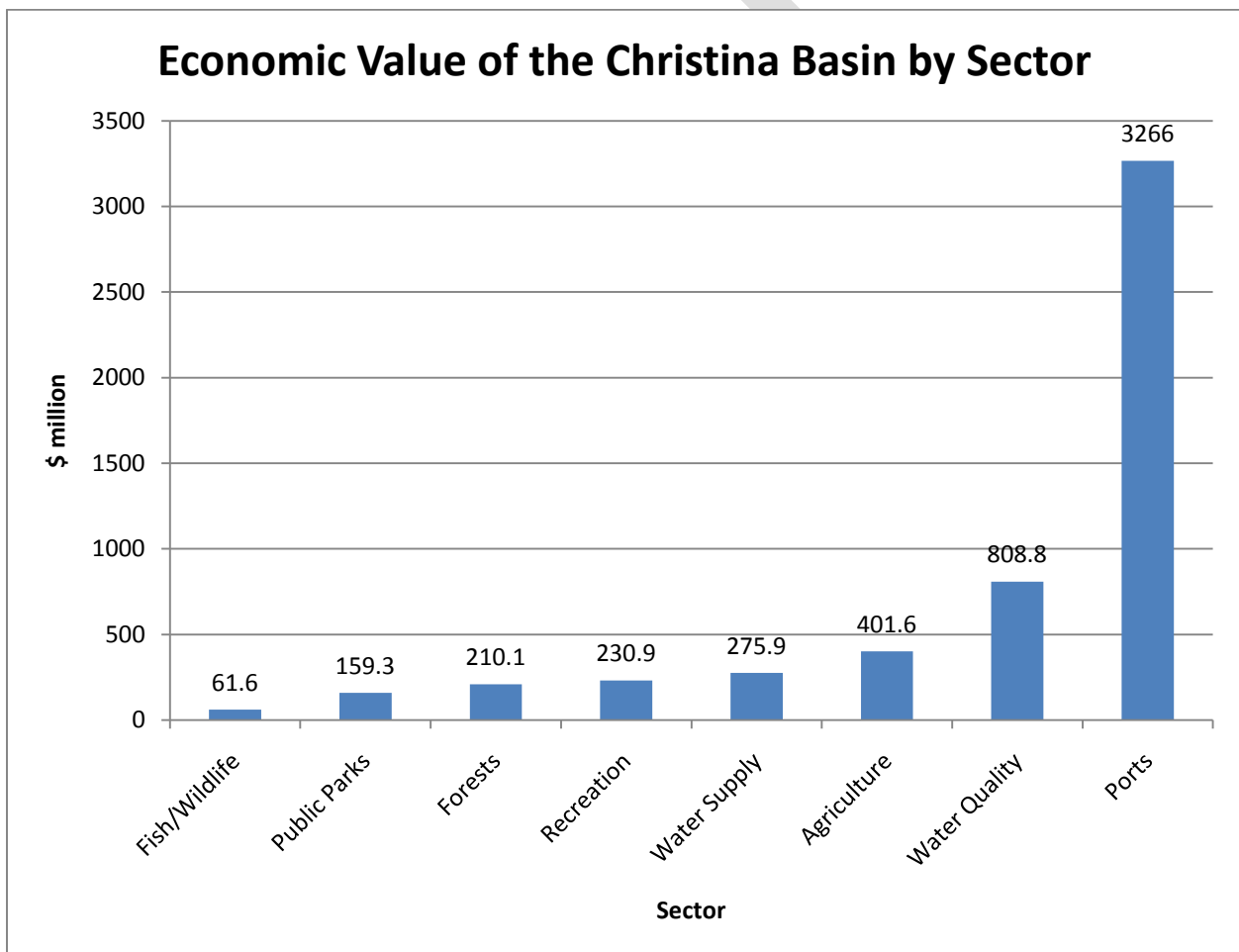


**Figure 1.** The Watersheds of the Christina Basin

### 3. Economic Value

The economic value of the Christina Basin from water quality, water supply, fish/wildlife, recreation, agriculture, forests and public parks benefits exceeds \$1.5 billion. Taking into the Port of Wilmington, the economic value of the Basin exceeds \$4.7 billion

• Water Quality	113M	• Water Quality	113M
• Water Supply	272M	• Water Supply	272M
• Fish/Wildlife	69M	• Fish/Wildlife	69M
• Recreation	297M	• Recreation	297M
• Agriculture	394M	• Agriculture	394M
• Forests	158M	• Forests	158M
• Public Parks	209M	• Public Parks	209M
		• Ports	3,266M
<b>Total &gt;1,512M</b>		<b>Total &gt;4,779 M</b>	



**Figure 2.** Economic Value of the Christina Basin by Sector

**Table 1.** Annual economic value of the Christina Basin

Sector	Activity	Brandywine (\$M)	Red Clay (\$M)	White Clay (\$M)	Christina River (\$M)	Basin (\$M)
Water Quality	Boatable (WTP=\$13.20) <sup>1</sup>	3.0	0.6	2.0	2.0	7.6
	Fishable (WTP=\$13.22) <sup>1</sup>	3.0	0.6	2.0	2.0	7.6
	Swimmable (WTP=\$112.75) <sup>1</sup>	28.0	5.4	14.0	21.0	68.4
	Increased Property Value (+8% over 20 yrs) <sup>2,3</sup>	359.8	88.2	144.0	104.0	696.0
	Water Treatment by Forest (\$76/mgd) <sup>4</sup>	1.8	0.0	0.8	0.1	2.7
	Wastewater Treatment <sup>5,6</sup>	23.0	1.9	0.8	0.7	26.4
Water Supply	Drinking Water Supply (\$7.85/1,000 gallons) <sup>6,7</sup>	137.3	1.3	93.0	38.0	269.6
	Reservoir Storage	2.6	0.0	0.0	0.0	2.6
	Irrigation Water Supply (\$300/acre-foot) <sup>8,9</sup>	1.3	0.3	0.5	0.1	2.2
	Industrial Water Supply (\$200/acre-foot) <sup>8,10</sup>	1.6	0.0	0.0	0.0	1.6
Fish/Wildlife	Fishing <sup>11</sup>	9.9	1.9	4.0	4.0	19.8
	Hunting <sup>11</sup>	11.4	1.6	3.0	2.0	18.0
	Wildlife/Bird-watching <sup>11</sup>	11.4	2.4	5.0	5.0	23.8
Recreation	Outdoor Recreation (241,020 participants) <sup>12</sup>	110.1	21.4	56.0	18.0	205.5
	State Parks (\$53/visit, 8,374 acres) <sup>13</sup>	22.5	0.0	3.0	0.0	25.5
Agriculture	Crop, poultry, livestock value (\$3,482/acre) <sup>14</sup>	283.6	39.0	62.0	17.0	401.6
Ports	Navigation (\$15/acre-foot)	0.0	0.0	0.0	66.0	66.0
	Port Activity	0.0	0.0	0.0	3200.0	3200.0
Forests	Carbon Storage (\$827/acre) <sup>15</sup>	71.5	11.1	19.0	10.0	111.6
	Carbon Sequestration (\$29/acre) <sup>15</sup>	2.5	0.4	0.6	0.3	3.8
	Air Pollution Removal (\$266/acre) <sup>15</sup>	23.0	3.6	6.0	3.0	35.6
	Building Energy Savings (\$56/acre) <sup>15</sup>	4.8	0.8	1.0	0.7	7.3
	Avoided Carbon Emissions (\$3/acre) <sup>15</sup>	0.3	0.0	0.7	0.0	1.0
Public Parks	Health Benefits (\$9,734/acre) <sup>16</sup>	51.6	7.9	76.0	20.0	155.5
	Community Cohesion (\$2,383/acre) <sup>16</sup>	12.6	1.9	19.0	5.0	38.5
	Stormwater Benefit (\$921/acre) <sup>16</sup>	4.9	0.8	7.0	2.0	14.6
	Air Pollution Control (\$88/acre) <sup>16</sup>	0.5	0.1	0.7	0.2	1.4
<b>Total</b>		<b>819.74</b>	<b>520.1</b>	<b>520.1</b>	<b>7,025.3</b>	<b>2115.0</b>

1. University of Delaware (2003). 2. EPA (1973). 3. Brookings Institute (2010). 4. Trust for Public Land, AWWA (2004). 5. DNREC (2010). 6. WRA. 7. Chester County Conservation District, & Chester Water Resources Authority (1998). 8. Resources for the Future (1996). 9. USDA (2007). 10. USGS (2005). 11. U.S. Fish and Wildlife Service (2008). 12. Outdoor Industry Foundation (2006). 13. PA DEP and Penn State. 14. USDA Census of Agriculture 2007 (2009). 15. U.S. Forest Service, Del Ctr. Hort. (2008). 16. Trust for Public Land.

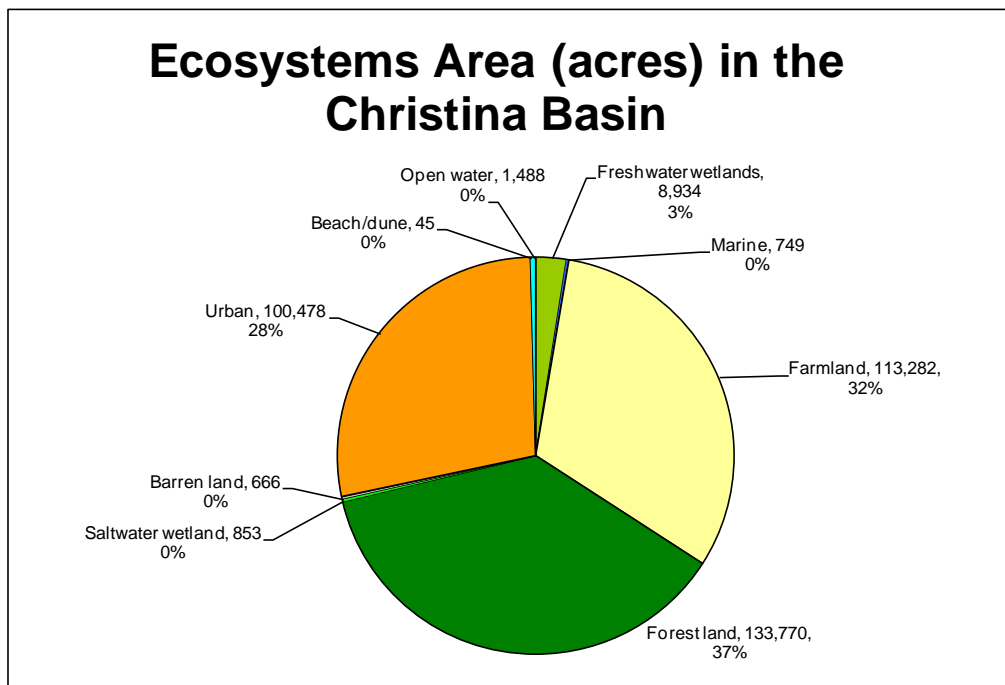
## 4. Ecosystem Services

The estimated value of goods and services provided in the watersheds of the Christina Basin (563 sq. mi. or 360,264 acres) is \$908.6 million (in 2010 dollars) with a net present value (NPV) of \$29.5 billion (Table 41). Ecosystem-services areas within the Christina Basin watersheds comprise forests (37.1%), farmland (31.4%), freshwater wetlands (2.5%), open water (.04%), marine (0.2%), and saltwater wetlands (.2%). Roughly thirty percent of the land in the Christina Basin is urban (Figure 18).

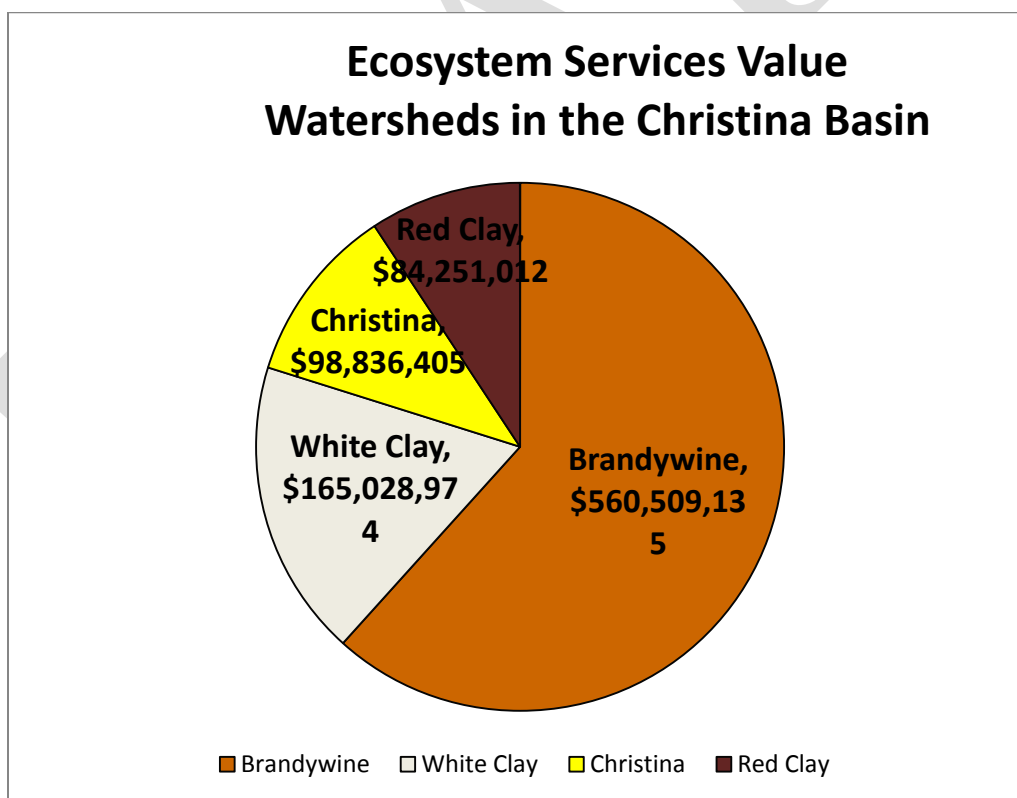
Farmlands, forest lands, and freshwater wetlands provide the highest total ecosystems goods and services values (Figures 19 and 21). The Brandywine Creek Watershed, at \$561 million, provides the highest value of annual ecosystem services, ahead of the White Clay Creek at \$165 million, and the Christina River at \$99 million (Figure 20 and 22). The Christina Basin watershed with the highest value of annual ecosystem services/acre is the Brandywine (\$2,702/acre), followed closely by the Red Clay (\$2,437/acre) and the White Clay (\$2,412/acre) watersheds (Figure 23).

Ecosystem goods and services in the Christina Basin watersheds using the NJDEP and USDA farm-good values are worth \$908.6 million (2010 dollars) or \$29.5 billion (NPV), which are conservatively in the lower end of the range. If lower per-acre estimates of ecosystem services from other studies were used instead of the NJDEP values, ecosystem services in the Christina Basin watersheds would be \$342.6 million or NPV = \$11 billion (Table 42). If higher per-acre estimates from other studies were used, the value of ecosystems in the Christina Basin watersheds would be \$3 billion or NPV = \$103.8 billion (Table 43).

<b><u>Estimate</u></b>	<b><u>PV (\$B)</u></b>	<b><u>NPV (\$B)</u></b>
Low	\$342.7 million	\$11.1 billion
NJDEP	\$908.6 million	\$29.5 billion
High	\$3.2 billion	\$103.8 billion

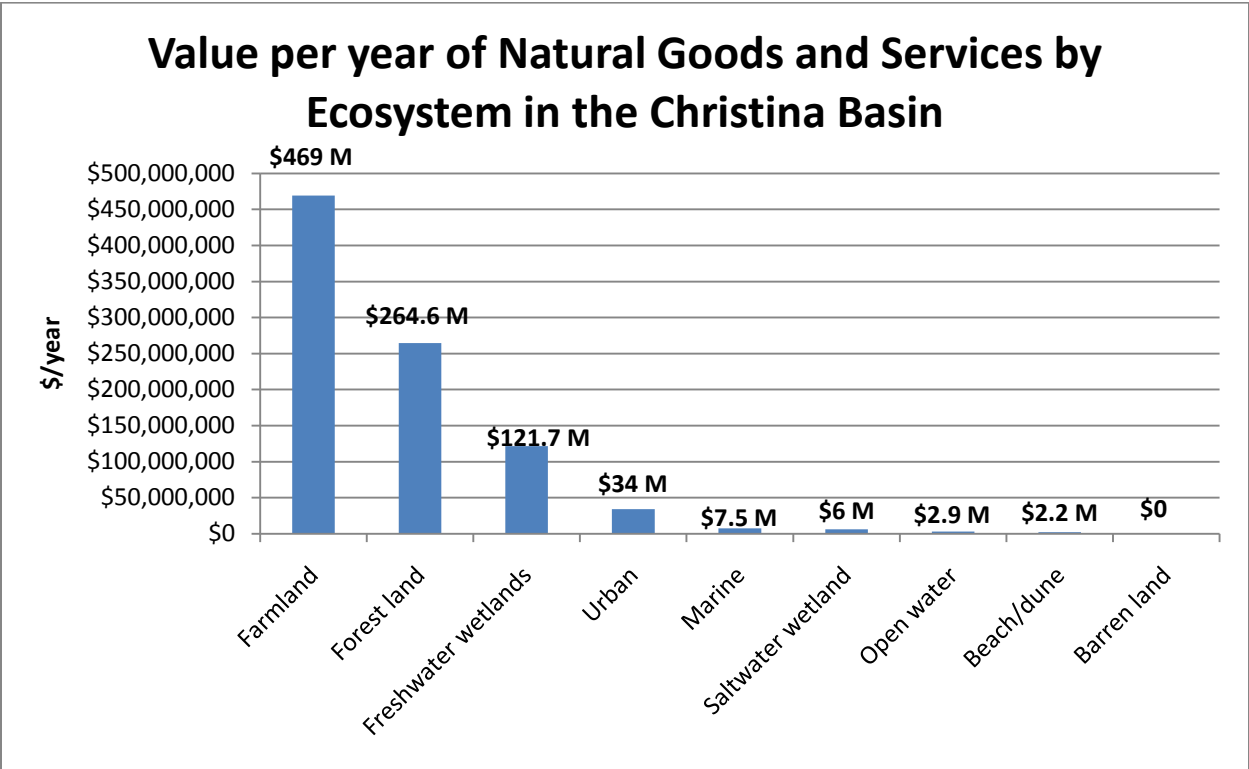


**Figure 3.** Ecosystems Service Areas in the Christina Basin

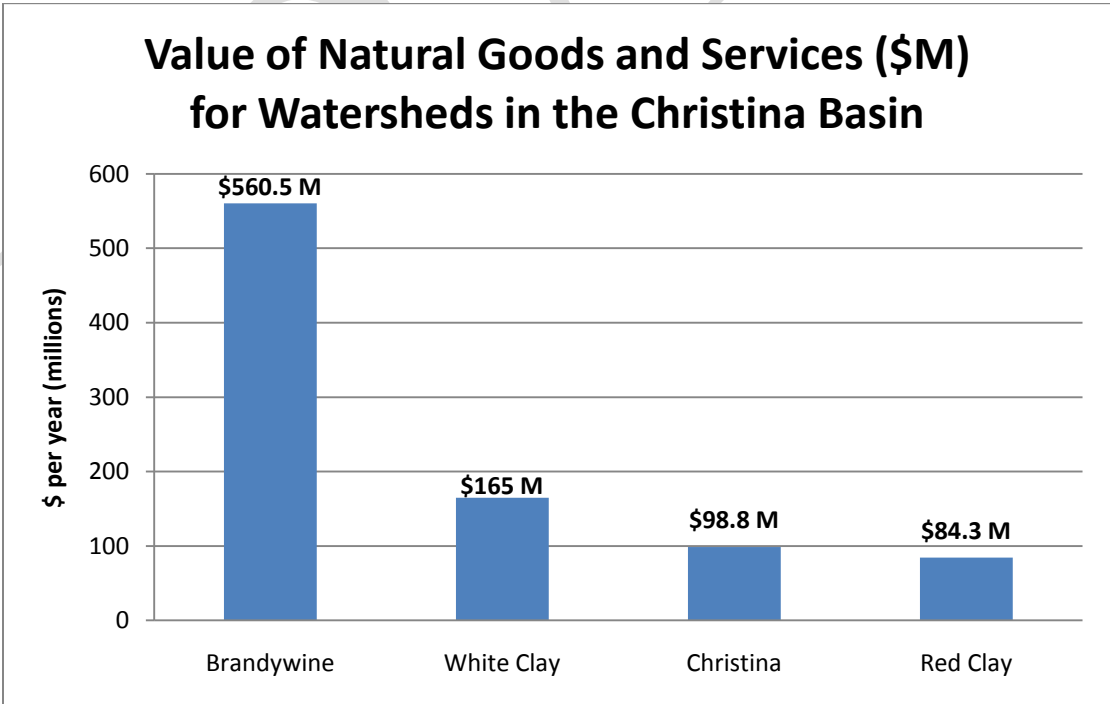


**Figure 4.** Value of Natural Goods and Services by Watershed in the Christina Basin





**Figure 5.** Natural Goods and Services Values (2010 dollars) in the Christina Basin



**Figure 6.** Value of Natural Goods and Services by Watershed in the Christina Basin

## 5. Jobs and Wages

Christina Basin watersheds are job engines containing water resources and habitats that support over 122,000 direct and indirect jobs and with over \$485 billion in annual wages in the coastal, farm, ecotourism, recreation, watershed organization, port, and water supply/wastewater industries.

**Table 2. Jobs and Wages Directly and Indirectly Related to Christina Basin Watersheds**

Sector	Brandywine		Red Clay		White Clay		Christina River		Basin	
	Jobs	Wages (\$M)	Jobs	Wages (\$M)	Jobs	Wages (\$M)	Jobs	Wage (\$M)s	Jobs	Wages (\$M)
Direct Watershed <sup>1</sup>	23,208	1,205	4,361	0	11,399	0.5	15,728	0.7	54,696	2,703
Indirect Watershed <sup>1</sup>	27,850	964	5,233	173,220	13,679	0.4	18,873	0.6	65,636	2,163
Coastal <sup>2,6</sup>	781	16	436	8,717,875	1,639	32.8	2,974	59.5	5,829	117
Farm <sup>3</sup>	3,453	2	411	416,279	846	0.7	69	0.2	4,778	4
Fish/Hunt/Bird <sup>4</sup>	1,121	37	204	6,691,214	427	14	373	12.2	2,062	68
Watershed Orgs. <sup>5</sup>	124	6	116	5,568,000	117	5.6	129	6.2	129	6
Ports	0	0	0	0	0	0	0	0	2,295	307
Water Supply <sup>7</sup>	175	10	0	0	99	5.5	18	1	293	16
Public Wells <sup>5</sup>	47	3	2	110,814	24	1.3	23	1.3	95	5
Wastewater <sup>5</sup>	58	2	5	212,000	4	0.2	2	0.9	70	3
<b>Total</b>	<b>&gt;51,000</b>	<b>&gt;2B</b>	<b>&gt;9,900</b>	<b>&gt;27</b>	<b>&gt;25,000</b>	<b>&gt;55</b>	<b>&gt;15,000</b>	<b>&gt;35</b>	<b>&gt;122,000</b>	<b>&gt;485B</b>

1. U.S. Census Bureau (2010). 2. National Coastal Econ. Program (2009). 3. U.S. Dept. of Agriculture., (2007)  
 4. U.S. Fish and Wildlife Service (2008). 5. WRA and DRBC (2010). 6. Martins Associates (2007)).  
 7. Delaware Tourism Office (2008).

**Table 3. Direct and Indirect Watershed-Related Jobs in the Christina Basin**

Sector	2007 North American Industry Classification System (NAICS) code	Direct Jobs <sup>1</sup>	Direct Wages <sup>1</sup> (x\$1000)	Indirect Jobs <sup>2</sup>	Indirect Wages <sup>2</sup> (x\$1000)
Construction	23711	214	12,553	257	10,042
Living/Resources	115, 31213, 42446, 44422, 44522, 44523	572	19,152	687	15,322
Minerals	21, 2211	49	3,568	59	2,854
Tourism/Recreation	42391, 45111, 532292, 532411, 44121, 44121, 441222, 712, 7131, 71312, 7139, 71391, 71393, 71394, 71399, 721, 72111, 7221, 722211, 722213, 72231, 722320	28,482	480,023	34,179	384,019
Transportation	483, 4832, 487, 4872, 4883, 488320	599	24,182	719	19,346
Environmental	541, 813211, 8134	23,626	2,089,870	28,351	1,671,896
Water/Wastewater	2213, 562	1,153	62,129	1,384	49,703
<b>SUM OF ALL INDUSTRIES</b>		<b>54,696</b>	<b>2,703,250</b>	<b>65,636</b>	<b>2,162,600</b>