Economic Impacts and Compliance Costs of Proposed EPA Numeric Nutrient Criteria for Florida Agriculture

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April 22, 2010

Abstract

This document provides a projection of costs and total economic impacts for Florida agricultural producers to attempt to meet the U. S. Environmental Protection Agency's proposed numeric nutrient criteria through the implementation of typical Best Management Practices (BMPs) and additional on-farm storm water treatment and retention practices.

Because the agricultural implementation of the proposed criteria has not been described in the EPA proposal, there is uncertainty in estimating the final compliance costs. For this reason, the assessment is presented as a range of compliance costs. Throughout the state and among all agricultural sectors, these costs will vary and may require expenditures in excess of those estimated, depending on the implementation requirements. Furthermore, implementation of all described applicable practices will not necessarily lead to attainment of the EPA-proposed nutrient criteria.

The total initial and recurring costs for Florida agriculture (including planted tree farms) to implement all applicable practices necessary to attempt to meet the EPA-proposed numeric nutrient criteria will vary depending on the amount of land involved and the types of practices required. In addition to typical BMPs such as nutrient management, irrigation management, fencing and rotational grazing, the authors conclude that more extensive additional; practices including the construction of on-farm water treatment/retention facilities will be necessary for all sectors of Florida agriculture. It is estimated that the total initial costs for Florida agriculture to implement all applicable practices will range from $855 million to $3.069 billion. The total recurring (annual) costs, which include the amortized initial capital costs, are estimated to range from $271 to $974 million. Lost revenues associated with land taken out of production to implement on-farm water treatment/retention practices are estimated to be $631 million annually. Thus, total recurring expenditures and revenue reductions for agriculture are estimated to range from $902 million to $1.605 billion annually.

Beyond the direct impact on the agricultural sector, Florida's economy as a whole will be affected significantly by these lost agricultural revenues. The total output impacts resulting from the $631 million in lost agricultural revenues and the secondary ripple effects on suppliers and employee spending are estimated to equal -$1.148 billion annually. The value-added impacts of these lost agricultural revenues are estimated to equal -$682 million per year. Annual impacts to Florida's labor income are estimated to be -$326 million, and the estimated loss of full-time, part-time, and seasonal jobs is -14,545.

Introduction

The numeric nutrient criteria for Florida water bodies recently proposed by the U. S. Environmental Protection Agency (EPA) would establish acceptable nutrient concentrations in surface waters at extremely low levels. This has created a great deal of controversy among stakeholders throughout the state, including local governments, utilities, businesses, agricultural producers, and others who are concerned that compliance with the proposed criteria may be impossible to achieve and may cause significant economic damages. Agricultural interests are particularly concerned that enforcement of these criteria would threaten the viability of agriculture in the state. The collective stakeholder concern is further escalated by the uncertainty and lack of transparency of the scientific basis from which the proposed numeric nutrient criteria were derived.

In its preliminary estimate of potential compliance costs, EPA estimated the annual costs for implementation of agricultural BMPs at $34.8 million ($27.9 million for nutrient management, $5.0 million for forest buffers, and $1.9 million for livestock fencing[1]). Initial capital costs for these BMPs were estimated at $112.9 million. EPA's cost estimates were generated using the assumption that the Florida Department of Environmental Protection (FDEP) draft numeric nutrient criteria would already be in place as part of Florida's water quality standards, that actions would have been taken and paid for to meet those criteria, and that EPA's proposed criteria would have only an "incremental" impact. However, no such criteria have even been proposed for adoption by the FDEP. EPA's assumption results in an estimate that only 45% of Florida's agricultural lands (6.13 million acres) would be affected by its proposed criteria. This document was developed to provide a more realistic projection of compliance costs and total economic impacts for Florida agricultural producers to attempt to meet the proposed criteria, based on the fact that Florida has not yet adopted numeric nutrient criteria and the authors related conclusion that the EPA-proposed criteria, if adopted, will affect 13.6 million acres of agricultural land rather than the EPA-estimated 6.13 million acres.

[1] U.S. EPA, Office of Water, Office of Science and Technology, "Preliminary Estimate of Potential Compliance Costs and Benefits Associated with EPA's Proposed Numeric Nutrient Criteria for Florida". January, 2010.

Costs of BMP & Water Treatment/Retention Implementation for Compliance

A range of estimated BMP and on-farm water treatment/retention costs for various agricultural land uses are presented in Tables 1a, 1b, and 1c. Table 1a represents the low end of the compliance cost estimates, and was created using net (harvested) agricultural acres and estimated costs per acre of typical BMPs. Typical BMPs are practices that would only be applied to harvested acres as defined in the Census of Agriculture. Table 1b represents the incremental costs of additional on-farm water treatment/retention facilities that would be applied not only to harvested acreage, but to the gross farm area. Based on modeled reduction estimates for typical BMPs, it is assumed that these additional treatment/retention facilities will be required to attempt to achieve EPA-proposed nutrient criteria. Table 1c includes both typical BMP and water treatment/retention costs added together, and represents the high end of the estimated cost of compliance.

The net and gross area (acres) of land used in Florida for each agricultural industry or commodity that would be subject to the new standards was taken from the 2007 Census of Agriculture (USDA-NASS, 2009) and the Forest Inventory and Analysis (USDA-Forest Service). While the agricultural sectors shown in Tables 1a, 1b, and 1c were classified according to the North American Industry Classification System (NAICS), some sectors represent an amalgamation of several different commodities; for example, row crops includes oilseeds, grains, vegetables and melons, tobacco, cotton, peanuts, strawberries, and other crops. The net area of specified agricultural land uses in Florida for 2007 was 11.63 million acres, including 4.85 million acres for tree plantations, 4.55 million acres for improved/unimproved pasture for beef cattle, 665,000 acres for citrus, 379,000 acres for sugarcane, and 331,000 acres for row crops. Gross farm area of specified agricultural land uses in 2007 was 13.60 million acres. Note that the silviculture acreage in tables 1a and 1b includes only managed (planted) acres.

The estimated per-acre costs for agricultural producers to implement the required BMPs were taken from a report prepared for the South Florida Water Management District by Soil & Water Engineering Technology, Inc. (SWET, 2008). The cost estimates in the SWET report are based, in part, on actual expenditures by the Florida Department of Agriculture and Consumer Services for agricultural BMP implementation and cost-share programs during the eight-year period prior to the report. Subsequently, the cost estimates in the report formed the basis of annual budget requests to the Florida Legislature to fund the agricultural component of the Northern Everglades and Estuaries Protection Program.

The initial and annual operating costs per acre for each agricultural sector or land use are itemized in Tables 1a and 1b. BMPs covered in this analysis included the full range of typical ownerimplemented practices, such as fertilizer management, grazing management, and livestock exclusion from waterways. Additional on-farm water treatment/retention practices include wetland restoration, water recovery/re-use systems, and on-site water treatment/retention systems. Initial (capital) costs for implementation of all practices include materials, labor, and engineering. Annual operating costs were estimated at 20 percent of the initial costs, consistent with good engineering practice, plus amortization of the capital investment at 10 percent interest over 20 years.

Initial costs per acre for typical BMPs range from $22 for Tree Plantations to $1,045 for Dairy farms, while annual costs per acre range from $8 to $332 (Table 1a). Initial costs per acre for additional on-farm treatment/retention range from $73 for Beef Cattle Ranching, to $750 for Dairy farms, while annual per-acre costs for additional practices range from $23 to $238 (Table 1b).

The estimated statewide total initial and annual costs to comply with the proposed EPA numeric nutrient criteria were calculated simply by multiplying the average cost per acre against the appropriate total acreage for each agricultural sector in the state (Tables 1a & 1b). The combined total costs were calculated by simple addition (Table 1c). Total initial costs for the implementation of typical BMPs were highest in the Citrus, Dairy, and Beef sectors, at $326, $130 and $115 million respectively. The largest total annual costs for typical BMPs occurred in the same three sectors, at $104, $41, and $36 million per year, respectively (Table 1a). Row crops, Silviculture, and Citrus are estimated to incur the largest initial costs in implementing additional on-farm water treatment/retention practices, at $681, $534, and $337 million respectively. The same three sectors are also projected to incur the largest recurring annual costs for implementing these practices, at $216, $169, and$107 million per year, respectively (Table 1b).

Both modeling (Watershed assessment Model, SWET) and empirical water quality data (STORET, FDEP) indicate that all applicable typical BMPs and additional on-farm water treatment/retention practices would be required to attempt to meet the EPA-proposed numeric nutrient criteria. For this reason, the combined estimated costs shown in Table 1c reflect the best estimate of the costs of implementation to attempt to comply with EPA-proposed criteria. The total initial cost for implementing both typical BMPs and water treatment/retention practices for all agricultural sectors in Florida is estimated to be $3.069 billion (Table 1c). The individual agricultural sectors expected to experience the greatest initial total costs for implementing all applicable practices are Row Crops, Citrus, and Silviculture, at $754, $663, and $641 million respectively. Recurring annual costs for the operation, maintenance, and debt service for all applicable practices over all agricultural sectors are estimated to total $974 million (Table 1c). Among the different agricultural sectors, total annual costs for all applicable practices combined were greatest for the same three sectors (Row Crops, Citrus, Tree Plantations), at $239, $211, and $203 million per year, respectively.

Table 1a. Estimated Costs of <u>Typical BMPs</u> for Florida's Agricultural Producers to Comply with EPA-proposed Numeric Nutrient Criteria

Agricultural Sector by North American Industry Classification	Net Area Used or Harvested, 2007 (acres)	Typical BMP Costs per Acre		Typical BMP Total Costs	
		Initial ($)	Annual ($)	Initial (million $)	Annual (million $)
Row crops (1111, 11121, 11191, 111192, 111333)	330,582	220.0	69.8	72.7	23.1
Citrus (11131, 11132)	664,847	490.0	155.6	325.8	103.5
Ornamentals (1114) (net of sod and food crops under cover)	67,359	220.0	69.8	14.8	4.7
Sod production	84,430	110.0	34.9	9.3	2.9
Sugarcane farming (11193)	378,587	110.8	35.2	41.9	13.3
Hay farming (11194)	297,578	58.0	18.4	17.3	5.5
Non-citrus fruit and berry farming (11133)	17,242	490.0	155.6	8.4	2.7
Beef cattle ranching and farming (11211)	4,549,384	25.3	8.0	115.1	36.4
Dairy cattle and milk production (11212)	124,128	1,045.0	331.7	129.7	41.2
Horse and other equine production (11292)	202,176	49.5	15.7	10.0	3.2
Poultry and egg production (1123)	58,078	58.0	18.4	3.4	1.1
Silviculture tree plantations (1131) (net of woodland pastures)	4,852,527	22.0	7.0	106.8	34.0
Total for All Agricultural Uses	**11,626,918**			**855.2**	**271.6**

Table 1b. Estimated Costs of <u>Additional On-Farm Water Treatment/Retention</u> for Florida Agricultural Producers to Comply with EPA- proposed Numeric Nutrient Criteria

Agricultural Sector by North American Industry Classification	Gross Farm Area 2007 (acres)	Treatment/Retention Costs per Acre		Treatment/Retention Total Costs	
		Initial ($)	Annual ($)	Initial (million $)	Annual (million $)
Row crops (1111, 11121, 11191, 111192, 111333)	1,548,413	440.0	139.7	681.3	216.3
Citrus (11131, 11132)	1,394,373	242.0	76.8	337.4	107.1
Ornamentals (1114) (net of sod and food crops under cover)	67,359	440.0	139.7	29.6	9.4
Sod production	84,430	330.0	104.8	27.9	8.8
Sugarcane farming (11193)	378,587	275.0	87.3	104.1	33.1
Hay farming (11194)	297,578	110.0	34.9	32.7	10.4
Non-citrus fruit and berry farming (11133)	47,861	242.0	76.8	11.6	3.7
Beef cattle ranching and farming (11211)	4,549,384	73.3	23.3	333.6	105.9
Dairy cattle and milk production (11212)	124,128	750.0	238.1	93.1	29.6
Horse and other equine production (11292)	202,176	110.0	34.9	22.2	7.1
Poultry and egg production (1123)	58,078	110.0	34.9	6.4	2.0
Silviculture tree plantations (1131) (net of woodland pastures)	4,852,527	110.0	34.9	533.8	169.5
Total for All Agricultural Uses	**13,604,894**			**2,213.7**	**702.9**

<u>Notes:</u> Annual costs represent amortized initial capital costs at 10% interest over twenty-years, plus operation and maintenance at 20% of capital costs. Costs for beef cattle calculated as average for improved pasture, unimproved pasture and woodland pasture. No cost values available for non-citrus fruits and berries; citrus values used to calculate cost because of similarity in management.

<u>Sources</u>: <u>Agricultural acreage:</u> USDA-NASS, *2007 Census of Agriculture, Florida*, Vol. 1, Geographic Area Series, Part 9, State and County data, Tables 8, 37, 46. <u>Forest acreage:</u> USDA-Forest Service, *Forest Inventory and Analysis*. Data for Florida, 2007, available at http:// fiatools.fs.fed.us/fido/standardreport.html. <u>All Costs:</u> Soil & Water Engineering Technologies, Inc. (SWET), 2008. *Nutrient Loading Rates, Reduction Factors and Implementation Costs Associated with BMPs and Technologies*, Appendix A, tables for phosphorous and nitrogen reduction BMPs.

Table 1c. Estimated <u>Combined Costs</u> of Typical BMPs and Additional On-Farm Water Treatment/Retention for Florida Agricultural Producers to Comply with EPA-proposed Numeric Nutrient Criteria

Agricultural Sector by North American Industry Classification	Combined Total Costs	
	Initial (million $)	Annual (million $)
Row crops (1111, 11121, 11191, 111192, 111333)	754.0	239.4
Citrus (11131, 11132)	663.2	210.6
Ornamentals (1114) (net of sod and food crops under cover)	44.4	14.1
Sod production	37.2	11.7
Sugarcane farming (11193)	146.0	46.4
Hay farming (11194)	50.0	15.9
Non-citrus fruit and berry farming (11133)	20.0	6.4
Beef cattle ranching and farming (11211)	448.7	142.3
Dairy cattle and milk production (11212)	222.8	70.8
Horse and other equine production (11292)	32.2	10.3
Poultry and egg production (1123)	9.8	3.1
Silviculture tree plantations (1131) (net of woodland pastures)	640.6	203.5
Total for All Agricultural Uses	**3,069.0**	**974.5**

Notes: Annual costs represent amortized initial capital costs at 10% interest over twenty-years, plus operation and maintenance at 20% of capital costs. Costs for beef cattle calculated as average for improved pasture, unimproved pasture and woodland pasture. No cost values available for BMPs on non-citrus fruits and berries; citrus values used to calculate cost because of similarity in management. No cost values available for poultry operations; hay farming values used to calculate cost because of land application use

Sources: Agricultural acreage: USDA-NASS, *2007 Census of Agriculture, Florida*, Vol. 1, Geographic Area Series, Part 9, State and County data, Tables 8, 37, 46. Forest acreage: USDA-Forest Service, *Forest Inventory and Analysis*. Data for Florida, 2007, available at http:// fiatools.fs.fed.us/fido/standardreport.html. All Costs: Soil & Water Engineering Technologies, Inc. (SWET), 2008. *Nutrient Loading Rates, Reduction Factors and Implementation Costs Associated with BMPs and Technologies*, Appendix A, tables for phosphorous and nitrogen reduction BMPs.

Regional Economic Impacts of Production Land Displacement

For Florida agricultural producers to attempt to comply with the EPA-proposed numeric nutrient criteria, it is anticipated that a significant amount of agricultural land will be displaced from production due to implementation of on-farm water treatment/retention systems. According to estimates provided by Florida agricultural engineer Del Bottcher, approximately 10 percent of the agricultural land affected by the EPA-proposed criteria will be needed to construct on-farm water treatment/ retention systems (personal communication). This will lead to a recurring reduction in agricultural industry output (revenues).

It is expected that agricultural producers will strive to locate on-farm treatment/retention systems on marginal or non-productive lands to the extent possible, such that overall production volume and value would decrease by less than 10 percent. Economic research has documented that farmers respond to reductions in their production acreage through a variety of adaptive strategies, including intensification of production on the remaining land base, and shifting cultivation to less marginal land[2]. The effective reduction in production volume is typically 60 to 80 percent of the acreage reduction. For this analysis, we chose a mid-range value of 70 percent, meaning that for a 10-percent reduction in production acreage, production volume would fall by 7 percent.

Total industry output (revenue) for agricultural sectors in Florida was about $9.02 billion in 2008 (latest data available, Table 2). Therefore, if the projected 7-percent decrease in annual output due to land displacement occurred uniformly across all agricultural sectors, the total annual revenue loss would be $631 million (Table 2). The largest changes in direct output would occur for Vegetable and Melon Farming ($152 million), Greenhouse and Nurseries ($135 million), and Fruit Farming ($138 million). Note that this analysis includes some additional agricultural sectors/commodities beyond those evaluated in Tables 1a, 1b, and 1c.

Exhibit 6-1 in the January 2010 Economic Analysis report by EPA indicated that the total area of agricultural and forest lands in Florida surrounding water bodies incrementally affected by their proposed numeric nutrient criteria is 6.13 million acres (Figure 1)[3]. This contrasts with a total of 13.6 million acres estimated by the USDA to be used for agricultural and planted forestry activities in Florida. Thus, by EPA estimates, only around 45 percent of Florida's agricultural lands will be affected by EPA-mandated numeric nutrient criteria (though this percentage varies across different agriculture sectors).

The authors contend that, rather than 6.13 million agricultural acres being affected by the EPA-proposed numeric nutrient criteria, a more realistic estimate of affected acres, based on modeling and water quality data, is 13.6 million acres. EPA assumed that Florida had adopted into its water quality standards draft numeric nutrient criteria being developed by FDEP and that agriculture is already in compliance with these FDEP draft criteria. However, no such criteria have been proposed or adopted into Florida law, and virtually all agricultural acreage statewide will be subject to implementation of typical BMPs and additional on-farm water treatment/retention practices to attempt to comply with EPA's proposed criteria. Consequently, the analysis that follows uses the latter estimate of affected agricultural acres to derive a high-end estimate of economic impact and uses the EPA-estimated acreage to derive a low-end estimate of economic impact. The analysis includes direct and indirect impacts to agriculture and related industries.

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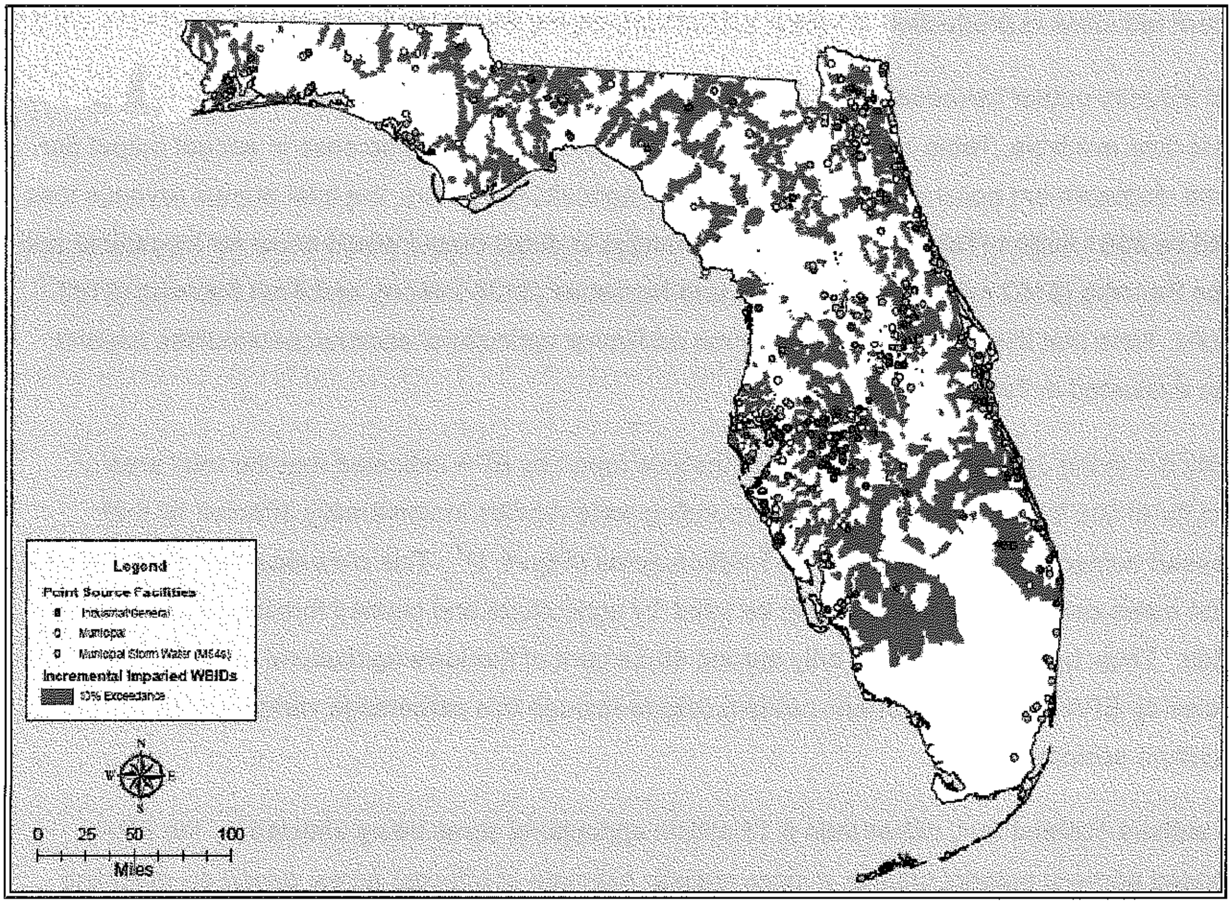
[2] For example, see paper by Erickson, M.H. and K. Collins, Effectiveness of acreage reduction programs. USDA-Economic Research Service, AER-530, *Agricultural-Food Policy Review*, July 1985, pp. 166-84.

[3] Incrementally impaired waters represent those water bodies that would not meet the new water quality standard above and beyond the baseline standard. This differs from the basis used in estimating compliance costs in Tables 1a, 1b, and 1c.

Figure 1. Incrementally Impaired Waters and Point Sources with Potential to Discharge Nutrients (Exhibit 6-2. EPA Jan. 2010)



The total regional economic impacts of reduced output by Florida agriculture were estimated using the Impact Analysis for Planning (IMPLAN) input-output software, and 2008 state dataset for Florida (Minnesota Implan Group, Inc., 2009). Input-output analysis is a well-established methodology for estimating the economy-wide effects of changes in industry activity arising from associated changes in business supply chain purchases of inputs and employee household spending, known as the indirect and induced multiplier effects, respectively. [4]

As shown in Tables 3 and 4, the high-end economic impact scenario results in a direct loss of annual industry output of $631 million, which leads to a total output impact of -$1.148 billion, including the indirect (supply chain) and induced (employee spending) effects. The direct loss of employment to the agricultural sectors is estimated at 7,780 full-time and part-time jobs, and total employment losses to the Florida economy are estimated at 14,545 jobs. Total value-added impacts to the state are estimated at -$682 million, including -$327 million in impacts on labor income (wages, salaries,

[4] Miller, R.E. and P.D. Blair, *Input-Output Analysis: Foundations and Extensions*, 2nd Edition, Cambridge Press, 750 pages, 2009.

benefits, proprietor income), and -$317 million in impacts on property income (rents, dividends, interest, etc.). Impacts on indirect business taxes paid to local and state governments were estimated at -$38 million, including taxes on property and sales, as well as other minor taxes, licenses and fees.

While total economic impacts of BMP implementation would be greatest in the agricultural sector, significant impacts would also occur in other industries due to the indirect/induced multiplier effects, as shown in Table 4. Other industries projected to incur significant employment impacts include Retail Trade (-608 jobs), Health and Social Services (-578 jobs), Government (-538 jobs), and Accommodation and Food Services (-333 jobs).

Table 2. Current Industry Output in Florida Agricultural Sectors and Projected Reduction in Output due to Implementation of On-farm Water Treatment/Retention for Compliance with EPA–proposed Numeric Nutrient Criteria

Agricultural Sector	Output (Revenue) in 2008 (million $) [1]	Projected Revenue Losses from a 7 % reduction on **13.6** million acres (million $)	Projected Revenue Losses from a 7 % reduction on **6.1** million acres (million $)
Oilseed farming	7.5	-0.53	-0.4
Grain farming	20.1	-1.41	-1.2
Vegetable and melon farming	2,164.3	-151.50	-124.0
Fruit farming	1,972.0	-138.04	-49.7
Tree nut farming	8.6	-0.60	-0.2
Greenhouse, nursery, & floriculture	1,930.2	-135.12	-85.0
Tobacco farming	4.0	-0.28	-0.2
Cotton farming	42.1	-2.95	-2.4
Sugarcane & sugar beet farming	442.2	-30.95	-25.3
All other crop farming	322.6	-22.58	-24.2
Cattle ranching and farming	404.0	-28.28	-9.9
Dairy cattle and milk production	463.8	-32.46	-1.6
Poultry and egg production	403.0	-28.21	-2.5
Animal production except cattle & poultry	174.8	-12.24	-1.1
Forestry, forest products & timber tracts	658.5	-46.10	-22.4
Total All Sectors	9,017.8	-631.24	-350.3

Source: *IMPLAN Professional* software, and Florida regional data. Minnesota Implan Group, Inc., Stillwater, MN, 2009.

Table 3. Summary of Annual Economic Impacts in Florida from Change in Agricultural Industry Output due to Implementation of On-farm Water Treatment/Retention for Compliance with EPA-proposed Numeric Nutrient Criteria on 13.6 Million acres (2008 dollars)

Impact Type	Employment (fulltime & part-time jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Direct Effect	-7,780	-121.1	-370.1	-631.2
Indirect Effect	-2,967	-65.4	-82.6	-145.9
Induced Effect	-3,798	-140.0	-229.1	-371.3
Total	-14,545	-326.5	-681.8	-1,148.4

Source: *IMPLAN Professional* software and Florida regional data. Minnesota Implan Group, Inc., Stillwater, MN, 2009.

Table 4. Total Economic Impacts in Florida, by Major Industry Group, of Change in Agricultural Industry Output due to Implementation of On-farm Water Treatment/Retention for Compliance with EPA-proposed Numeric Nutrient Criteria on 13.6 million acres (2008 dollars)

Industry Group	Employment (fulltime & part-time jobs)	Output (million $)	Value Added (million $)	Labor Income (million $)	Other Property Type Income (million $)	Indirect Business Taxes (million $)
Agriculture, Forestry, Fisheries	-10,147	-685.0	-402.9	-160.5	-229.0	-13.4
Mining	-7	-2.5	-0.5	-0.2	-0.3	0.0
Utilities	-24	-13.4	-9.4	-2.8	-5.2	-1.5
Construction	-244	-26.6	-10.6	-9.6	-0.9	-0.1
Manufacturing	-103	-42.1	-9.2	-5.5	-3.3	-0.5
Wholesale Trade	-194	-30.3	-19.7	-11.4	-4.1	-4.2
Retail Trade	-608	-35.8	-24.4	-14.9	-4.2	-5.3
Transportation & Warehousing	-163	-15.3	-8.3	-5.8	-2.2	-0.4
Information	-53	-14.5	-5.8	-3.4	-1.9	-0.5
Finance & Insurance	-243	-42.5	-23.0	-12.8	-9.3	-1.0
Real Estate & Rental	-278	-72.7	-51.4	-5.9	-37.6	-7.9
Professional & Tech. Services	-286	-29.8	-18.0	-14.9	-2.6	-0.4
Management of Companies	-24	-4.3	-2.6	-2.0	-0.6	0.0
Administrative & Waste Services	-241	-11.8	-7.3	-5.7	-1.4	-0.2
Educational Services	-89	-4.4	-2.6	-2.4	-0.2	0.0
Health & Social Services	-578	-43.6	-27.3	-23.3	-3.7	-0.4
Arts- Entertainment & Recreation	-83	-6.7	-3.6	-2.1	-1.0	-0.5
Accommodation & Food Services	-333	-17.8	-9.9	-6.5	-2.3	-1.1
Other Services	-310	-15.3	-8.6	-6.2	-1.7	-0.7
Government & non-classified	-538	-34.0	-36.6	-30.7	-5.9	0.0
Total All Industries	-14,545	-1,148.4	-681.8	-326.5	-317.4	-38.0

Source: *IMPLAN Professional* software and Florida regional data. Minnesota Implan Group, Inc., Stillwater, MN, 2009.

The reductions in agricultural revenues under the low-end scenario, based on EPA estimates of affected agricultural acres, are shown in Tables 2, 5, and 6. The projected decrease in annual output on affected acreage due to land displacement to construct on-farm water treatment/retention facilities would be about $350 million per year. The largest changes in direct output would occur for Vegetable and Melon Farming ($124 million), Greenhouse and Nurseries ($85 million), and Fruit Farming ($50 million) as shown in Table 2.

The direct loss of annual industry output of $350 million leads to a total output impact of -$635 million, including the indirect (supply chain) and induced (employee spending) effects. The direct loss of employment to the agricultural sectors is estimated at 3,546 full-time and part-time jobs, and total employment losses to the Florida economy are estimated at 6,660 jobs (Table 5). Table 6 shows total value-added impacts for the state, which are estimated at -$388 million, including -$177 million in impacts on labor income (wages, salaries, benefits, proprietor income), and -$190 million in impacts on property income (rents, dividends, interest, etc.). Impacts on indirect business taxes paid to local and state governments are estimated at -$21 million, including taxes on property and sales as well as other minor taxes, licenses and fees.

While total economic impacts would be greatest in the agricultural sector, significant impacts would also occur in other industries due to the indirect/induced multiplier effects, as shown in Table 6. Other industries projected to incur significant employment impacts include Retail Trade (-284 jobs), Health and Social Services (-269 jobs), Government (-252 jobs), and Accommodation and Food Services (-155 jobs).

Table 5. Summary of Annual Economic Impacts in Florida from Change in Agricultural Industry Output due to Implementation of On-farm Water Treatment/Retention for Compliance with EPA-proposed Numeric Nutrient Criteria on 6.1 Million acres (2008 dollars).

Impact Type	Employment (fulltime & part-time jobs)	Labor Income (million $)	Value Added (million $)	Output (million $)
Direct Effect	-3,546	-65.9	-217.1	-350.3
Indirect Effect	-1,342	-34.9	-45.8	-78.5
Induced Effect	-1,771	-76.6	-125.2	-206.6
Total	-6,660	-177.4	-388.1	-635.4

Source: *IMPLAN Professional* software and Florida regional data. Minnesota Implan Group, Inc., Stillwater, MN, 2009.

Table 6. Total Economic Impacts in Florida, by Major Industry Groups, of Change in Agricultural Industry Output due to Implementation of On-farm Water Treatment/Retention for Compliance with EPA-proposed Numeric Nutrient Criteria on 6.1 Million acres (2008 dollars)

Industry Group	Employment (fulltime & part-time jobs)	Output (million $)	Value Added (million $)	Labor Income (million $)	Other Property Type Income (million $)	Indirect Business Taxes (million $)
Agriculture, Forestry, Fisheries	-4,600	-377.3	-234.6	-86.5	-140.9	-7.2
Mining	-3	-1.4	-0.3	-0.1	-0.2	0.0
Utilities	-11	-7.0	-5.1	-1.5	-2.8	-0.8
Construction	-116	-14.3	-5.9	-5.4	-0.5	-0.1
Manufacturing	-48	-22.8	-5.0	-3.0	-1.8	-0.3
Wholesale Trade	-88	-16.1	-10.5	-6.1	-2.2	-2.2
Retail Trade	-284	-19.5	-13.3	-8.2	-2.3	-2.9
Transportation & Warehousing	-74	-8.2	-4.4	-3.0	-1.2	-0.2
Information	-25	-7.9	-3.1	-1.8	-1.1	-0.2
Finance & Insurance	-113	-23.2	-12.6	-7.0	-5.0	-0.5
Real Estate & Rental	-142	-40.8	-29.4	-3.5	-21.4	-4.5
Professional & Tech. Services	-132	-16.6	-9.8	-8.1	-1.5	-0.2
Management of Companies	-11	-2.4	-1.4	-1.1	-0.3	0.0
Administrative & Waste Services	-113	-6.5	-4.0	-3.1	-0.8	-0.1
Educational Services	-41	-2.5	-1.4	-1.3	-0.1	0.0
Health & Social Services	-269	-23.8	-14.9	-12.7	-2.0	-0.2
Arts- Entertainment & Recreation	-38	-3.7	-2.0	-1.1	-0.6	-0.3
Accommodation & Food Services	-155	-10.0	-5.4	-3.6	-1.2	-0.6
Other Services	-144	-8.6	-4.7	-3.4	-0.9	-0.4
Government & non-classified	-252	-22.6	-20.1	-16.8	-3.2	0.0
Total All Industries	-6,660	-635.4	-388.1	-177.4	-190.0	-20.8

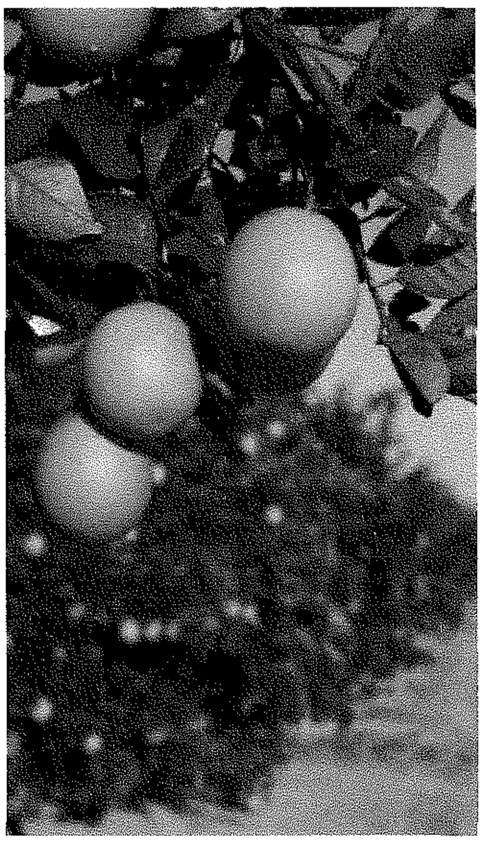
Source: *IMPLAN Professional* software and Florida regional data. Minnesota Implan Group, Inc., Stillwater, MN, 2009.

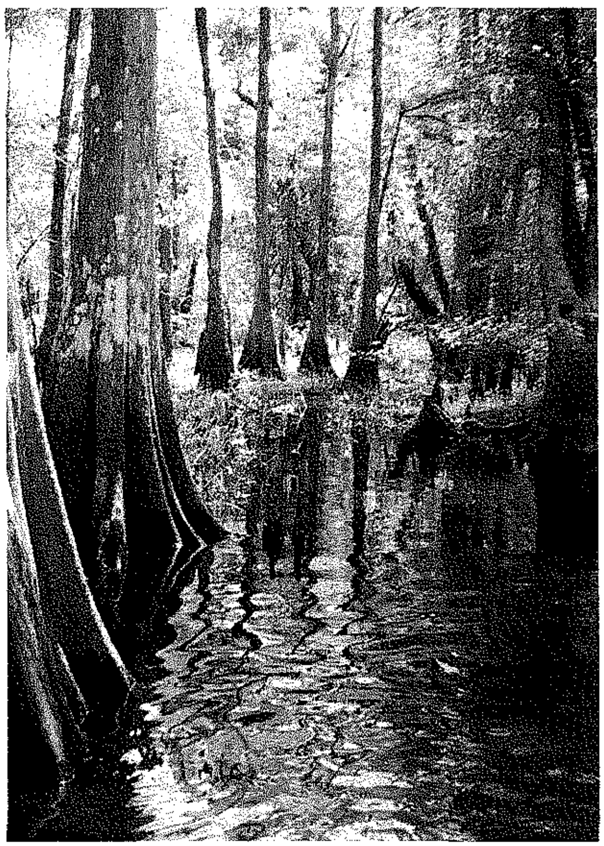
Summary

EPA's analysis of economic impact to Florida agriculture and related industries was incomplete, both in terms of the estimated number of agricultural acres affected and the methods used to determine economic impact. Even using EPA's estimates of affected acreage (6.13 million acres), our analysis, excluding the direct implementation costs of all applicable practices, reveals that annual lost revenues associated with land taken out of production to implement on-farm water treatment/retention practices would be $350 million a year. A more realistic assessment, using water quality modeling and monitoring data, shows that 13.6 million acres of agriculture will experience direct costs. Rather than the $34.9 million total annual cost that EPA suggested, the authors assert that a more justifiable estimate of direct costs is from $902 million to $1.605 billion annually, with additional indirect economic impacts to the state of $1.148 billion annually.

Cardno ENTRIX

Shaping the Future





Economic Analysis of the Proposed Federal Numeric Nutrient Criteria for Florida

November, 2010

Florida Numeric Nutrient Criteria No. 02953001.00

Prepared For

Florida Water Quality Coalition

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Executive Summary

Florida currently has a narrative nutrient standard to guide the management and protection of its waters. In January 2010, the Environmental Protection Agency (EPA) published proposed "Water Quality Standards for the State of Florida's Lakes and Flowing Waters" which details numeric nutrient criteria (federal proposed NNC). Estuarine, marine, and canal criteria will be the subject of a subsequent phase of rule-making and are not considered in this report. EPA provided an assessment (i.e. "EPA Economic Analysis") of the potential benefits and costs of its proposed federal NNC, along with an assessment of the economics associated with the draft NNC rule from the Florida Department of Environmental Protection (FDEP).[1] Per unit compliance costs from the EPA Economic Analysis differed widely from estimates provided by other entities, including FDEP.

On behalf of the Florida Water Quality Coalition, Cardno ENTRIX has conducted an independent study of compliance costs using the EPA Economic Analysis, the economic studies conducted by the regulated community, public comments, and information gathered from interviews of many Florida entities that will be affected by the proposed rule. In contrast to many previous analyses, this study considers the impact of uncertainty about the stringency with which the NNC would be applied, the compliance costs for different types of water bodies compared to the benefits, and the indirect costs on the Florida economy. This study provides a summary of findings regarding the relative magnitude of the direct and indirect costs of the proposed federal NNC, as well as a review of EPA's benefit estimating methodology and findings. The major findings of the study are:

- The costs of the proposed federal NNC regulations far exceed the EPA estimates. The EPA has inadequately accounted for existing baseline conditions, failed to address all direct costs, and did not considered all indirect costs to businesses and the public including the costs of uncertainty. If the EPA enforces "end-of-pipe" criteria (requiring all discharger effluent levels to be at or below the NNC), the total annual costs could range from $3.1 to $8.4 billion (based on the estimated fifth and ninety-fifth percentile of costs). Even if EPA enforces criteria to a less strict Best Management Practices (BMPs) and Limit of Technology (LOT) standard in which effluent is not at or below the federal proposed NNC, then the annual costs could range from $1.0 to $3.2 billion (based on the estimated fifth and ninety-fifth percentile of costs in this scenario).[2] These annual costs include operation and maintenance costs a well as capital costs annualized over a 30-year period; estimated annual costs may extend indefinitely past the 30-year period as new capital costs may be required.

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1 Environmental Protection Agency, 2010, "Preliminary estimate of Potential Compliance Costs and Benefits Associated with EPA's Proposed Numeric Nutrient Criteria for Florida".

2 Even assuming, as the EPA Economic Analysis does, that the direct compliance costs of the proposed federal NNC are limited to implementing BMP's and LOT for dischargers located only on impaired water bodies ($481 million annually), this analysis still estimates that the direct compliance costs are 45 times greater than the upper end of EPA costs ($10.6 million). It is important to note that the FDEP disagreed with EPA's characterization of LOT and the assumption that implementation of BMPs would be sufficient to comply with the proposed federal NNC.

- There are significant distributional and socioeconomic impacts of EPA's proposed regulations. There will be high costs to economically distressed areas as well as substantial economic costs and dislocation impacts on certain economic sectors in the state. Over 20 counties in Florida have poverty rates that exceed 20 percent (the national average is 14 percent); annual compliance costs in these high poverty counties are expected to total $256 to $647 million annually. While some industries such as construction may benefit from the criteria, many industries such as housing and retail trade are expected to suffer.
- The benefits associated with EPA's new water quality standards are uncertain. There is little quantifiable benefit demonstrated with respect to improving water quality in healthy water bodies that will now be considered "impaired" under EPA regulations. For example, with 90 percent certainty, the annual end-of-pipe compliance costs for these "newly" impaired water bodies are estimated in this study to range from $0.8 to $2.1 billion, with an average estimated cost of $1.3 billion.

ES.1 Direct Compliance Costs of the Proposed Federal NNC Far Exceed the EPA Estimates

The EPA cost estimates fail to consider the impact of uncertainty and therefore underestimate the overall cost of the proposed federal NNC regulation. There are two factors driving the uncertainty about the direct compliance costs:

1. Uncertainty in the level of treatment that will be required of affected entities (i.e., expected increased per unit treatment cost to dischargers), and;
2. Uncertainty in the number of affected entities (i.e., expected number of dischargers needing new or additional treatment).

The EPA Economic Analysis estimates costs of implementing BMPs and upgrading current technology, but notes "it may be infeasible to meet the criteria instream due to technology limitations (p. 6)". The EPA states that regulatory relief may need to be considered, including lakes criteria adjustment procedures, site-specific alternative criteria (SSAC), restoration standards, variances, or use attainability analyses (together referred to as "variances" hereafter). In its economic analysis, the EPA did not address the feasibility or costs of utilizing these provisions. The EPA asserts that it does not know the extent of the use of these variances and therefore it cannot estimate compliance costs. A more reasonable approach would be to estimate the costs of using alternative technologies (such as reverse osmosis) that may be required for dischargers to meet the actual federal criteria and estimate the uncertainty that end-of-pipe criteria may be required for all water bodies. The Cardno ENTRIX study uses this latter approach. The study synthesizes the results of several existing cost estimates to provide a clearer picture of the costs and uncertainties associated with the proposed federal NNC. The study uses standard statistical techniques for estimating costs under uncertainty and different enforcement scenarios about compliance levels for the proposed federal NNC.

Compliance costs were estimated for two treatment level scenarios: 1) an End-of-Pipe Requirement that assumes that the proposed federal NNC will require all dischargers on affected water bodies to reduce their effluent levels to at or below the NNC; and 2) a less strict requirement that assumes that compliance will be achieved using standard BMPs and reaching LOT of existing technology. Effluent levels under the standard BMP and LOT Requirement will not achieve the criteria, and actual nutrient reductions required to comply with the proposed federal NNC will be specific to each water body. According to the EPA, to an unknown degree, variances from strict compliance with the criteria may be granted for specific water bodies. We could find no information about the likelihood that variances would be granted although members of the public filed comments regarding the lack of perceived feasibility of pursuing and receiving widespread variances from the rule. Also, EPA's reliance on variance provisions raises a more fundamental issue regarding the reasonableness of analyzing the economic impact of the proposed federal NNC in the context of regulators granting an unknown and potentially limitless number of exceptions to the standards. Due to the uncertainty regarding both variances and the treatment requirement, we include implementation of standard BMPs and LOT as an alternative scenario to the End-of-Pipe Requirement. This scenario does not include the costs of conducting studies in attempts to obtain variances.

Additionally, the study estimates compliance costs using different numbers of affected entities based on varying assumptions regarding the application of the proposed federal NNC to different water body types (i.e., currently impaired, newly impaired due to NNC, and unimpaired under NNC). The EPA Economic Analysis assumes that increased treatment costs occur only for newly impaired water bodies; our analysis estimates costs for newly impaired, currently impaired, and unimpaired water bodies. Under all scenarios, compliance cost estimates use Florida's current water quality standard as the baseline. Furthermore, under all scenarios, compliance cost estimate are based on current costs of water treatment and do not anticipate changes in cost structures due to advances in technology.

The figures below summarize the results. Figure ES-1 and Figure ES-2 show the potential range of annual compliance costs associated with the two principal scenarios we evaluated.

Figure ES-1 shows that there is a 90 percent chance that total annual costs will (potentially indefinitely) range from $3.1 to $8.4 billion (in 2010 dollars) assuming an End-of-Pipe Requirement for complying with the proposed federal NNC for all inland water bodies, excluding South Florida. Figure ES-2 shows there is a 90 percent chance that annual costs for affected entities under the BMP and LOT Requirement scenario on all water bodies will range from $1.0 to $3.3 billion. Much of this cost is upfront capital cost that likely would be incurred in the first few years of implementing the NNC. Cost estimates are based on the assumption that capital costs are paid back during a 30-year time period; however the estimated annual costs may extend indefinitely past the 30-year period as operation and maintenance and, potentially, new capital costs will be required. Again, it is important to note that, under both scenarios, these costs would be in addition to current or currently anticipated costs for compliance under Florida's existing water quality standards and associated regulations.

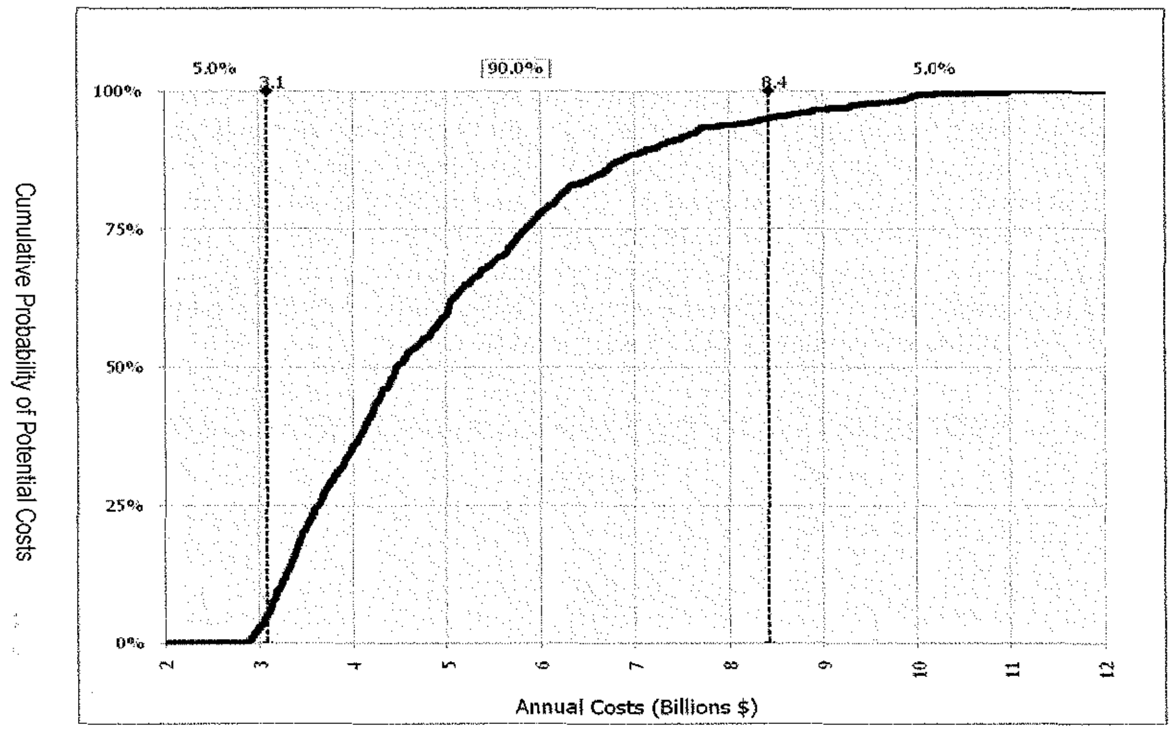


Figure ES-1 **Financial Risk – End-of-Pipe Requirement Annual Cost**

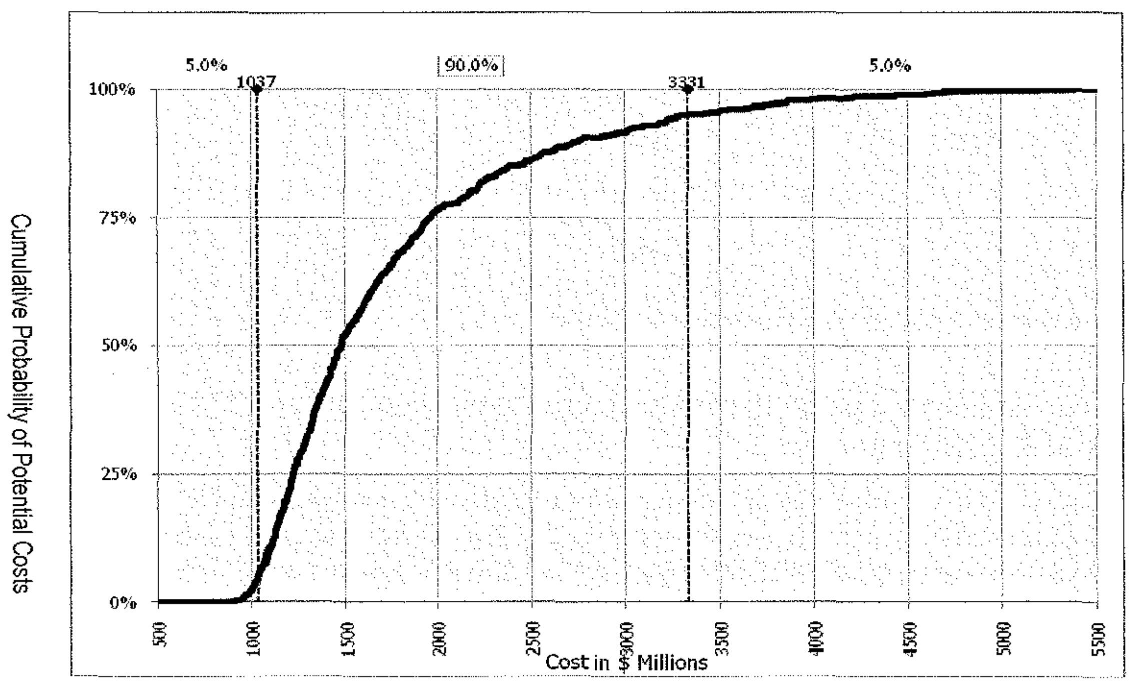


Figure ES-2 **Financial Risk – BMP and LOT Requirement Annual Cost**

Figure ES-3 shows the estimated annual direct compliance costs to the six sectors analyzed: agriculture, municipal wastewater treatment plants (WWTPs), industry, urban stormwater, septic tanks, and state agencies (for development and enforcement of 'Total Maximum Daily Load' or TMDL limits). It shows that average expected annual costs are significant for all sectors, ranging from $240 million for septic tanks and over $2.1 billion for stormwater, based on the End-of-Pipe Requirement in all inland waters (these costs change to $41 million to $783 million based on the BMP and LOT Requirement). As indicated in Figure ES-3, stormwater costs in particular rise dramatically if enforcement of the proposed federal NNC is to meet the End-of-Pipe Requirement and applies to all inland water bodies. Stormwater and municipal WWTP costs are largely borne by local city and county governments, and thus are passed on to rate payers or tax payers. Together with the cost to state agencies of implementing and developing TMDLs, total costs to the public sector are expected to account for approximately 60 percent of total costs.

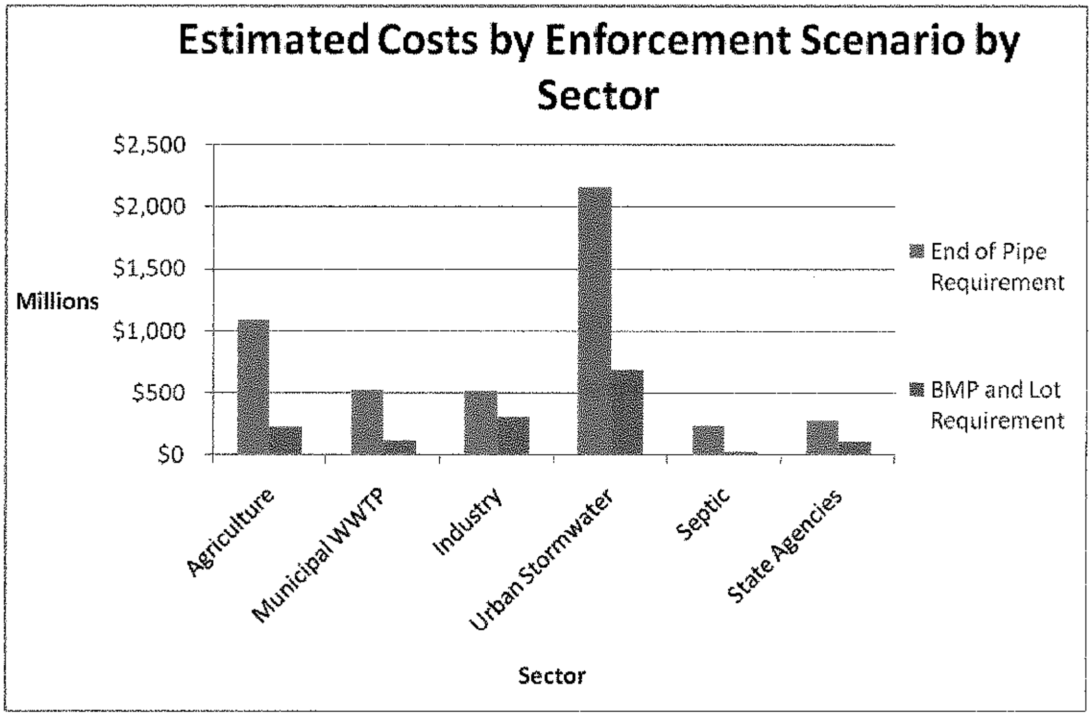


Figure ES-3 Direct Annual Compliance Costs by Scenario and Sector

ES.2 There are Significant Distributional and Socioeconomic Impacts of EPA's Proposed Regulations

There will be high costs to economically distressed areas as well as substantial economic costs and dislocation impacts on certain economic sectors in the state. Many counties already experiencing severe socioeconomic conditions will feel the impacts of the proposed federal NNC. Over 20 counties in Florida have poverty rates that exceed 20 percent (the national average is 14 percent); annual compliance costs in these counties are expected to total $256 to $647 million. Complying with the proposed federal NNC will cause significantly higher costs on a per capita and per income basis in counties with poverty rates exceeding 20 percent. Under the End-of-Pipe Requirement scenario, the average cost of compliance per person ($1,342) is three and a half times greater in these counties than in counties with poverty rates under 20 percent. Further, in this scenario, the cost per dollar earned (4 percent) is 300 percent higher in these counties indicating that a larger proportion of each dollar earned will be used to pay for the proposed federal NNC compliance. For example, in Hamilton County, the cost per person of End of Pipe Requirement scenario compliance is projected to be over $11,700, or 467 percent of total county earnings.

Further impacts may include increases in utility costs, which can also depress housing prices and further depress the retail and commercial development industry. Implementation of the proposed federal NNC could increase the cost of owning a home, and therefore decrease the value of a home; it can also divert spending from the service and retail sectors to spending on utilities.

ES.3 Benefits Associated with EPA's New Water Quality Standards are Uncertain

Benefits identified in the EPA Economic Analysis are highly uncertain. Many believe that the benefits from vastly increasing the number of water bodies listed as impaired fail to justify the costs. Florida water quality experts review Florida surface waters for nutrient impairment in accordance with Florida's existing Impaired Waters Rule (IWR), and these experts believe that the vast majority of Florida lakes and flowing waters with existing water quality problems are already identified as impaired water bodies. As such, most of the estimated 2,174 water bodies that may be newly listed as impaired under the proposed federal criteria likely do not merit being listed as impaired in light of the established Designated Uses for Florida waters and will not benefit from imposing the proposed federal NNC. This study shows that the potential compliance costs for "newly" impaired water bodies account for more than 25 percent of total costs (Figure ES-4). Listing water bodies with acceptable ecological and human health conditions as impaired would allocate state resources unnecessarily to develop TMDLs, create "restoration" programs and create or increase treatment costs for discharges to these water bodies. Experts in Florida water resource management feel these limited resources would be better spent improving the water quality of those waters already listed as impaired for nutrients under the current IWR.

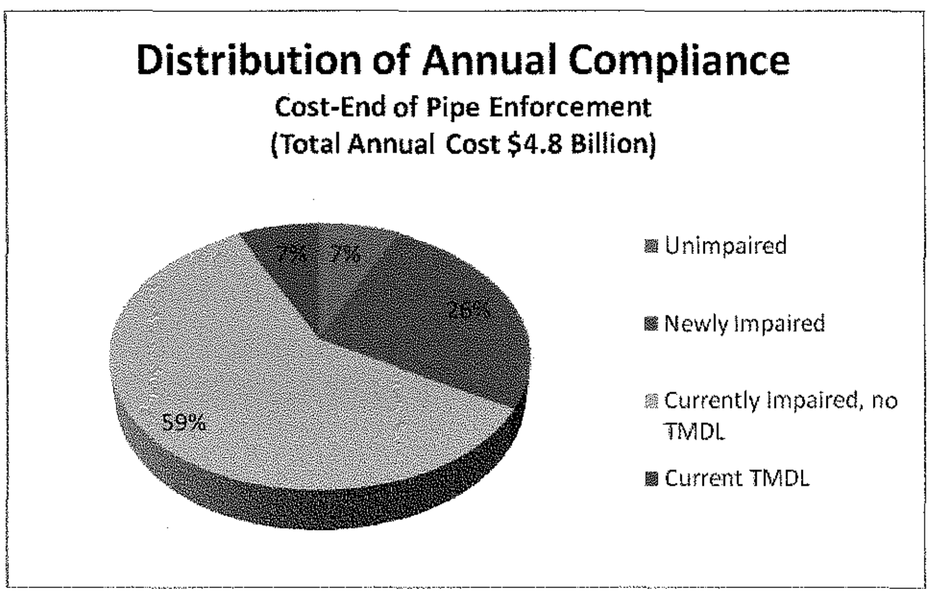


Figure ES-4 Distribution of Annual Compliance Cost by Water Body Category

In addition, the EPA's estimate of benefits is highly uncertain, and it is reasonable to assume that the benefits from the proposed federal NNC should be large enough to equal or outweigh the costs. EPA points to the potential economic value of improved water quality in both its preamble and in a separate Technical Support Document. Both discussions have the same two flaws. First, information and validation showing that specific locations will benefit in meaningful, measurable ways from imposing the criteria are lacking. As a general matter, economic benefits arising from these types of actions are site-specific and EPA's benefits assessment provides no information about the potential site-specific benefits (and their relationship to costs). In this sense, problems with EPA's economic benefits estimates mirror the flaws with several aspects of the technical approach to setting the proposed federal NNC (i.e., lack of clear connection between the required nutrient reduction and the anticipated ecological response). Secondly, even when focusing on "generic" rather than site-specific benefits, the studies cited by the EPA do not provide reliable estimates of water quality improvements.

Chapter 1

Introduction

Florida currently has a narrative nutrient standard to guide the management and protection of its waters. In January 2010, the Environmental Protection Agency (EPA) published proposed "Water Quality Standards for the State of Florida's Lakes and Flowing Waters" that detail numeric nutrient criteria (federal proposed NNC). EPA provided an assessment ("EPA Economic Analysis") of the potential benefits and costs of its proposed federal NNC, as well as an assessment of the economics of the draft NNC rule from the Florida Department of Environmental Protection (FDEP). During the public comment period, numerous Florida municipalities, industries, non-profit agencies, and state agencies (including the FDEP) provided comments on the proposed rule and the EPA Economic Analysis. Many of these comments disputed the methods and the findings of the EPA Economic Analysis.

1.1 Purpose and Scope of Analysis

On behalf of the Florida Water Quality Coalition, Cardno ENTRIX has conducted an independent review of the EPA Economic Analysis, the economic studies conducted by the regulated community, the public comments on the proposed federal NNC, and has also interviewed many Florida entities that will be affected by the proposed rule. This study provides a summary of findings regarding the relative magnitude of the direct and indirect costs of the proposed federal NNC. Similar to the EPA Economic Analysis, direct costs are estimated for five sectors: agriculture, municipal wastewater treatment plants (WWTPs), urban stormwater, industry, and septic tanks. Additionally, costs are estimated for state resource agencies to develop and implement TMDL thresholds for impaired water bodies. The purpose of this analysis was not to develop independent compliance cost estimates for each sector, but rather to utilize existing cost estimates to standardize estimates and incorporate uncertainty into total cost estimates.

This analysis provides estimates of direct compliance costs that reflect the best available information about the uncertainty of the costs and the impact of the proposed federal NNC. The geographic scope of the analysis is inland lakes and flowing water bodies, excluding South Florida, for which NNC establishment has been postponed. Estuarine, marine, and South Florida canal criteria will be the subject of a subsequent phase of rule-making and are not considered in this analysis. Furthermore, under all scenarios, compliance cost estimate are based on current costs of water treatment and do not anticipate changes in cost structures due to advances in technology.

While the EPA analysis estimated that the proposed federal NNC are applicable to 5,089 water bodies (as designated by water body identification numbers or WBIDs), this analysis identifies and estimates costs based on 5,147 water bodies. This study analyzes the potential impact of requiring additional water treatment by dischargers to all 5,147 water bodies. In contrast, the

EPA analysis assessed impacts only on the 190 streams that it classified as 'incrementally' impaired compared to the draft Florida NNC.

This analysis shows impacts by sector, by water body impairment status, and by county. It also provides a summary of the indirect impacts of the proposed federal NNC on the Florida economy and quality of life. Finally, the analysis includes a review of the benefits of the proposed federal NNC as estimated by the EPA.

1.2 Organization

This report is organized into five chapters. Following this introduction, Chapter 2 summarizes the methodology and data used to estimate direct costs, including the statistical methods used to incorporate uncertainty. Chapter 3 presents estimates of direct compliance costs by sector and water body impairment status. Chapter 4 discusses indirect and distributional impacts, while Chapter 5 reviews the methods and findings of EPA's estimated benefits.

Chapter 2

Methods for Estimating Compliance Costs

To estimate direct compliance costs, our methodology is based on the following primary steps:

1. Collect all existing cost estimates, and define ranges in all primary variables driving per unit costs (i.e. costs per acre, per septic tank, per million gallons treated daily (mgd), etc). Primary variables driving per unit costs include implementation rate, capital cost, existing level of technology, operation and maintenance cost, interest rate, and payment period.

2. Estimate per unit expected average compliance cost. To incorporate uncertainty, use low, high, and most likely cost estimates for each variable, and conduct Monte Carlo statistical analysis to estimate the most likely average per unit compliance cost across entities in Florida for each sector studied. Conduct several Monte Carlo analyses for each sector to account for different levels of potentially required treatment. Monte Carlo methods, described in more detail below, are commonly used for modeling costs when there is significant uncertainty in inputs

3. Collect spatial data on dischargers and on water body impairment status. Estimate the number of affected entities by sector by water body impairment status (water body category) and county, identifying characteristics that would affect the choice of per unit treatment cost (such as whether a municipal WWTP had existing LOT according to EPA and whether it was located in a county with deep well injection).

4. Multiply the number of units (acres, mgd, septic tanks) of affected entities in each water body category in each county by the relevant per unit cost to estimate total costs by water body category and by county.

This chapter describes the primary data sources, the definition of baseline conditions, how uncertainty was incorporated into the analysis, and how water body impairment status and the number of affected entities were estimated. Finally, per unit compliance costs estimated using Monte Carlo methods are presented.

2.1 Use of Existing Data and Interviews

All direct cost estimates in this study are derived from existing cost estimates, including those presented in EPA Economic Analysis, the FDEP Review of EPA's Economic Analysis (FDEP Economic Analysis), and reports submitted in the public comment process from municipalities, industries, and other affected entities. To thoroughly understand and document cost estimate assumptions, Cardno ENTRIX spoke with many authors of original cost estimate reports prepared in response to the proposed federal NNC. These sources of information were supplemented with numerous additional interviews with water quality professionals in Florida, including representatives from trade groups, industry, municipalities, FDEP, and other consulting firms. Cardno ENTRIX spoke with organizations such as the Florida Water Environment Association (FWEA), FDEP, EPA, Florida Pulp and Paper Association, and Florida Stormwater Association (FSA) on the individual, regional, and industry specific impacts and costs associated with the proposed federal NNC. Engineering processes and costs were also discussed with engineers from multiple leading engineering firms with specialized experience in Florida and with the EPA proposal. These interviews were used to identify the key variables driving costs and to identify ranges in uncertainty according to these experts and report authors. It is important to note that each cost estimate provided to Cardno ENTRIX included its own assumptions and uncertainties that were not all independently evaluated in this study.

Spatial data was also gathered, including data on water body impairment status, National Pollution Discharge Elimination System (NPDES) permits, and land use and land cover data.

2.2 Baseline Conditions

In specifying a baseline for cost-benefit analysis, EPA guidance on cost-benefit analysis requires that all aspects of the baseline condition that are uncertain and all assumptions made in specifying the baseline should be clearly identified. The EPA Economic Analysis does not provide adequate information on this issue.[3]

The goal of economic analysis should be to provide an overall assessment of the potential benefits and costs of the proposed federal NNC. Because the total costs and benefits of the proposed rule are critical knowledge for the State of Florida and its residents, there is a reasonable expectation that EPA should use a baseline that considers total costs and benefits. The EPA asserts that, because the draft FDEP criteria are likely to be implemented in the absence of the proposed federal NNC, the FDEP criteria constitute a baseline. This is incorrect. The FDEP proposed criteria do not represent the current regulatory conditions, had not yet been formally proposed as criteria, and could have been changed by FDEP in response to public comments. In addition, when the EPA finalizes its proposed federal NNC, the FDEP criteria will never have been in force and the current narrative criteria would still constitute the baseline for comparison.

This analysis uses the narrative criteria currently in place in Florida as its baseline condition. Thus, it is important to acknowledge that the incremental effect of the proposed federal NNC is not known for some water bodies. For example, there are some water bodies that are currently impaired for which TMDLs have not yet been completed. As it is not known what would be required under the TMDL that would be created under the baseline condition, the incremental additional compliance that would be required by the proposed federal NNC is not known. Similarly, it is not known what additional compliance costs may be required of dischargers to water bodies with established TMDLs. In the absence of water body-specific information on how the proposed federal NNC would differ from the current narrative criteria, this analysis estimates potential additional compliance costs to all water body types, regardless of impairment status.

[3] According to the EPA's January 2010 Proposed Rule, the FDEP criteria used in the EPA Economic Analysis to describe a baseline condition differs from the draft FDEP criteria. Finally, the EPA does not use its actual proposed federal NNC in the EPA Economic Analysis.

2.3 Incorporation of Uncertainty

A primary driver in the wide variation in existing cost estimates regarding the proposed federal NNC is the treatment of uncertainty. In fact, it is the major reason that the EPA cost estimates are unrealistically low. The fundamental cause of the difference between the FDEP Economic Analysis estimates and the EPA estimates is that the EPA Economic Analysis estimates costs of implementing best management practices (BMPs) and upgrading current technology, but notes that "it may be infeasible to meet the criteria instream due to technology limitations (p. 6)". In contrast, the FDEP estimates are based on all sectors reducing discharges to the proposed federal NNC standards to the extent feasible under reverse osmosis and other technologies.

The EPA states that regulatory relief may need to be considered, including a proposed lakes criteria adjustment procedure, granting of site-specific alternative criteria (SSAC), use of restoration standards to extend the compliance period, variances, or Use Attainability Assessments (UAAs) (together referred to as "variances" hereafter). The EPA acknowledges that it does not know the extent of the use of these variances and therefore it cannot estimate compliance costs. Recognizing the inherent uncertainty in estimating compliance cost, this study has identified two factors driving uncertainty and has developed processes for incorporating this uncertainty into cost estimates.

Two primary factors driving uncertainty on direct compliance costs are:

1. Uncertainty in the level of treatment that will be required of affected entities (i.e., expected increased per unit treatment cost to dischargers), and;

2. Uncertainty in the number of affected entities (i.e., expected number of dischargers needing new or additional treatment).

For the first factor, our approach in this analysis is to incorporate uncertainty by looking at two levels of treatment that may be required: a lower level utilized by EPA in its cost analysis that relies on standard BMPs and upgrading existing technology to what EPA characterizes as the LOT, and a higher level that requires all dischargers (direct dischargers to surface water as well as septic tanks) to reduce effluent nutrient levels to the proposed federal NNC (i.e. an End-of-Pipe Requirement). Experts in Florida agree that in many cases, effluent levels under the standard BMP and LOT requirement will not be at or below the criteria, and actual nutrient reductions required to comply with the proposed federal NNC will be specific to each water body. However, as assumed in the EPA Economic Analysis, it is possible that standard BMPs and LOT, in conjunction with variances, may be sufficient to comply with certain criteria in at least some water bodies. According to the EPA, to an unknown degree, variances from strict compliance with the criteria may be granted for specific water bodies although members of the public filed comments regarding the lack of perceived feasibility of pursuing and receiving widespread variances from the rule. Also, EPA's reliance on variance provisions raises a more fundamental issue regarding the reasonableness of analyzing a standard's economic impact in the context of regulators granting an unknown and potentially limitless number of exceptions to the standards. Due to the uncertainty regarding both variances and the enforcement requirement, we include implementation of standard BMPs and LOT as an alternative scenario to the End-of-Pipe Requirement. Our evaluation does not include the costs of conducting studies in attempts to obtain variances.

Within these two levels of treatment, there is significant uncertainty regarding compliance costs for any given facility. To incorporate this uncertainty into our estimates, we collected a broad range of cost estimates at each treatment level for each sector and then developed a Monte Carlo simulation specific to each sector to estimate the most likely compliance costs for both the BMP and LOT Requirement and End-of-Pipe Requirement treatment levels.[4]

To address the second factor, as discussed above, this analysis presents all results by water body type and sector (the EPA Economic Analysis estimates costs only for water bodies that are newly listed as impaired under the proposed federal NNC). This method enables easy comparison of how costs differ based on which water bodies and which sectors must upgrade their water treatment due to the proposed federal NNC.

Finally, while not explicitly incorporated into cost estimates, it is important to acknowledge the cost of uncertainty itself. For example, a business would prefer to deal with a known cost of $2 million rather than a cost that ranges from $ 1 to $3 million, even though the expected cost is the same in both cases. The proposed federal NNC introduce considerable uncertainty in doing business in the following areas: the timing of implementation of the requirements, scheduling of the building of the technology, the likelihood of variances, and timing of the TMDL process. Further, much of the technology being discussed has not been implemented in many industries and there is a high level of uncertainty associated with the performance of the technology and possible costs resulting from poor performance.

2.4 Costs by Class of Potentially Affected Water Body

There are an estimated 5,147 water bodies that may be affected by the proposed federal NNC.[5] As the cost of compliance may vary depending on the impairment status of water bodies, this analysis classified four types of water body categories and assessed the number of potentially affected dischargers by water body category.

2.4.1 Water Body Categories

The four water body categories are:

- Category 1: Unimpaired: These water bodies are currently unimpaired and are expected to remain unimpaired under the proposed federal NNC. Entities discharging to these water bodies may be subject to increased water treatment costs if implementation of the proposed federal NNC requires all effluent levels to meet the criteria (end-of-pipe criteria), even if water body sampling indicates that ambient nutrient concentrations are below the proposed federal NNC.

[4] Monte Carlo is a statistical technique often used to simulate physical systems or any system involving a significant amount of risk. The uncertainty in cost estimates in this study is captured by the Monte Carlo simulations to generate estimates of most likely compliance costs for each affected sector.

[5] This number is based on an FDEP database, and differs slightly from the 5,089 number presented in the EPA Economic Analysis.

- Category 2: Newly Impaired: These water bodies are currently classified as unimpaired under the narrative criteria and are expected to become impaired under the proposed federal NNC. These water bodies are expected to be subject to increased water treatment costs under all implementation scenarios.
- Category 3: Currently Impaired, No TMDL: These water bodies are currently listed as impaired under the current narrative criteria but do not have an associated TMDL. Many TMDLs are in the development process and implementing the proposed federal NNC may require redevelopment of TMDLs.
- Category 4: Currently Impaired, TMDL: These water bodies are currently listed as impaired under the current narrative criteria and have a TMDL. It is not known if EPA will accept the TMDL as site-specific alternative criteria (SSAC), or if new TMDLs would need to be developed to comply with the proposed federal NNC.

The number of inland water bodies (excluding South Florida) in each category was estimated using a dataset developed by FDEP to analyze impairment status under the proposed NNC. Table 2-1 summarizes the number of water bodies (each with a distinct water body identification number, or WBID) in each of four categories.

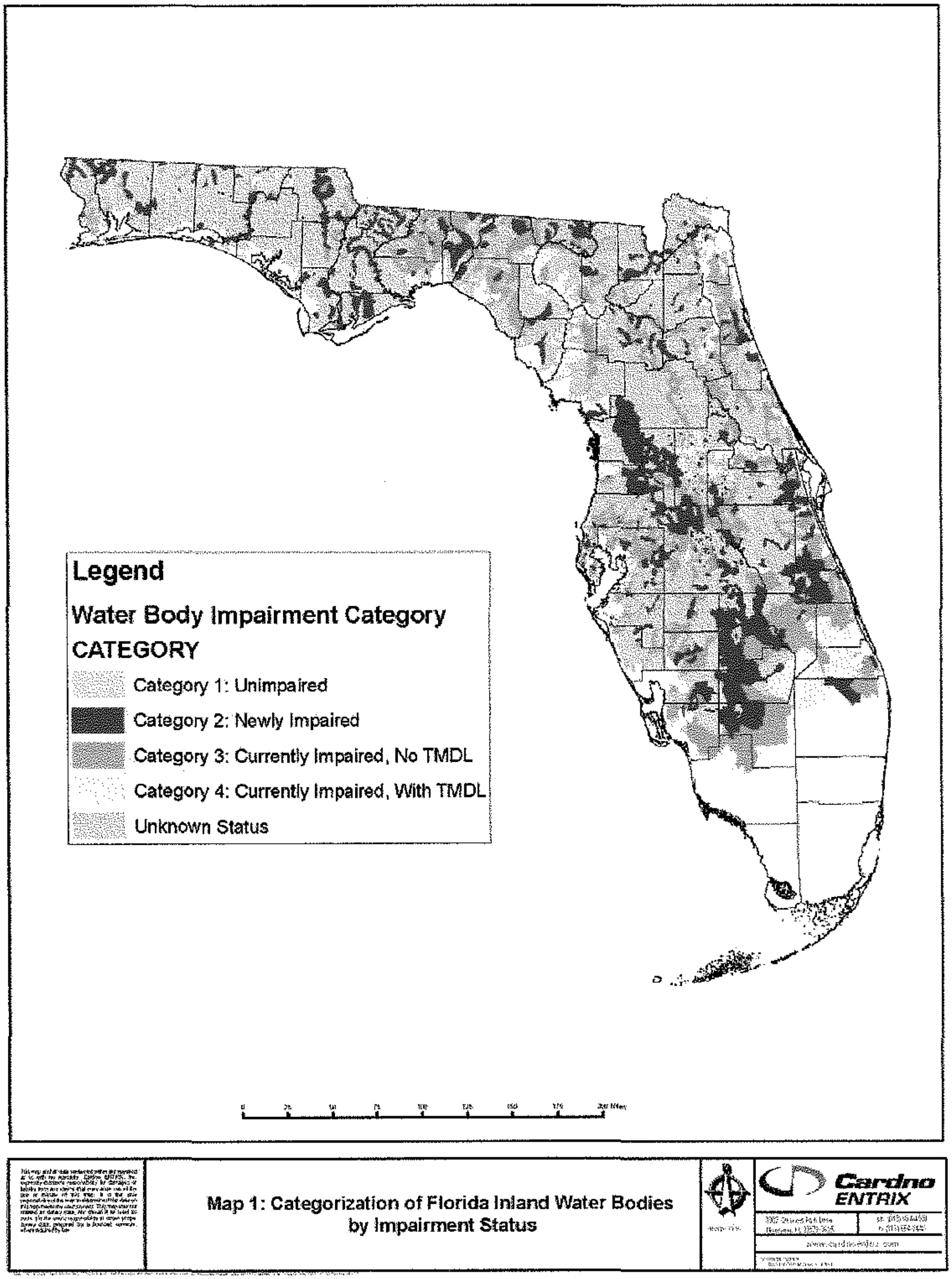
As indicated in the Table 2-1, there are 3,370 water bodies (66 percent of all WBIDs expected to be covered by the proposed federal NNC) for which there is not enough existing water quality data to classify their current or potential future impairment status. Of the water bodies with known impairment status, approximately 9 percent are in Category 1, not currently or newly impaired, 42 percent would become impaired under the proposed federal NNC (Category 2), and 50 percent are currently impaired (Categories 3 and 4). Assuming that the number of water bodies with unknown impairment status are similarly distributed results in the following number of water bodies in Categories 1, 2, 3, 4 (Table 2-1). (To account for uncertainty in the impairment status of these 3,370 water bodies, a range was utilized as indicated in italics in column five of Table 2-1).[6] There are also 39 water bodies that may become unimpaired as a result of the proposed federal NNC; these water bodies were not separately analyzed. Map 1 spatially presents impairment status by water body category.

[6] The range was calculated by allowing the percent allocation of unknown status water bodies to each category to vary by + / - 20 percent. For example, based on the current distribution, the number of newly impaired water bodies is 42 percent. The range applied to unknown water bodies was therefore 33.6% to 50.4% (0.8*42% and 1.2*42%).

Table 2-1 Water Bodies Covered by Proposed Federal NNC by Impairment Category

Water Body Type	Impairment Status: Current Narrative Criteria	Impairment Status: Proposed Federal NNC	Number of Water Bodies (WBID)	Total Known and Estimated Number of Water Bodies[1]	Dischargers Affected by NNC?
Category					
1: Unimpaired	Unimpaired	Unimpaired	154	442 *(Range: 388- 505)*	Yes, if criteria applied as end-of-pipe criteria
2: Newly Impaired	Unimpaired	Impaired	762	2,174 (Range: 1,921 – 2501)	Yes
3: Currently Impaired, no TMDL	Impaired without TMDL	Impaired	753	2,426 (Range: 2,058 – 2,711)	
4: Current TMDL	Impaired with TMDL	Impaired	105	105	Yes, if TMDL not accepted as SSAC
Unknown Status					
Insufficient Data to Classify			503		
Not Included in FDEP Database			2,870		
Total			5,147	5,147	

1. The number of water bodies in categories 1 through 4 based on redistributing water bodies of unknown status to categories 1, 2, and 3.



Map 1 Categorization of Florida Inland Water Bodies by Impairment Status

2.4.2 Number of Affected Entities by Water Body Category

Combining spatial data on the impairment status of each of the 5,147 waterbodies with spatial data on NPDES permits, agricultural acreage, acreage draining into each water body, and total acreage in each county, the number and size of potentially affected entities was estimated for each water body category. Table 2-2 provides the results of this analysis. Details regarding the analysis are summarized below.

Table 2-2 Potentially Affected Dischargers by Water Body Category

Sector	Units	1: Unimpaired	2: Newly Impaired	3: Currently Impaired, no TMDL	4: Current TMDL	Total
Agriculture Gross Acres	Acres	1,456,900	4,722,000	6,724,000	701,800	13,604,900
Agriculture Harvested Acres	Acres	1,292,000	4,198,000	5,669,100	468,200	11,626,900
Urban Stormwater (Estimated MS4 Service Area)	Acres	192,000	714,1000	1,926,000	177,000	3,009,000
Septic	# Tanks	237,800	714,400	1,067,400	170,200	2,189,800
Municipal Wastewater (NPDES permit capacity)	MGD	22.8	72.6	222.6	18.5	336.5
Existing Treatment Not at LOT	MGD	15.1	50.7	150.1	15.7	231.6
Access to Deep Well Injection	MGD	19.2	19.3	49.0	0.7	88
Industrial (NPDES permit capacity)[1]	MGD	13.7	42.1	163.0	29.6	284.4
Access to Deep Well Injection	MGD	0	0	27.0	0	27.0
State Agency	TMDL	0	1,087	0 – 1,213	0 - 53	1,087 – 2,353

1. In addition, there are 9 permits for phosphate fertilizer operations, with an estimated 4 billion gallons of wastewater per facility to dispose of at plant closure.

- Agriculture: Total acreage in each water body category was based on the 2007 Census data on harvested and gross acreage, and allocated to county and water body category using proportions based on data from the Florida Land Use Classification Code (FLUCC) for all agricultural lands (FLUCC 2000). Due to uncertainty regarding the proportion of total harvested and gross acreage that drains to inland waters as well as changes in acreage since 2007, a range of total agricultural acreage was utilized, equal to 85 to 105 percent of total 2007 acreage.
- Urban Stormwater: The GIS dataset on MS4 permits provided the number and location of stormwater permits discharging to the 5,147 inland water bodies, but did not provide the service area acreage. To estimate service area acreage by permit, permits were also classified by county. Based on the proportion of population in the county relative to other counties, and the total urban acreage draining to inland waters in Florida (3,000,900 acres as estimated in the FDEP Economic Analysis), acreage was allocated to each stormwater permit in each county. For example, Alachua County has two percent of the population of all counties with MS4 permits on inland water bodies. Therefore, it was assumed that there were 63,000 urban acres served by MS4s in Alachua County (two percent of 3,000,900 acres). As there are three MS4 permits in Alachua County, there are an estimated 21,000 acres in each stormwater permit. Based on this method, the average stormwater permit has a service area

of approximately 58,000 acres. This evaluation excludes all smaller urban and suburban areas that are not included in an MS4 permit.

- Septic: Data from the Florida Department of Health provided the number of septic systems in each county. These septic systems were allocated to each water body category based on the proportion of land in the county found in each water body category. For example, in Brevard County, three percent of land is estimated to be located in areas draining to Category 4 water bodies. It was therefore assumed that three percent of septic tanks in Brevard County are in Category 4 watersheds. It is possible that proportionately more septic tanks drain to impaired water bodies rather than unimpaired water bodies. As some acreage in many counties does not drain to inland water bodies, not all septic tanks in Florida are included in the analysis.
- Municipal Wastewater: 128 NPDES permits classified as 'sewerage' and 'water supply' that discharge to inland water bodies were identified. These permits were cross referenced with the 94 NPDES permit numbers for the WWTP dischargers reported in Appendix A of the EPA Economic Analysis. An additional 10 NPDES permits were identified in this process that were classified under different SIC codes (i.e., residential mobile home sites). Based on data from the EPA report, facilities were classified by whether their existing treatment was at LOT or not. In addition to classification by water body, WWTP were classified based on their current level of treatment and options for additional treatment. Based on WWTP facilities with data in the EPA report, approximately one-third of treatment capacity is at LOT treatment. It was assumed therefore for the facilities without a matching record in the EPA report, that one-third of capacity, on average, is currently at LOT treatment. Furthermore, data from the FDEP underground injection control program was utilized to identify which WWTP facilities are located in counties with existing Class 1 injection wells. It was assumed that all facilities in these counties, with the exception of Polk County,[7] would have access to sites for deep well injection (as opposed to reverse osmosis technology). Our evaluation does not include assessment of the economic value of water that would be "lost" from Florida's hydrologic cycle due to deep well injection.
- Industrial: Similar to municipal wastewater, the location and capacity of NPDES permits in industries with nutrient discharges (as identified by SIC in the FDEP Economic Analysis) was overlapped with the WBID boundaries to identify the total discharge capacity by water body category. Industrial facilities located in counties with existing Class 1 injection wells were also identified to determine potential treatment options.
- TMDL: Based on the number of WBIDs in each water body category, the number of TMDLs that may be required was estimated by assuming that two WBID are covered by one TMDL based on the current Florida average as cited in the EPA Economic Analysis.

2.5 Summary of Per Unit Cost Ranges by Sector

Cardno ENTRIX summarized and standardized costs using data provided from the EPA Economic Analysis, as well as from Florida municipalities, industries, non-profit agencies, and

[7] Polk County is not included in this assumption as the required depth of a municipal deep well in that area is not cost effective (FWEA Report). It is reasonable to assume the same may be true for other Florida counties.

state agencies (including the FDEP) provided during the public comment period. Per unit costs, whether on a per acre basis for agriculture, or a per million gallon day (mgd) capacity for wastewater treatment costs, differed widely by data source. Based on this variation, Cardno ENTRIX collected the range of reasonable cost estimates and then estimated the most likely per unit cost using Monte Carlo simulations for each affected sector.

Monte Carlo analysis is a statistical technique that systematically incorporates uncertainty into quantitative analysis to improve decision-making. It was first developed for the Manhattan Project and has been used for over 60 years to understand the impact of multiple sources of uncertainty. The EPA recognizes the value of Monte Carlo techniques for dealing with uncertainty. [8][9]

As much of the variation in cost estimates is based on differing assumptions regarding what will be required to comply with the proposed federal NNC, costs are estimated using Monte Carlo methods at two different levels:

- <u>End-of-Pipe Requirement</u> This level of compliance cost assumes that the proposed federal NNC are implemented as an end-of-pipe criteria, and will require all dischargers on water bodies subject to the EPA criteria to reduce their effluent levels to at or below the NNC. Experts in Florida NPDES permitting largely agree this is the most likely scenario for facilities seeking renewal of NPDES permits.
- <u>BMP And LOT Requirement</u> This level of compliance cost assumes that compliance will be achieved using standard BMPs and reaching LOTs. Assuming that the proposed federal NNC are not enforced as End of Pipe criteria, there is still great uncertainty regarding how much treatment will be required by each sector to achieve compliance. Additionally, there is uncertainty regarding the degree to which the EPA will grant variances, and the cost of obtaining these variances. Given these uncertainties, this level of per unit cost is intended to capture the range of costs that may result assuming that the federal proposed NNC are not implemented as End of Pipe criteria.

Tables 2-3 and 2-4 summarize unit compliance costs for the two scenarios. These per unit cost values represent the estimated average compliance cost across all potentially affected entities discharging to inland waters in Florida.

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8 Environmental Protection Agency, ""Guiding Principles for Monte Carlo Analysis" (EPA/630/R-97/001)", accessed online at: http://www.epa.gov/ncea/pdfs/montcarl.pdf.

9 A simple example can be helpful. Suppose the annual BMP compliance costs for a specific crop range from $10 to $20 and the number of acres in a county could be between 5,000 and 20,000. A Monte Carlo model will randomly select a value from the price range and randomly select a value from the acre range and calculate an estimate of annual compliance costs. This process is repeated 1,000 times and provides 1,000 different estimates of compliance costs. The average of the 1,000 estimates is the expected or mean cost. The 1,000 estimates can be sorted from high to low to provide a confidence interval.

Table 2-3 Per Unit Average Annual Compliance Costs – BMP and LOT Requirement

Sector	Unit	Mean	BMP / LOT
Municipal WWTP	MGD	$590,000	Upgrade BNR to LOT
Municipal Stormwater (MS4)	Acre of Service Area	$260	Implement stormwater BMPs on 0 to 78% of urban lands[10]
Industry (NPDES Permits)	MGD	$1,500,000	Upgrade BNR to LOT
Agriculture	Acre	$23	Implement BMPs on Harvested Acreage
Septic Tanks	Septic Tank	$19	Repair Septic Tanks at a rate of 0.5 – 3% annually
State Resource Agencies	TMDL	$98,000	Develop and Implement TMDLs

Table 2-4 Per Unit Average Annual Compliance Costs – End of Pipe Requirement

Sector	Unit	Mean	End of Pipe Requirement
Municipal WWTP[11]			
Microfiltration – Reverse Osmosis	MGD	$1,870,000	Reverse Osmosis
Deep Well Injection	MGD	$750,000	Deep Well Injection
Municipal Stormwater (MS4)	Acre of Service Area	$718	Implement or Upgrade BMPs on 78 to 100% Acreage
Industry (NPDES Permits)			
Microfiltration – Reverse Osmosis	MGD	$1,870,000	Reverse Osmosis
Deep Well Injection	MGD	$750,000	Deep Well Injection
Phosphate Fertilizer	Facility	$5,200,000	Reverse Osmosis
Agriculture	Acre	$83	BMP Implementation on Harvested Acreage and On-Farm Retention/Treatment on Gross Acreage
Septic Tanks	Septic Tank	$110	Replace Septic Tanks at a Rate of 3-6% Annually
State Resource Agencies	TMDL	$98,500	Develop and Implement TMDLs

[10] Based on FDEP Economic Analysis estimate that 78 percent of urban lands in Florida were developed prior to the 1982 stormwater rule.

[11] Includes cost of deep well injection for the estimated 33 percent of dischargers located in counties where deep well injection is possible, and cost of reverse osmosis technology for all other dischargers.

Chapter 3

Compliance Cost Estimates

This chapter has two sections. The first summarizes the per unit costs of compliance for each sector at two different water treatment levels based on the cost results from the Monte Carlo simulations. The second combines the per unit cost information with the number of affected dischargers (presented above in Chapter 2) to estimate total compliance costs by sector and water body category. All annual costs presented in this Chapter include annualized capital costs (based on a 30-year period and a three to seven percent interest rate) as well as annual operation and maintenance costs. Annual cost estimates are based on the assumption that capital costs are paid back during a 30-year time period; however the estimated annual costs of $1.0 to $8.4 billion may extend indefinitely past the 30-year period.

3.1 Total Cost Estimate Findings by Water Body Category

To estimate total costs, per unit compliance costs presented in Tables 2-3 and 2-4 were combined with the total number of entities that discharge to Florida inland lakes and rivers (excluding the South Florida region). Total cost estimates assuming all dischargers to inland water bodies must comply are presented in Tables 3-1 and 3-2 for the two levels of per unit cost estimates (BMP/LOT Requirement and End of Pipe Requirement) for complying with the proposed federal NNC for all inland water bodies, excluding South Florida. Under the BMP and LOT Requirement, there is a 90 percent chance that total annual costs will (potentially indefinitely) range from $1.0 to $3.3 billion, with an average cost estimate of $1.71 billion. Under the End-of-Pipe Requirement, there is a 90 percent chance that annual costs for affected entities range from $3.1 to $8.4 billion, with an estimated average cost estimate of $4.82 billion. Of the total End of Pipe Requirement cost, an estimated 57 percent is annualized capital costs while the remaining 43 percent is annual operation and maintenance costs (see Appendix B).

While significantly higher than the estimates from the EPA Economic Analysis, these estimates are less than originally anticipated by certain sectors in Florida. This is primarily due to two factors. First, these cost estimates take into account uncertainty, including required implementation rates, capital costs, annual operation and maintenance costs, and geographic variation in available treatment methods. Second, these estimates exclude costs in South Florida that were included in several other reports.

Table 3-1 Annual Cost of Compliance by Water Body Category Assuming All Dischargers Affected by Proposed Federal NNC (Millions $) – BMP and LOT Requirement

Sector	Water Body Category 1: Unimpaired	2: Newly Impaired	3: Currently Impaired, no TMDL	4: Current TMDL	Total
Agriculture	$23	$81	$143	$25	$272
Municipal WWTP	$9	$30	$89	$9	$137
Industry	$21	$63	$244	$44	$372
Urban Stormwater	$50	$186	$501	$46	$783
Septic	$4	$13	$20	$3	$41
State Agencies	$0	$107	$0	$0	$107
Total	**$107**	**$481**	**$997**	**$128**	**$1,712**
Proportion	6%	28%	58%	7%	100%

These are the means of the Monte Carlo simulation assuming BMP and LOT criteria applied to all sectors and all water body categories.

Table 3-2 Annual Cost of Compliance by Water Body Category Assuming All Dischargers Affected by Proposed Federal NNC (Millions $) – End-of-Pipe Requirement

Sector	1: Unimpaired	2: Newly Impaired	Water Body Category 3: Currently Impaired, no TMDL	4: Current TMDL	Total
Agriculture	$103	$363	$552	$77	$1,095
Municipal WWTP	$21	$114	$361	$34	$530
Industry	$29	$93	$330	$70	$522
Urban Stormwater	$138	$513	$1,383	$127	$2,161
Septic	$26	$78	$117	$19	$240
State Agencies	$44	$107	$120	$5	$275
Total	**$361**	**$1,269**	**$2,863**	**$332**	**$4,824**
Proportion	7%	26%	59%	7%	100%

These are the means of the Monte Carlo simulation assuming end-of-pipe criteria applied to all sectors and all water body categories.

3.1.1 Potential Cost Savings by Water Body Category

Costs can vary not only by the level of water treatment implementation as shown in Tables 3-1 and 3-2, but also by the number of entities that are affected. If dischargers in all water body types are equally affected by the proposed federal NNC, then approximately 85 percent of costs are borne by Category 2 (newly impaired) and Category 3 (currently impaired with no TMDL) water bodies. However, while proportionately small, significant cost savings could be attained if no additional requirements are imposed from the proposed federal NNC on the remaining sectors:

- Cost Savings on Unimpaired Water Bodies: If there are no incremental costs due to the proposed federal NNC on water bodies that are unimpaired (Category 1), then six to seven percent of costs are saved, or from $107 million to $361 million annually.
- Cost Savings on Water Bodies with TMDLs: If all nutrient-related TMDLs are accepted as SSAC, and no additional nutrient reductions are required on these water bodies (beyond what already required by the TMDL and BMAP), then seven percent of costs are saved, or from $128 million to $332 million annually.

3.2 Summary of Cost Ranges by Scenario

Table 3-3 summarizes the range of costs estimated in this study, based on differing implementation requirements and different numbers of affected water bodies. Direct compliance costs are estimated to range from approximately $1.5 billion to $4.8 billion annually for 30 years or more. Costs of $1.5 billion correspond to the BMP and LOT Requirement on newly impaired (Category 2) and currently impaired water bodies lacking a TMDL (Category 3). Costs of $4.8 billion correspond to implementation of the End of Pipe Requirement on all water body categories. The present value of incurring $4.8 billion in compliance costs over 30 years (at a five percent discount rate) is $74.2 billion.

Table 3-3 Annual Compliance Costs by Enforcement Scenario (Millions $)

Sector	End of Pipe Requirement, All Water Bodies	End of Pipe Requirement, Impaired Water Bodies without TMDL (Category 2, 3 only)	BMP and LOT Requirement, Impaired Water Bodies without TMDL (Categories 2, 3 only)
Agriculture	$1,095	$915	$224
Municipal WWTP	$530	$476	$119
Industry	$522	$423	$307
Urban Stormwater	$2,161	$1,896	$687
Septic	$240	$196	$33
State Agencies	$275	$227	$107
Total	**$4,824**	**$4,132**	**$1,477**

These are based on the means of the Monte Carlo simulation.

Chapter 4

Indirect and Distributional Costs

The proposed federal NNC will have impacts far beyond the direct compliance costs. These indirect impacts can significantly affect the economy and quality of life in Florida. The proposed federal NNC will have an adverse impact on economic development activities and affect the ability of the state to attract new businesses. The proposed federal NNC would raise the cost of doing business in Florida and may make it harder for the state to attract and retain businesses and residents. For example, the pulp and paper industry estimates that water quality treatment upgrade required to comply with the federal proposed NNC may increase the cost of producing paper by $5 to $6 per ton, which is a two to three percent cost increase. Furthermore, many stormwater and wastewater utility experts have commented to EPA in recent public meetings that some of the criteria are not achievable at all using current technology, so the price of compliance shifts from water treatment costs to complete elimination of discharges or closing of facilities.

As written, the proposed federal NNC may lead to significant price changes as many WWTPs, industrial point sources, and agricultural non-point sources that are required to implement modifications to meet the NNC. The push to comply may lead to price increases in the scarce resources needed to attain compliance. These include the demand for engineering, construction, machinery, technology, and labor that may drive up the price of these goods and services. In addition, the cost of compliance could be extensive enough to change prices and the cost of doing business in Florida. The EPA Economic Analysis should include descriptions of the potential price changes faced by consumers, the regulated industries, and their supply chains. Therefore, the federal NNC, as proposed, will likely lead to price increases by these providers, which will increase compliance costs above historically computed averages. Even a modest three percent increase in demand in this industry would increase total costs by 2 to 3 billion dollars in present value terms. Moreover, other industries in Florida that use these industries will also suffer price increases. Additionally some industries may be restricted from developing new locations or expanding existing businesses due to difficulty in obtaining new discharge permits on water bodies classified as impaired. This also can stunt growth and economic development.

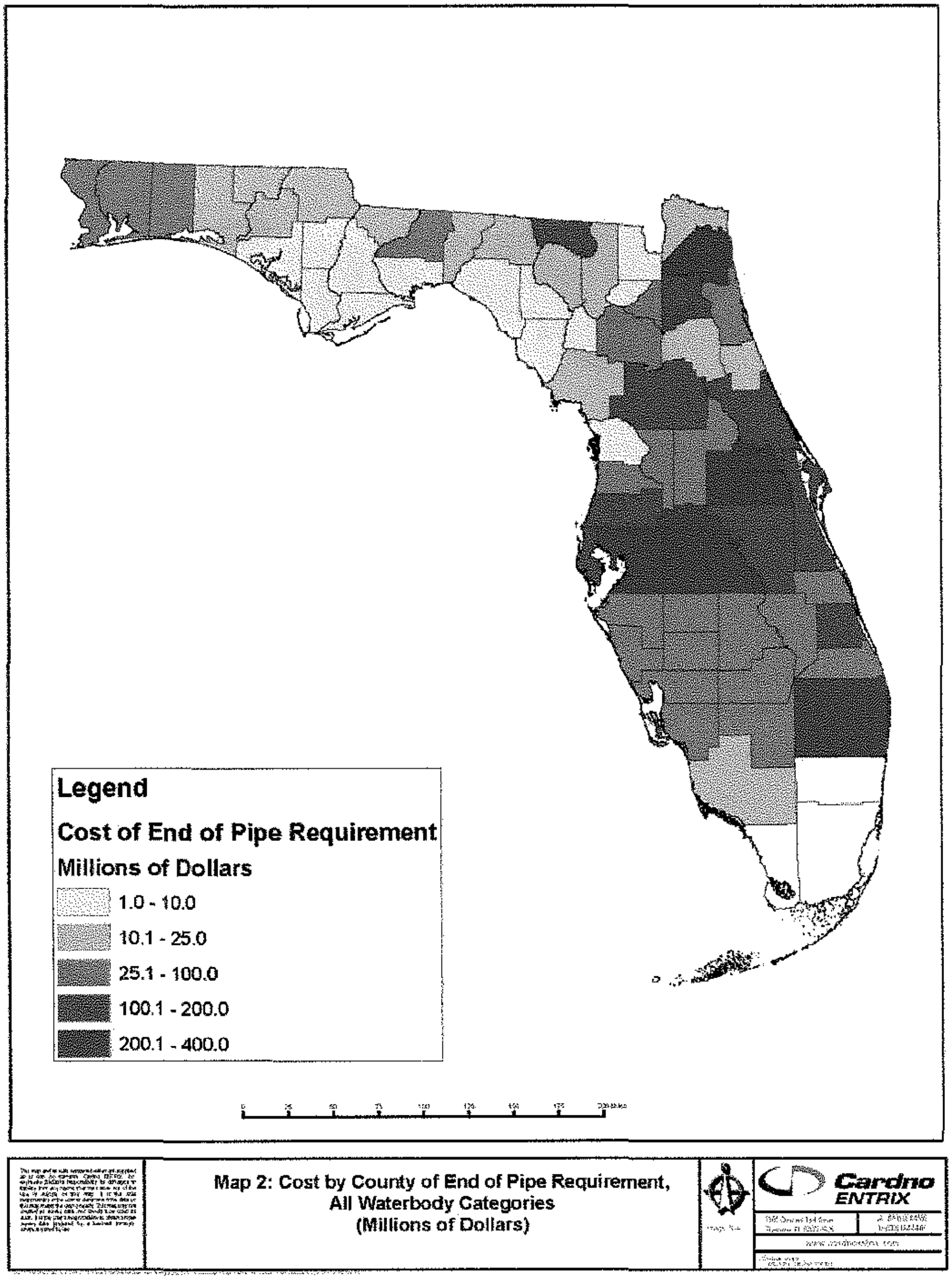
Finally, meeting the proposed federal NNC will affect air quality and green house gas emission. If reverse osmoses technologies are required, energy use will increase significantly, resulting in increased emissions of CO_2, SO_x, and NO_x in Florida. Upgrades for the phosphate industry alone are estimated by that industry to increase energy use by 159 million kilowatt-hours per year, a seven percent increase of total Florida energy use. In addition, the phosphate industry predicts that implementing reverse osmoses technology to comply with the proposed criteria will increase CO_2 emissions by 31,000 ton per year, SO_x emissions by 100 tons per year, and NO_x emissions by 50 tons per year. For the Florida pulp and paper industry, energy use could increase by 123 million kilowatt-hours per year.

4.1 Distributional Effects

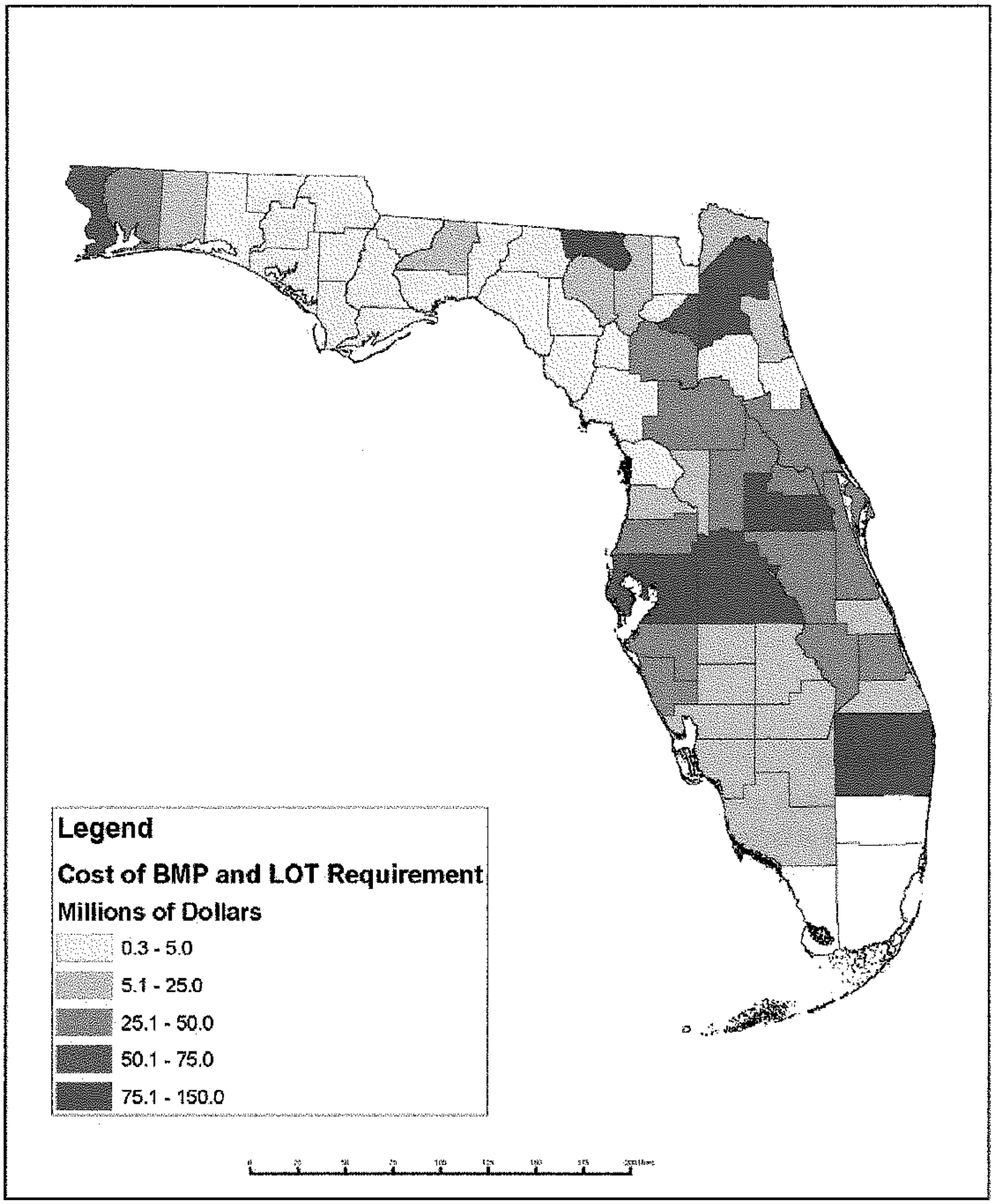
Federal guidance documents clearly state that the distributional impacts are an important component of an economic analysis. Most prominently, The Unfunded Mandates Reform Act of 1995 (UMRA) requires an examination of the potential disproportionate impacts on state, local, and tribal governments; urban or rural or other types of communities; or particular segments of the private sector. OMB Best Practices require that when distributional effects are thought to be important, the analysis should include their magnitude, likelihood, and incidence of effects on particular groups.

4.2 Effects by County/Region

Total direct compliance costs were estimated by county; cost findings from both the BMP and LOT Requirement Scenario and the End of Pipe Requirement Scenario, assuming all water bodies are affected, are presented in Maps 2 and 3. These costs exclude TMDL development costs, which are expected to occur at the state level rather than the local level.



Map 2 **Cost by County of End of Pipe Requirement**



Map 3: Cost by County of BMP and LOT Requirement,
All Waterbody Categories
(Millions of Dollars)

Cardno ENTRIX

Map 3 Cost by County of BMP and LOT Requirement

The economic burden of the proposed NNC may be greatest in areas that are already suffering from high unemployment or low income. Many counties already experiencing severe socioeconomic conditions will feel the impacts of the proposed federal NNC. Table 4-1 summarizes total estimated direct compliance costs for each county with poverty exceeding 20 percent in 2008, as reported and defined by the U.S. Census Bureau.[12] The impacts of these costs will be felt not only by local agricultural and industrial producers, but also by residents in the form of higher utility rates, and potentially, fewer employment opportunities. Increased utility rates to pay for capital upgrades to municipal WWTP and urban stormwater facilities may depress housing prices and further depress the retail and commercial development industry.

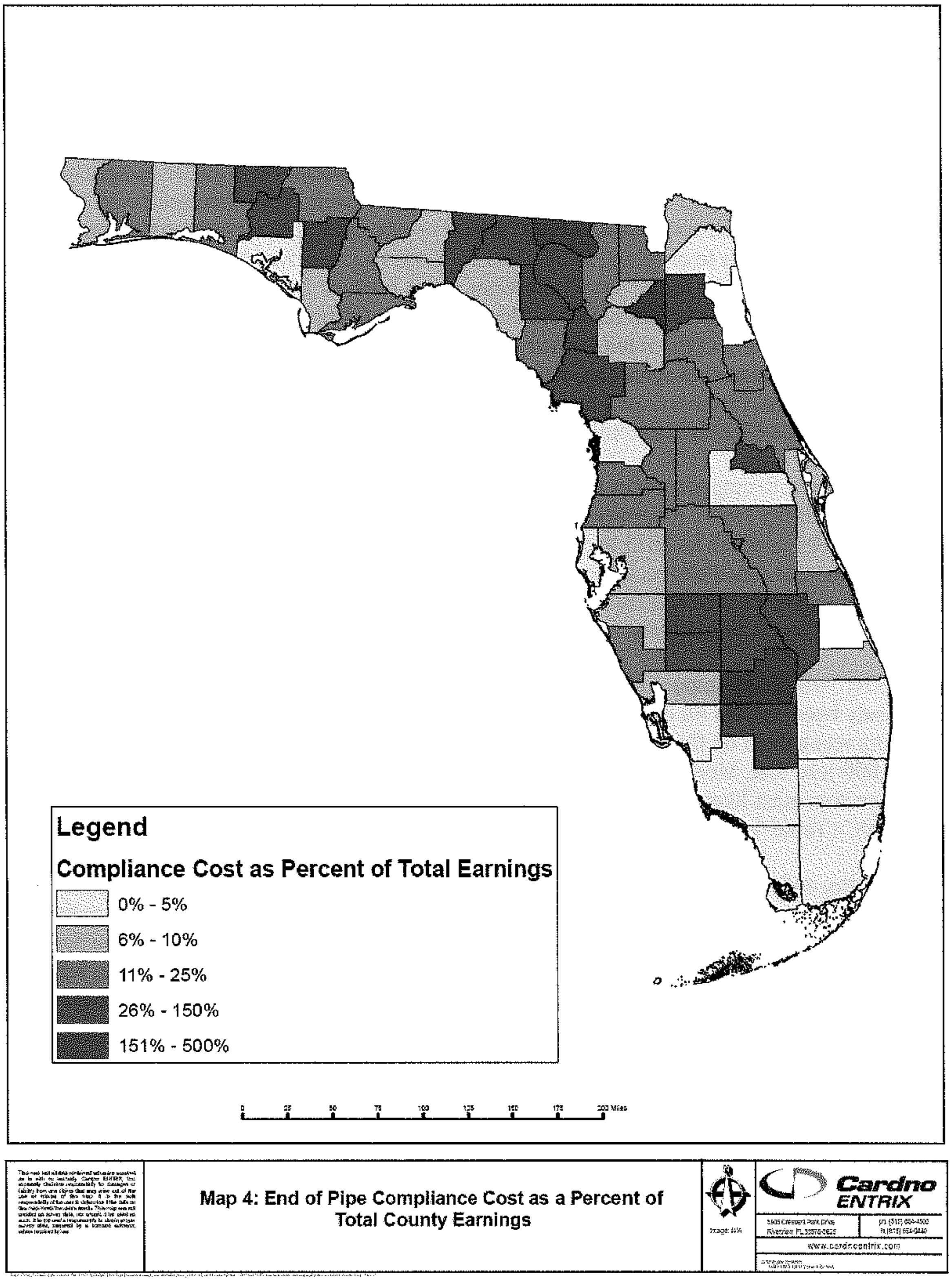
As shown in Table 4-1, complying with the proposed federal NNC will cause significantly higher costs on a per capita and per income basis in counties with poverty rates exceeding 20 percent. The average cost of compliance per person ($1,342) is three and a half times greater in these counties than in counties with poverty rates under 20 percent. Further, the cost per dollar earned (70 percent) is greater by a magnitude of three in these counties, indicating that a larger proportion of each dollar earned will be used to pay for the proposed federal NNC compliance (including costs to individuals in the form of increased utility rates and septic tank upgrades as well as increased costs to businesses). For example, in Hamilton County, the cost per person of End of Pipe Requirement compliance is over $11,700, or 467 percent of total county earnings.

[12] The U.S. Census defines the poverty threshold for an under-65 household of two people and one child as $14,840.

Table 4-1 Compliance Costs for Counties with Poverty Rate at or Above 20 Percent

County	End of Pipe Requirement, All Water Body Categories ($millions)	Poverty Rate (Percent in 2008)	Annual Compliance Cost Burden per Person, End of Pipe	Compliance Cost Burden as % of Total Earnings, End of Pipe
HAMILTON	$172.6	29.3%	$11,750	467%
GADSDEN	$10.4	26.6%	$210	11%
LAFAYETTE	$5.3	25.6%	$610	48%
HENDRY	$76.4	23.8%	$1,870	94%
MADISON	$10.2	23.6%	$510	10%
UNION	$2.9	23.6%	$190	35%
WASHINGTON	$11.1	23.2%	$450	26%
FRANKLIN	$2.4	23.1%	$200	11%
HARDEE	$45.1	23.1%	$1,590	85%
PUTNAM	$16.3	23.1%	$220	11%
TAYLOR	$4.1	22.9%	$180	8%
DIXIE	$2.8	22.8%	$170	17%
DESOTO	$91.2	22.4%	$2,620	145%
GLADES	$27.9	21.8%	$2,583	204%
LIBERTY	$2.8	21.5%	$345	13%
GULF	$1.5	21.2%	$92	6%
HOLMES	$19.6	21%	$1,010	90%
CALHOUN	$6.2	20.9%	$430	31%
OKEECHOBEE	$60.3	20.8%	$1,510	79%
ALACHUA	$77.6	20%	$300	7%
Subtotal	**$646.8**	-	-	-
Average	**$32.34**	-	**$1,340**	**70%**
Remaining Counties, Average	**$88.68**	-	**$390**	**21%**

Map 4 illustrates the estimated end-of-pipe compliance cost burden by county relative to total county earnings. As indicated in the map, several counties face compliance costs that exceed 150 percent of 2010 total county earnings.



Map 4 End of Pipe Compliance Cost as a Percent of Total County Earnings

4.3 Effects by Industry

Imposing the federal NNC may have societal impacts on the economic welfare of Florida residents and businesses that are clearly not captured by the EPA Economic Analysis. Compliance costs of the magnitude contemplated by the proposed NNC will cause economic dislocations of an unknown magnitude. Employment in some sectors will suffer as agricultural and other businesses struggle with direct compliance costs as well as the increased cost of doing business as a result of increased water utility rates. For example, agricultural employment can be expected to decrease due to cropland conversion for BMPs such as forested buffers. Local and state governments will also suffer from reductions in tax revenue from the decreased value of agricultural land. Consumers will have less disposable income because of increased utility costs, which will adversely affect the retail industry and supply chain. Although increases in engineering and construction spending will provide benefits, the magnitude is unclear because firms supplying these resources may need to bring in out-of-state resources, which will result in "leakages" from the Florida economy.

The costs incurred to upgrade water treatment by WWTPs will be passed on to households in the form of higher utility rates. According to the November 18, 2009 FWEA report, sewer rates could increase by as much as $673 to $726 per household in areas where tertiary upgrades are needed. Further, as noted above, increased business costs may affect business viability and economic growth in Florida and further compound the economic hardship already being experienced in these communities.

Federal NNC will likely impose significant compliance costs on those Florida industries that have already been hardest hit by the recession. Since 2006, employment decreased in 98 of the 122 sectors recognized by the State of Florida current Employment Statistics resulting in more than 828,000 jobs lost. Moreover, approximately 38 percent of all jobs lost since 2006 were lost in the 10 sectors most likely to incur financial effects through implementation of proposed federal NNC (Table 4-2).

Manufacturing and mining industries will face particular challenges to growth under the burden of direct compliance costs. Pulp mills and paper manufacturing facilities, for example, reduced their employment base by 12 percent between 2006 and 2010. Similarly, mining – in particular phosphate mining— industries, which face disproportionately high costs of compliance, will be hard pressed to recover from a four year trend of downsizing and job loss (e.g. employment in mining is down 22 percent since 2006).

Federal NNC will also likely burden Florida's struggling retail sector, which decreased by 10 percent, or over 99,000 jobs, since 2006. Small businesses may not incur direct costs of compliance, but their cost of doing business may increase due to increased water utility rates. Furthermore, as consumers are expected to face higher sewer and water rates due to the federal proposed NNC, they will have less money to spend in retail and service industries. An increased cost of doing business coupled with elevated construction costs may also make Florida less attractive to new businesses and residents compared to nearby states, thereby further inhibiting long-term retail growth.

Although growth may be stunted in some sectors, it is important to recognize that the proposed federal NNC would also cause short-term redistribution of economic activity to other sectors. Some sectors, including construction, civil engineering and contracting, may benefit indirectly from Federal NNC as additional construction projects occur to implement BMPs and upgrade water treatment facilities. Approximately 300,000 construction jobs were lost in Florida between 2006 and 2010, including 75,000 in residential construction, 26,500 in heavy and civil engineering construction, and 57,500 in contracting. The construction sector may be negatively affected by proposed federal NNC to the extent that upfront compliance costs discourage growth, particularly in the residential housing market. In many cases, however, federal NNC could lead to new construction, engineering and contracting jobs where major upgrades are made to infrastructure and wastewater treatment.

Table 4-2 summarizes the industries that may be most significantly affected by the proposed federal NNC, together with the recent trends in employment, the expected direction of impact from NNC (positive or negative), and the magnitude of the industry's employment multiplier effect. The employment multiplier indicates how many jobs, in all sectors of the Florida economy, are supported for every $1 million in output from a particular industry. For example, residential construction has an employment multiplier of 20.6, indicating that 20.6 jobs are created in Florida for every $1 million in increased residential construction output.

Table 4-2 Affected Industries and Expected Direction and Magnitude of Ripple Effect

Industry	2006 – 2010 Change in Employment (#)	2006 – 2010 Change in Employment (%)	Expected Direction of NNC Impact	Employment Multiplier[1]
Residential Construction	-75,000	-53%	-	20.6
Building Equipment Contractors	-57,467	-35%	+ / -	20.6
Heavy and Civil Engineering Construction	-26,500	-33%	+	20.6
Architectural and Engineering Firms	-21,000	-23%	+	18.3
Retail Trade	-99,000	-10%	-	23.0
Agriculture	3,700	8%	-	10.5-24.1[2]
Real Estate, Rental, and Leasing	-33,100	-18%	-	1.5
Paper Manufacturing	-1,300	-12%	-	8.6 – 9.5
Chemical Manufacturing	-1,700	-8%	-	3.2 – 5.4[3]
Mining, Except Oil and Gas	-900	-22%	-	9.3
Total	**-312,300**			

[1] Number of jobs supported for every $1 million in output.

[2] Low estimate: Poultry and egg production; high estimate: Greenhouse, nursery, and floriculture production

[3] Low Estimate: Synthetic dye and pigment manufacturing; high estimate: fertilizer manufacturing

Chapter 5

Uncertain Benefits

Benefits identified in the EPA Economic Analysis are highly uncertain, both because of methodological issues in the EPA approach, and also because of potential for little benefit to be derived from vastly increasing the number of water bodies listed as impaired in Florida.

5.1 Little to No Benefit to 'Improve' Unimpaired Water Bodies

There are currently 858 water bodies that are impaired under existing water quality standards in Florida. An estimated 2,174 will be newly impaired under the proposed federal criteria. The proposed federal NNC will effectively increase fivefold the number of water bodies considered impaired in Florida, and will raise the proportion of impaired water bodies from five percent to 35 percent (based on 6,129 Florida water bodies—both freshwater and marine throughout all of Florida—designated by water body identification numbers).

Florida water quality experts generally agree that most Florida lakes and flowing waters with water quality problems have already been identified as impaired water bodies though the state's ongoing systematic evaluation of water body health in accordance with Florida's existing Impaired Waters Rule. As such, most of the 2,174 water bodies that will be newly impaired under the proposed federal criteria may not merit being listed as impaired and would not substantially benefit from imposing the NNC and thus the benefits received would be lower or non-existent. Listing water bodies with acceptable water quality as impaired allocates state resources unnecessarily to develop TMDLs and increase treatment costs for facilities discharging into these newly listed water bodies where the benefits gained are relatively low.

Benefits identified in the EPA Economic Analysis are highly uncertain. Many believe that the benefits from vastly increasing the number of impaired water bodies fail to justify the costs. Florida water quality experts believe that Florida lakes and flowing waters with water quality problems are already identified as impaired water bodies under the narrative criteria. As such, most of estimated 2,174 water bodies that may be newly impaired under the proposed federal criteria likely do not merit being listed as impaired and will not benefit from imposing the proposed federal NNC. This study shows that the potential compliance costs for "newly" impaired water bodies could account for more than 25 percent of total costs (Figure 5-1). Listing water bodies with good water quality as impaired will allocate state resources unnecessarily to develop TMDLs and increase treatment costs for facilities discharging into these water bodies.

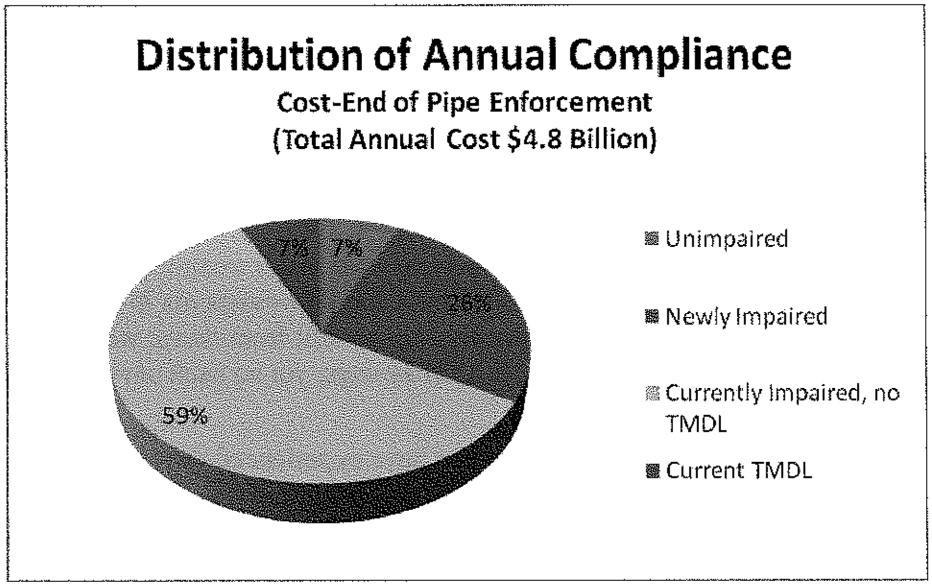


Figure 5-1 **Distribution of Annual Compliance by Water Body Category**

5.2 Methodological Concerns with EPA Approach

EPA points to the potential economic value of improved water quality in both its preamble and in a separate Technical Support Document. Both discussions have the same two flaws. First, information and validation showing that specific locations will benefit in meaningful, measurable ways from imposing the criteria are lacking. As a general matter, economic benefits arising from these types of actions are site specific and EPA's benefits assessment provides no information about the potential site specific benefits (and their relationship to costs). In this sense, problems with EPA's economic benefits estimates mirror the flaws with several aspects of the technical approach to setting the federal NNC (i.e., lack of clear connection between the required nutrient reduction and the anticipated ecological response). Second, even when focusing on "generic" rather than site-specific benefits, the studies cited by the EPA do not provide reliable estimates of water quality improvements.

5.2.1 EPA Benefit Estimate

EPA includes a rough benefits estimate of reducing nutrient loadings to Florida waters. Unfortunately, this estimate does not provide a reliable indicator of benefits. Most importantly, benefits are always site-specific. Without information about the change in water quality at a site and how people value those specific benefits, any quantification of values is highly uncertain.

Putting aside the need for site-specific value estimates, the EPA rough benefit estimate is problematic for the following reasons:

- EPA uses the changes in the water quality for rivers and applies those to all lakes as well. This was done in response to the availability of data on lake water quality improvements. This assumption may bias the results by an unknown magnitude.

- The water quality index used by the EPA is based on the average judgment of a panel of experts convened over 35 years ago. There is no reason to believe these weights reflect current science or are relevant to the water quality conditions in Florida.
- The change in the water quality index from imposing the criteria is trivial in magnitude. There is no reason to believe that minute changes in an index could result in a scientifically meaningful change in how people value and use the water body,
- EPA asserts that there are unquantified benefits from reductions in water treatment costs by municipalities and industrial users from imposing the criteria and improvements in agricultural production. However, if there were a positive net benefit from these, we would expect the EPA cost of compliance estimates to show a net savings; yet no such savings are estimated.
- If there were indeed net benefits, then the EPA should not have experienced the backlash of comments and critiques posted by all sectors regarding the proposed criteria.

5.2.2 Benefits Cited by EPA

EPA cites the results of Dodds et al. as an example of recreation and property value impacts from improved water quality. This study estimates the national value of these benefits at between $670 million and $4.0 billion annually. However, this study does not provide reliable estimates of the benefits. When estimating recreation benefits, the authors assume recreation use is evenly dispersed over land, which is highly unrealistic. The study also uses the wrong measure of economic value, expenditures, instead of consumer surplus. The property value estimates are also flawed. The study uses a "generic" baseline level of nutrient loading, and uses a single estimate of the property value increases from improved water quality to estimate nationwide benefits.

In short, EPA's study provides insufficient information about the economic value of the proposed federal NNC for Florida. Better information about benefits is clearly needed since annual costs could be as high as $8.4 billion for Florida, which is higher than the $4.0 billion in national benefits.

Chapter 6

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Appendix A

Table of Annual Direct Compliance Costs

Table A-1 Total Cost and Poverty Rate by County (in millions)

County	Compliance Cost: BMP and LOT Requirement, All Water Bodies	Compliance Cost: End of Pipe Requirement, All Water Bodies	Poverty Rate (2008)
ALACHUA	$30.8	$77.57	20
BAKER	$1.3	$4.99	15.3
BAY	$0.5	$3.06	11.9
BRADFORD	$62.3	$89.90	19.3
BREVARD	$40.9	$123.48	10.7
CALHOUN	$1.3	$6.24	20.9
CHARLOTTE	$7.1	$29.53	10.3
CITRUS	$1.4	$8.75	15.8
CLAY	$83.3	$148.08	8.3
COLLIER	$6.5	$20.07	10.2
COLUMBIA	$6.9	$23.78	18
DESOTO	$16.5	$91.19	22.4
DIXIE	$0.6	$2.79	22.8
DUVAL	$75.6	$221.36	12.1
ESCAMBIA	$67.2	$94.55	16
FLAGLER	$4.7	$22.45	9.8
FRANKLIN	$0.7	$2.43	23.1
GADSDEN	$2.5	$10.37	26.6
GILCHRIST	$2.7	$9.71	16.8
GLADES	$6.2	$27.89	21.8
GULF	$0.3	$1.53	21.2
HAMILTON	$124.0	$172.58	29.3
HARDEE	$7.5	$45.08	23.1
HENDRY	$22.9	$76.44	23.8
HERNANDO	$11.4	$34.73	12.4
HIGHLANDS	$20.9	$89.39	16.7
HILLSBOROUGH	$110.7	$328.57	13.9
HOLMES	$3.4	$19.61	21
INDIANRIVER	$22.2	$62.43	12.4
JACKSON	$3.3	$22.02	19
JEFFERSON	$2.6	$10.38	18.5
LAFAYETTE	$1.7	$5.26	25.6
LAKE	$29.2	$88.51	10.3
LEE	$11.2	$29.69	10.6

LEON	$20.3	$65.46	18.6
LEVY	$3.0	$15.75	17.8
LIBERTY	$0.5	$2.82	21.5
MADISON	$2.4	$10.24	23.6
MANATEE	$26.9	$87.89	12.2
MARION	$29.6	$120.39	16
MARTIN	$13.6	$46.45	10.4
NASSAU	$7.2	$12.35	8.9
OKALOOSA	$13.5	$41.18	8.7
OKEECHOBEE	$25.8	$60.32	20.8
ORANGE	$80.7	$256.96	13.7
OSCEOLA	$27.0	$104.58	11.9
PALMBEACH	$91.8	$244.51	11.7
PASCO	$31.9	$101.39	13.2
PINELLAS	$60.1	$177.38	10.9
POLK	$144.5	$396.99	15.3
PUTNAM	$4.2	$16.29	23.1
SANTAROSA	$27.5	$79.44	9.9
SARASOTA	$27.0	$79.21	9.9
SEMINOLE	$42.0	$204.59	9.3
STJOHNS	$16.0	$49.83	7.9
STLUCIE	$46.8	$132.31	12.9
SUMTER	$8.2	$32.31	13.2
SUWANNEE	$6.7	$21.44	19.9
TAYLOR	$1.0	$4.14	22.9
UNION	$0.6	$2.94	23.6
VOLUSIA	$46.2	$145.61	12.9
WAKULLA	$1.4	$2.94	13
WALTON	$4.7	$17.72	14.9
WASHINGTON	$2.9	$11.07	23.2
Subtotal	$1,604.3	$4,548.9	
TMDL Cost	$107	$275	
Total	$1,711	$4,824	

Appendix B

End of Pipe Requirement Compliance Cost: Present Value, Annualized Capital, and Annual Operation and Maintenance Costs

Table B-1 presents the total estimate cost of the End of Pipe Requirement on an annual basis. As indicated in the table, annualized capital costs account for an estimated 57 percent of compliance cost, while annual operations and maintenance account for the remaining 43 percent. In total present value terms, calculated over 30 years using a five percent discount rate, total direct compliance costs are estimated at $74.2 billion.

Table B-1 End of Pipe Requirement, All Water Bodies Costs (Millions $)

	Annual Cost			
	O &M Cost	Capital Cost	Total Cost	Present Value of Costs Over 30 Years
Agriculture	$429.0	$665.8	$1,095	$16,830.1
Municipal WWTP	$215.6	$314.9	$530	$8,154.6
Industry	$222.0	$300.2	$522	$8,027.0
Urban Stormwater	$939.2	$1,221.9	$2,161	$33,221.5
Septic	$55.3	$185.1	$240	$3,694.8
State Agencies	$226.3	$48.9	$275	$4,232.0
Total	$2,087.4	$2,736.8	$4,824	$74,160.0
Proportion	43%	57%	100%	

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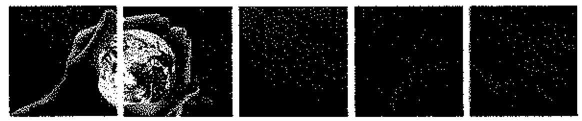

Assessment of Financial Impact on Phosphate Mining and Mineral Processing: Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

Prepared for:
The Florida Phosphate Industry

Prepared by:
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Nashville, Tennessee

Date:
April 2010

Project Number:
20-24190A

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1.0 Introduction and Background

On January 26, 2010, the United States Environmental Protection Agency (EPA) proposed numeric nutrient water quality standards for all lakes and flowing waters within the State of Florida.[1] ENVIRON International Corporation (ENVIRON), on behalf of the member facilities of the Florida Phosphate Industry (FPI), has prepared this assessment of financial impact on phosphate mining and mineral processing (herein referred to as "the White Paper") that presents an assessment of the financial impact of complying with the proposed standards for discharges of stormwater and stormwater commingled with process water (herein referred to as "stormwater") from permitted NPDES outfalls associated with the phosphate mining (Minerals) and phosphate fertilizer production (Concentrates) facilities. This White Paper specifically presents an evaluation of the impact with respect to costs to comply (i.e., cost for providing treatment) and associated multi-media impacts.

The proposed State of Florida nutrient standards that EPA has currently proposed are for in-stream protective values (IPV) for Total Nitrogen (TN) and Total Phosphorous (TP). The currently proposed standards that are specific to the existing discharges (based on receiving waterbody type and location) from the member facilities are IPV standards for TN ranging from 1.479 mg/L to 1.798 mg/L; and for TP ranging from 0.359 to 0.739 mg/L. Proposed downstream protective values (DPV) for TN, which were originally proposed but have since been deferred by EPA until 2011, range from 0.55 mg/L to 1.05 mg/L. Therefore, for the purposes of the evaluation provided in this White Paper, compliance impact costs assumed that the currently proposed limiting standards of 1.479 mg/L TN and 0.359 mg/L TP would need to be met. The technologies selected for review are available today and should be able to meet either standard.[2] This approach provides for a reasonable margin of safety for those discharges that fall within the total IPV range.

This White Paper includes the following:

- Effluent Data Review and Design Basis Development;
- Technology Evaluation;
- Selected Technologies Capital and Operating Cost Estimates;
- Selected Technologies Multi-Media Impacts Evaluation; and,
- Statewide Compliance Costs and Multi-Media Impacts Evaluation.

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1 Federal Register / Vol. 75, No. 16 / Tuesday, January 26, 2010 / Proposed Rule.

2 Please note that TN and TP standards would more than likely be converted to monthly average and daily maximum effluent limits for compliance within an effective National Pollutant Discharge Elimination System (NPDES) Permit. Without the allowance for mixing, the monthly average effluent limits would be approximately equivalent to the proposed TN and TP standards.

2.0 Effluent Data Review and Design Basis Development

ENVIRON has reviewed and characterized the effluent data of stormwater discharges provided by the FPI member facilities ("subject facilities") in order to develop a design basis. Specific data currently available from the FPI subject facilities included outfall-specific flows, TN, and TP.

The number of discharges (from individual outfalls) of the FPI subject facilities that could be impacted from the proposed TN and TP standards were based on a historic review of the TN and TP arithmetic maximum concentrations, flows, and receiving stream type of the individual outfall (i.e., outfalls currently discharging to estuaries were not included since no standards for estuaries are currently proposed). Based on the review, for this evaluation the number of outfalls from the FPI subject facilities that could be impacted from the proposed TN and TP standards was calculated to be 51.

Table 2-1 provides a histogram summary of the flow data reviewed that were used as the basis for the compliance cost assessment provided in this White Paper. Based on the evaluation and as summarized in the table below, ENVIRON has assumed three discharge flow volume scenarios that occur 80% of the time for the outfalls evaluated: 5, 20, and 50 million gallons per day (MGD or mgd).

It is anticipated that the FPI subject facilities discharges would still be able to achieve the necessary TN and TP reductions at the upper range of flows most of the time; therefore, ENVIRON concluded the 80% flow values would be reasonably appropriate for the design of a treatment/discharge option alternative for the purposes of development and comparison of costs and associated multi-media impacts. However, in actuality during high flow events (such as from a rain event exceeding a 24-hour 100-year storm or from extended heavy rainfall from tropical storms or hurricanes), part of the flow would likely need to be bypassed to storage or discharged without treatment. Therefore the necessary reductions necessary to meet the proposed TN and TP standards may not be able to be achieved at all times, and additional surge storage or some form of regulatory relief may be required for compliance under extreme conditions.

The following table is a summary of the data showing the range of flows (mgd):

	50%	80%	90%
Minerals	0 – 25	0 – 50	0 – 100
Concentrates[3]	0 – 41	0 - 6.5	0 – 7.7

For TN and TP concentrations, ENVIRON is assuming TN and TP influent concentrations (i.e., existing outfall effluent concentrations) of 5.0 mg/L and 5.0 mg/L, respectively, based on the FPI

[3] The 50th percentile flow range is greater than the 80th and 90th percentile flows due to the lack of individual flow data points for some Concentrates facilities that would be necessary to calculate percentiles.

subject facility outfall data review. Because consistent analytical data were not available on the forms of TN (or TP), ENVIRON assumed that most of the TN in the discharges from the Minerals operations is comprised of Total Kjeldahl Nitrogen (TKN) while most of the TN in the discharges from the Concentrates facilities is comprised of Ammonia-Nitrogen, based on discussions with and consensus of the FPI member companies. For TP, ENVIRON has made no assumptions regarding the type of prevalent forms present in discharges from the subject facilities.

With respect to other parameters that could impact design-specific parameters for treatment technology/option type and/or efficiency, it is assumed that most of the water that would be treated originates from rainfall (i.e., stormwater) and therefore would have similar characteristics with respect to alkalinity, hardness (low), and pH (slightly below neutral) to rainwater. With respect to TDS, it is assumed to be slightly higher than the rain water (500 to 1000 mg/L) due to potential commingling with process wastewater and as confirmed by analytical data.

3.0 Technology Evaluation

This section presents an evaluation of currently available technologies and/or discharge options capable of reducing TN and TP concentrations in stormwater discharges similar to those found from discharges associated with the FPI member subject facilities. Technologies evaluated focused on end-of-pipe technologies/discharge options that can treat both TN and TP together. Those technologies/discharge options that have been demonstrated to reliably achieve the needed reduction to both the TN and TP proposed standards were selected for cost development and multi-media impact analysis.

The technologies/discharge options evaluated for end-of-pipe TN and TP reduction are the following:

- Reverse Osmosis/Deep Well Injection;
- Deep Well Injection;
- Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/ Dechlorination;
- Floating Treatment Wetlands;
- Constructed Treatment Wetlands;
- Algal Turf Scrubber™;
- Algaewheel®; and,
- Reverse Osmosis/Zero Liquid Discharge.

3.1 Reverse Osmosis/Deep Well Injection

Reverse osmosis (RO) is a membrane-specific process that has been widely used for operations requiring high-purity waters, like boilers, and therefore would be suitable for the treatment of the TN and TP in the discharges from the subject facilities to reliably achieve the proposed TN and TP standards. The RO process consists of a series of semi-permeable membranes by which waters that require treatment are pumped at extremely high pressures through the void spaces between the membranes, resulting in the concentrating of ions to produce a reject stream on the exterior of the membrane. The reject stream then would need to be managed/disposed.

For the stormwater discharges from the subject facilities, it is assumed that pre-treatment consisting of filtration would be required for the influent, and the reject stream from a single RO membrane system would be of a quality that would allow it to be further treated via a second RO membrane system.[4] The reject from the second-stage RO would then be disposed of via deep well injection.

[4] Please note that this is an assumption based on limited knowledge of the design-specific parameters. Without the second RO membrane treatment, the resulting reject volume would be approximately double.

Deep well injection of wastewater involves the practice of placing fluids in a permeable underground formation or aquifer by gravity flow or under pressure through an injection well. This method of wastewater disposal is considered viable at locations where hydrogeologic formations have sufficient confinement, porosity, and permeability to accept the fluids without endangering underground sources of drinking water (USDW). In general, an USDW is defined as an aquifer that contains a total dissolved solids (TDS) concentration of less than 10,000 milligrams per liter (mg/L) and must be protected.

The most common type of industrial injection well is classified as a Class I well and is used to inject nonhazardous waste or municipal waste below the lowermost USDW. There are more than 125 active Class I wells in Florida. The majority of the Class I injection facilities in Florida dispose of non hazardous, secondary-treated effluent from domestic wastewater treatment plants. At locations where hydrogeologic conditions are suitable and where other disposal methods are not possible or may cause contamination, subsurface injection below all USDWs is considered a viable and lawful disposal method. There are favorable hydrogeologic conditions in Florida where the underground formations have the natural ability to accept and confine the waste, though these vary in depths across the State of Florida, ranging to as deep as 6,000 feet below ground surface (bgs). Given the variability in depths, it has been assumed that the construction of extremely deep wells would be required for disposal of the treated stormwater based on review of the geology of central Florida.

In summary, the Reverse Osmosis/Deep Well Injection technology/discharge option alternative would be effective to reliably treat both the TN and TP to below the proposed standards and therefore will be retained for costs and multi-media impacts evaluation.

3.2 Deep Well Injection

The deep well injection discharge option assumes that the stormwater is directly pumped via the injection wells without pre-treatment. Because RO is not employed for this option, the discharge volumes would be significantly higher (about 10 times higher) and therefore larger wells and equipment (e.g., pumps and headers) would be required. Since this discharge option alternative would be effective in eliminating the discharges associated with the subject facilities, thereby not requiring compliance with the proposed standards, it has been retained for costs and multi-media impacts evaluation.

We note, however, that complete sequestration of rainfall and stormwater runoff is not considered a viable alternative for mining (Minerals) facilities, which are required under other state and federal rules to maintain normal hydrologic flows to downstream lands and waters. Therefore, this option would be available only to Concentrates facilities.

3.3 Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination

Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination Systems are conventional and well-demonstrated technologies for treatment of wastewaters that require aggressive treatment to meet low concentration objectives.

The TP reduction will be addressed via the chemical precipitation/filtration step. This step will consist of the addition of iron for precipitation followed by sand filtration for the removal of the precipitated TP. This step has been well demonstrated for treatment of TP and therefore is appropriate for the subject stormwater discharges.

The TN (only the ammonium portion) reduction would be addressed via the breakpoint chlorination step. The TN would be removed via its conversion from ammonium to nitrogen gas by the addition of sodium hypochlorite. Before discharge, the wastewater streams typically have to be dechlorinated via the addition of an additional chemical such as sodium bisulfite. It is unknown if the breakpoint chlorination technology would be effective on forms of TN that do not primarily consist of ammonia-nitrogen (i.e., the effectiveness is mixed with forms of TN primarily comprised of TKN).

Though the effectiveness for multiple forms of the TN is unknown at this time, given its well-demonstrated effectiveness for reduction of the TP and its proven effectiveness for reduction of the forms of TN primarily consisting of ammonia-nitrogen, this technology has been retained for costs and multi-media impact evaluation.

3.4 Floating Treatment Wetlands

Floating treatment wetlands are artificial marshes or swamps that are specifically designed and constructed for treatment of discharges such as wastewater, stormwater runoff, and sewage treatment. Among the many pollutants that can be treated via wetlands are nutrients (both TN and TP). Floating treatment wetlands are constructed areas in which free-flowing water is allowed to pass through the wetland medium and the plant rhizosphere. For TN, treatment is primarily via microbial nitrification and subsequent denitrification releases, such as nitrogen gas, to the atmosphere. For TP, it is primarily removed via co-precipitation with iron, aluminum, and calcium compounds located in the root-bed medium.

Limited full-scale data exist for both TN and TP removal effectiveness. TN removals have been reported from 60 to as high as 86 percent with the potential for the effluent TN objective of under 1 mg/L to be achieved with detention times ranging from 15 to 20 days.[5] For TP, removal efficiencies are less effective due to the limited opportunity for the TP in the wastewater to come into contact with the root-bed medium.

[5] Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment Design Manual, EPA Office of Research and Development, September 1988 (EPA/625/1-88/022).

Required overflow rates for wetlands generally range from 16,000 to 54,000 gallons per day per acre (gpd/ac), and are highly dependent on site-specific conditions. For the subject facility flow scenario of 5 MGD, this would result in a required area ranging from about 100 to as large as 300 acres with about a 6 day retention time. For the required 15 to 20-day retention time, this would require an area ranging from about 250 to about 800 acres.

In limited cases, such expanses of land may be available to implement this option; however, based on our understanding of typical mining (Minerals) and processing (Concentrates) facility operations and lands, we have concluded that this alternative would rarely be an option. Given the unknown efficiencies with respect to TP removals for floating treatment wetlands coupled with the significantly large treatment areas required, this technology will not be further evaluated.

3.5 Constructed Treatment Wetlands

Constructed treatment wetlands are similar to floating treatment wetlands with the primary difference being subsurface flow versus the free-water flow for the floating treatment wetlands. With the exception of TP removal, which is expected to be greater for constructed treatment wetlands given the increased contact of the TP in the wastewater with the root-bed medium, constructed treatment wetlands are not as efficient as floating treatment wetlands. Therefore, it is anticipated that for similar performance constructed treatment wetlands would be significantly larger than floating treatment wetlands and thus this technology will also not be further evaluated.

3.6 Algal Turf Scrubber™

Algal Turf Scrubber™ Systems are biological treatment systems that reduce pollutants by a multitude of biological processes. For TN and TP specifically, the primary removal mechanism is via biological uptake. Pursuant to the company website, typical area requirements for an Algal Turf™ Scrubber System would be 0.25 acres per 1 MGD, resulting in minimum area requirements for subject discharges to be 2.5 acres (for the 5 MGD flows) up to 12.5 acres (for the 50 MGD flows). However, no data on full-scale applications for treatment of these types of discharges could be found, nor could any data with respect to anticipated TN and TP removal efficiencies. Given the limited data, this technology will not be evaluated further.

3.7 Algaewheel® System

The Algaewheel® system is a patented biological treatment technology capable of producing substantial amounts of algae for a variety of uses, including nutrient removal. A review of this technology via the company website indicated the implementation of full-scale applications, but it appears to be used mainly for municipal sanitary systems. Pursuant to the company website information, treatment would also require upfront filtration followed by downstream clarification, thereby increasing the cost for installation. Given that no specific information, data, or information could be found for the technology in general and specifically for the treatment effectiveness with respect to TN and TP, this technology will not be evaluated further.

3.8 Reverse Osmosis/Zero Liquid Discharge

The Reverse osmosis (RO)/Zero Liquid Discharge System is a process in which the RO reject (the process of which is described in detail in Section 3.1) is disposed via a zero liquid discharge (ZLD) process. The ZLD process is an evaporator followed by a crystallizer. The salts, which are remaining after the crystallizer step, then need to be managed off-site as a solid waste.

RO/ZLD is a well demonstrated technology for treatment of wastewaters with all types of contaminants and therefore would be very effective for the treatment of the TN and TP within the FPI subject stormwater discharges. Therefore, this technology will be retained for costs and multi-media impact evaluation.

4.0 Selected Technologies Capital and Operating Costs Estimates

This section summarizes the cost estimates for the selected technologies/discharge options identified in the previous section. As described in Section 2.0, costs were developed for three discharge flow scenarios: 5 MGD, 20 MGD, and 50 MGD.

Capital costs and annual operating and maintenance (O&M) costs were developed for Reverse Osmosis/Deep Well Injection (RO/Deep Well), Deep Well Injection, Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination (Chemical Treatment), and Reverse Osmosis/Zero Liquid Discharge (RO/ZLD) alternatives.

The capital costs for each technology/discharge option assumes a total installed cost, which includes the purchased cost of the major equipment and any supporting and/or ancillary necessary equipment (e.g., buildings, concrete support pads, holding tanks, pumps, chemical feed equipment, controls, electric conduits, piping, etc.), costs for installation (including contractor indirect expenses and overhead and profit), engineering costs for design, including electrical, controls, and contractor expenses, and a 30% contingency.

The O&M costs for each technology/discharge option includes assumed costs for labor to operate[6], energy[7], chemical, solids disposal[8], and maintenance[9] (i.e., parts and equipment necessary to purchased on a regular basis to maintain proper operation). For the O&M costs associated with solids disposal, an assumption has been made that these solid wastes will not require management as characteristic hazardous wastes, which would result in significantly higher disposal costs than those assumed for this White Paper.

The tables below present summaries of both the capital and operating costs for each treatment/discharge option and design flowrate:

Capital Costs ($Million)				
Flow	**RO/Deep Well**	**Deep Well**	**Chemical Treatment**	**RO/ZLD**
5 mgd	22	73	19	56
20 mgd	78	290	66	125
50 mgd	190	730	150	270

6 Labor rate assumed to be $30 per man-hour.
7 Energy costs based on electrical cost rate of $0.07 per Kilowatt-hour.
8 Solids disposal costs assumed to be $30 per ton.
9 Maintenance costs assumed to be 3% of capital equipment costs for each technology and for those technologies that includes deep well injection, 2% of deep well injection installed costs.

O&M Costs ($Million/year)				
Flow	RO/Deep Well	Deep Well	Chemical Treatment	RO/ZLD
5 mgd	0.7	1.3	1.5	2.1
20 mgd	2.1	4.6	5.1	6.8
50 mgd	4.8	11.3	12.2	16.0

4.1 Reverse Osmosis/Deep Well Injection

Tables 4-1 and 4-2 summarize the capital and O&M costs for the 5 MGD stormwater flow scenario, Tables 4-3 and 4-4 for the 20 MGD stormwater flow scenario, and Tables 4-5 and 4-6 for the 50 MGD flow scenario.

The Reverse Osmosis (RO)/Deep Well Injection alternative consists of the construction of a 2-Stage RO for treatment of stormwater (including upfront filtration of the water prior to the 1st Stage RO to protect the membranes) before discharge via the existing outfall, and construction of a deep well for disposal of the 2nd Stage RO reject waters. A conceptual process schematic is provided on Figure 4-1.

4.2 Deep Well Injection

Tables 4-7 and 4-8 summarize the capital and O&M costs for the 5 MGD stormwater flow scenario, Tables 4-9 and 4-10 for the 20 MGD stormwater flow scenario, and Tables 4-11 and 4-12 for the 50 MGD flow scenario.

The Deep Well Injection alternative consists of the construction of a deep well for disposal of all the stormwater flow for the three cases. Please see Figure 4-2 for a Conceptual Process Schematic.

4.3 Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination

Tables 4-13 and 4-14 summarize the capital and O&M costs for the 5 MGD stormwater flow scenario, Tables 4-15 and 4-16 for the 20 MGD stormwater flow scenario, and Tables 4-17 and 4-18 for the 50 MGD flow scenario.

The Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination alternative consists of the construction tanks for the addition of the iron for the precipitation process, followed by sand filters for the filtration process, sludge filter press and associated dewatering equipment for collection and management of the solids from the filtration process backwash waters, and chemical tanks and associated chemical feed systems for the breakpoint chlorination/dechlorination process for treatment of the stormwater before discharge via the existing outfall. A conceptual process schematic is provided on Figure 4-3.

4.4 Reverse Osmosis/Zero Liquid Discharge

Tables 4-19 and 4-20 summarize the capital and O&M costs for the 5 MGD stormwater flow scenario, Tables 4-21 and 4-22 for the 20 MGD stormwater flow scenario, and Tables 4-23 and 4-24 for the 50 MGD flow scenario.

The Reverse Osmosis (RO)/Zero Liquid Discharge (ZLD) alternative consists of the construction of a 2-Stage RO for treatment of stormwater before discharge via the existing outfall; and construction of a ZLD consisting of an evaporator followed by a crystallizer (for solids disposal) for treatment of the 2nd Stage RO reject waters. A conceptual process schematic is provided on Figure 4-4.

5.0 Selected Technologies Multi-Media Impacts Evaluation

Construction, installation and operation of the selected technologies will have impacts to other media that include solid waste, energy, and air emissions. Projected solid waste, energy and emission impacts are presented on Tables 5-1 through 5-12 for the selected technologies.

Solid waste impacts involve generation of solids and associated annual landfill space requirements. The solids generated from the selected technologies include the filtration solids (from the Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination alternative) and the dry salt cake solids (from the RO/ZLD alternative).

Projected impacts of energy consist of the trade-off with an equivalent population and additional impacts with respect to the indirect (i.e., offsite) air emissions as a result of producing the power necessary for operations of the selected technologies/discharge options.

Please note that the multi-media impacts summarized as part of this White Paper are conservative given that they do not include all the impacts such as transportation impacts (e.g., the delivery of the solid waste to the landfill), landfill operation impacts (e.g., more equipment will be necessary for management of the waste at the landfill), and local impacts specific to the FPI member facility (e.g., the loss of land needed for construction and operation of the selected technology/discharge option).

5.1 Reverse Osmosis/Deep Well Injection

Tables 5-1, 5-2, and 5-3 summarize the multi-media impacts associated with the implementation and operation of the Reverse Osmosis/Deep Well Injection alternative for the 5 MGD, 20 MGD, and 50 MGD flow scenarios, respectively.

Multi-media solid waste (from filtration solids), energy, and indirect air emission impacts are calculated for implementation and operation of the Reverse Osmosis/Deep Well Injection alternative.

Reverse Osmosis/Deep Well Injection Multi-media Impacts Summary

Flow	Solid Waste Impacts		Electrical Impacts					
	Generation ton/yr	Landfill yd^3/yr	Equivalent Population		CO_2 ton/yr	SO_x ton/yr	NO_x ton/yr	Hg lb/yr
			Res. Cust.	People				
5 mgd	51	100	50	175	450	1	0.7	0.1
20 mgd	204	500	209	730	1,900	5.2	2.9	0.6
50 mgd	510	1,300	530	1,900	4,700	13	7.2	1.4

5.2 Deep Well Injection

Tables 5-4, 5-5, and 5-6 summarize the multi-media impacts associated with the implementation and operation of the Deep Well Injection alternative for the 5 MGD, 20 MGD, and 50 MGD flow scenarios, respectively.

Because no significant multi-media solid waste impacts are anticipated for implementation and operation of the Deep Well Injection alternative, only multi-media energy and indirect air emission impacts are calculated with the implementation of this alternative.

Deep Well Injection Multi-media Impacts Summary								
	Solid Waste Impacts		Electrical Impacts					
	Generation	Landfill	Equivalent Population		CO_2	SO_x	NO_x	Hg
Flow	ton/yr	yd^3/yr	Res. Cust.	People	ton/yr	ton/yr	ton/yr	lb/yr
5 mgd	0	0	20	70	177	0.5	0.3	0.05
20 mgd	0	0	79	280	710	2.0	1.1	0.2
50 mgd	0	0	196	690	1,770	4.9	2.7	0.5

5.3 Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination

Tables 5-7, 5-8, and 5-9 summarize the multi-media impacts associated with the implementation and operation of the Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination alternative for the 5 MGD, 20 MGD, and 50 MGD flow scenarios, respectively.

Multi-media solid waste (from filtration solids), energy, and indirect air emission impacts are calculated for implementation and operation of the Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination alternative.

Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination Multi-media Impacts Summary								
Flow	Solid Waste Impacts		Electrical Impacts					
	Generation	Landfill	Equivalent Population		CO_2	SO_x	NO_x	Hg
	ton/yr	yd^3/yr	Res. Cust.	People	ton/yr	Ton/yr	ton/yr	lb/yr
5 mgd	51	130	30	110	203	0.6	0.3	0.1
20 mgd	204	500	91	319	814	2.3	1.2	0.2
50 mgd	510	1,300	226	791	2,034	5.7	3.1	0.6

5.4 Reverse Osmosis/Zero Liquid Discharge

Tables 5-10, 5-11, and 5-12 summarize the multi-media impacts associated with the implementation and operation of the Reverse Osmosis/Zero Liquid Discharge alternative for the 5 MGD, 20 MGD, and 50 MGD flow scenarios, respectively.

Multi-media solid waste (from filtration and dry salts cake solids), energy, and indirect air emission impacts are calculated for implementation and operation of the Reverse Osmosis/Zero Liquid Discharge alternative.

Reverse Osmosis/Zero Liquid Discharge Multi-media Impacts Summary								
Flow	Solid Waste Impacts		Electrical Impacts					
	Generation	Landfill	Equivalent Population		CO_2	SO_x	NO_x	Hg
	ton/yr	yd^3/yr	Res. Cust.	People	ton/yr	ton/yr	ton/yr	lb/yr
5 mgd	3,300	8,000	1,200	4,200	10,800	30	17	3.2
20 mgd	15,000	37,000	4,800	16,800	43,000	119	66	12.6
50 mgd	38,000	90,000	12,000	42,000	108,000	300	166	32

6.0 Statewide Compliance Costs and Multi-Media Impacts Evaluation

This section presents a summary of the Statewide Compliance Costs and Multi-media Impacts for the FPI subject facilities to meet the proposed TN and TP standards.

For this evaluation for the Minerals Facilities, where the majority of the form of TN present is as TKN, the Reverse Osmosis/Deep Well Injection alternative was chosen as the technology most appropriate for reliably meeting both the TN and TP standards proposed in January 2010.[10]

For this evaluation for the Concentrates Facilities, where the majority of the form of TN present is as Ammonia-Nitrogen, the Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination alternative was chosen as the technology most appropriate for reliably meeting both the TN and TP standards proposed in January 2010.[10]

Table 6-1 summarizes the Statewide Compliance Costs and Multi-media Impacts analysis. For determining the statewide compliance cost, the outfall flow histogram presented as Table 2-1 and the costs per flow scenario presented in Section 4.0 were scaled based on the most appropriate discharge flow per outfall.

The following equation was used for scaling the capital costs:

Scaled Cost (@ 80% Outfall flow) = Cost (at closest 5, 20, or 50 MGD flow scenario) x (80% Outfall flow / Flow scenario flow) ^0.6.

A linear curve fit analysis using all three flow scenarios (5, 20, or 50 MGD) was performed for calculating operation and maintenance costs and associated multi-media impacts.

As summarized on Table 6-1, capital and associated annual O&M costs to comply with the proposed TN and TP standards statewide are $1.6 billion capital and $59 million/yr O&M respectively. The associated multi-media impacts would be a total energy impact resulting in direct trade-offs with 4,000 residential customers (13,000 people), indirect air emission impacts resulting in equivalent CO_2 emissions of 31,000 ton/yr, SO_x emissions of 100 ton/yr, NO_x emissions of 50 ton/yr, and equivalent mercury (Hg) emissions of 10 lb/yr.

As previously discussed in Section 2.0, the statewide costs and associated multi-media impacts presented in Table 6-1 were based on 80% flow values, which are assumed to be reasonably appropriate for the design of a treatment/discharge option alternative for the purposes of development and comparison of these costs and associated multi-media impacts. However, in actuality during high flow events (such as from a rain event exceeding a 24-hour 100-year storm or from extended heavy rainfall from tropical storms or hurricanes), part of the flow would likely

[10] Please note that compliance with other water quality parameters (such as conductivity) would also have to be evaluated before implementation of the chosen technology.

need to be bypassed to storage or discharged without treatment. Therefore as previously discussed the necessary reductions necessary to meet the proposed TN and TP standards may not be able to be achieved at all times, and additional surge storage or some form of regulatory relief may be required for compliance under extreme conditions.

With respect to the costs for complying with the stricter DPV standards for TN of 0.55 mg/L that may be imposed in January 2011, the capital costs and associated multi-media impact costs presented in Table 6-1 are anticipated to be approximately similar with potential increases of Operation and Maintenance Costs of up to 10% for the Reverse Osmosis/Deep Well Injection, Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination, and Reverse Osmosis/Zero Liquid Discharge alternatives primarily associated with additional treatment chemicals that may be required.

In addition to the financial impacts presented in this White Paper, the time needed for implementation is also an important factor to consider for meeting the proposed TN and TP standards. At a minimum, implementation of the chosen alternative would require time to obtain the necessary permits, perform bench-scale/field-scale pilot studies, prepare the design package for procurement, procure the required equipment, coordinate with the necessary contractors, oversee the construction, and conduct the start-up and testing activities. Without delays in associated regulatory and engineering processes, this would be expected take a minimum of 3 to 5 years.

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Tables

TABLE 2-1 Outfall Histogram Summary

Assessment of Financial Impact on Phosphate Mining and Mineral Processing: Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

Outfall	Concentrates/ Mining	FLOW		
		50%	80%	90%
001	Concentrates	0.3	0.58	1
002	Concentrates	2	3	4.8
003	Concentrates	1.8	3	4
004	Concentrates	0	0	1.7
005	Concentrates	0	0	1.2
006	Concentrates	2.7	4.7	5.6
007	Concentrates	4	5.41	6.8
008	Concentrates	0	6.5	7.7
009	Concentrates	0	0	0
010	Concentrates	0	0	0
011	Concentrates	0	0	0
012	Concentrates	0	0	0
013	Concentrates	41	no data	no data
014	Concentrates	2.1	no data	no data
015	Concentrates	2.7	no data	no data
016	Concentrates	2.6	no data	no data
017	Concentrates	3.5	no data	no data
018	Concentrates	14.9	no data	no data
019	Concentrates	18	no data	no data
020	Concentrates	5.4	no data	no data
021	Concentrates	14.9	no data	no data
022	Minerals	0	50	60
023	Minerals	0	27.2	37.8
024	Minerals	0	0	0
025	Minerals	0	4.6	13.7
026	Minerals	0	0	15.9
027	Minerals	0	0	15.9
028	Minerals	25	50	100
029	Minerals	0	0	0.8

TABLE 2-1 Outfall Histogram Summary

Assessment of Financial Impact on Phosphate Mining and Mineral Processing: Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

Outfall	Concentrates/ Mining	FLOW		
		50%	80%	90%
030	Minerals	0	4.27	8.21
031	Minerals	0	0.29	0.88
032	Minerals	0	0	4.4
033	Minerals	0	4.57	16.67
034	Minerals	0	0	0.56
035	Minerals	0	9.6	13
036	Minerals	0	4.86	9.72
037	Minerals	1.23	1.23	2.4
038	Minerals	0	0.69	2.4
039	Minerals	2.5	5.1	7.66
040	Minerals	3.43	22	44.7
041	Minerals	3.02	9.61	12.81
042	Minerals	6.26	18.78	37.5
043	Minerals	0	2.59	4.67
044	Minerals	0	9.34	15
045	Minerals	0	0	0
046	Minerals	1	6	9.8
047	Minerals	12.8	21.98	22.98
048	Minerals	5.14	15.42	30.8
049	Minerals	3	no data	no data
050	Minerals	6.3	no data	no data
051	Minerals	1.3	no data	no data
TOTALS		**187**	**291**	**521**

TABLE 2-2. Design Basis Table
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

FLOW	AVERAGE TOTAL NITROGEN (1)	AVERAGE TOTAL PHOSPHORUS
5 MGD	5 mg/L	5 mg/L
20 MGD	5 mg/L	5 mg/L
50 MGD	5 mg/L	5 mg/L

NOTES
1. ENVIRON assumes that the Minerals facilities total nitrogen will be mainly comprised of TKN and the Concentrates facilities total nitrogen will be mainly comprised of ammonia

Table 4-1. Reverse Osmosis/Deep Well Capital Costs (5 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

PARAMETER	SIZE OF UNIT	DESCRIPTION	COST BASIS	TOTAL COST (ROUNDED)
SITE WORK & PROCESS BUILDING				
Building	297 ft^2	Pre-engineered steel, includes site work + foundation	Previous quotations	$37,138
Compressed Air System	1 lot	Instrumentation/process air	ENVIRON Estimate	$100,000
Potable Water Connection	1 lot	One bathroom/shower facility	ENVIRON Estimate	$50,000
Potable Water Distribution	1 lot		ENVIRON Estimate	$50,000
SUBTOTAL				$237,138
PROCESS EQUIPMENT				
Stage 1 RO Feed Pumps	597 gpm	Centrifugal, includes 1 installed spare	Perry's ChE Handbook	$151,000
Stage 1 RO Membrane Units	38,118 ft^2	Based on GE Water PRO Series 450 Unit	Previous Quotations	$2,744,000
Stage 2 RO Membrane Units	38,118 ft^2	Based on GE Water PRO Series 450 Unit	Previous Quotations	$784,000
				$3,679,000
TOTAL EQUIPMENT COSTS (rounded)				**$3,917,000**
Electrical	10%	Assumed at 10% of equipment purchase cost	Perry's ChE Handbook	$368,000
Field Instrumentation	10%	Assumed at 10% of equipment purchase cost	Perry's ChE Handbook	$368,000
Electrical Infrastructure	10%	Substations, transmission lines, etc.	ENVIRON Assumption	$368,000
PLC Programming	10%	Assumed at 10% of equipment purchase cost	ENVIRON Assumption	$368,000
Fire Protection System	Lot		Previous quotations	$20,000
Piping/Valves	30%	Assumed at 30% of equipment purchase cost	Perry's ChE Handbook	$1,104,000
Subtotal				**$2,596,000**
TOTAL DIRECT COSTS				**$6,513,000**
Indirect Costs	35%		ENVIRON Estimate	$2,280,000
Contractor Overhead/Profit	20%		ENVIRON Estimate	$1,300,000
Deep Well and Monitoring Wells	0.5 MGD	Based on ENVIRON experience includes all direct costs	Previous Quotations	$5,000,000
Subtotal				**$8,580,000**
TOTAL DIRECT + INDIRECT COSTS				**$15,093,000**
Engineering	15%		ENVIRON Estimate	$2,263,950
Contingency	30%		Perry's ChE Handbook	$4,527,900
TOTAL PROJECT COST				**$22,000,000**

Table 4-2. Reverse Osmosis/Deep Well Operations and Maintainance Costs (5 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ITEM	COST	UNITS	OPERATING TIME HRS/WK	OPERATING POWER kW	UNITS/ YR	TOTAL COST	COMMENTS
Labor	$30	$/hr	168	--	8,736	$262,000	Crew of 1, continuous coverage
Electrical	$0.07	$/kW-h	168	73	8,760	$45,000	3 Stage pump system at 30, 60, and then 20 psig
Membrane Replacement	$800	$/unit	--	--	194	$156,000	20% replacement per year
Solids Disposal	$30	$/ton	--	--	102	$3,000	
Maintenance Costs	3%					$210,370	Based on Process Equipment Cost including 2% Deepwell
				TOTAL ANNUAL O&M COSTS:		$700,000	

Table 4-3. Reverse Osmosis/Deep Well Capital Costs (20 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

PARAMETER	SIZE OF UNIT	DESCRIPTION	COST BASIS	TOTAL COST (ROUNDED)
SITE WORK & PROCESS BUILDING				
Building	2,048 ft^2	Pre-engineered steel, includes site work + foundation	Previous quotations	$255,959
Compressed Air System	1 lot	Instrumentation/process air	ENVIRON Estimate	$100,000
Potable Water Connection	1 lot	One bathroom/shower facility	ENVIRON Estimate	$50,000
Potable Water Distribution	1 lot		ENVIRON Estimate	$50,000
SUBTOTAL				$455,959
PROCESS EQUIPMENT				
Stage 1 RO Feed Pumps	2,687 gpm	Centrifugal, includes 1 installed spare	Perry's ChE Handbook	$462,000
Stage 1 RO Membrane Units	38,118 ft^2	Based on GE Water PRO Series 450 Unit	Previous Quotations	$9,800,000
Stage 2 RO Membrane Units	38,118 ft^2	Based on GE Water PRO Series 450 Unit	Previous Quotations	$2,352,000
				$12,614,000
TOTAL EQUIPMENT COSTS (rounded)				**$13,070,000**
Electrical	10%	Assumed at 10% of equipment purchase cost	Perry's ChE Handbook	$1,262,000
Field Instrumentation	10%	Assumed at 10% of equipment purchase cost	Perry's ChE Handbook	$1,262,000
Electrical Infrastructure	10%	Substations, transmission lines, etc.	ENVIRON Assumption	$1,262,000
PLC Programming	10%	Assumed at 10% of equipment purchase cost	ENVIRON Assumption	$1,262,000
Fire Protection System	Lot		Previous quotations	$20,000
Piping/Valves	30%	Assumed at 30% of equipment purchase cost	Perry's ChE Handbook	$3,785,000
Subtotal				**$8,853,000**
TOTAL DIRECT COSTS				**$21,923,000**
Indirect Costs	35%		ENVIRON Estimate	$7,670,000
Contractor Overhead/Profit	20%		ENVIRON Estimate	$4,380,000
Deep Well and Monitoring Well	2 MGD	Based on ENVIRON experience includes all direct cost	Previous Quotations	$20,000,000
Subtotal				**$32,050,000**
TOTAL DIRECT + INDIRECT COSTS				**$53,973,000**
Engineering	15%		ENVIRON Estimate	$8,095,950
Contingency	30%		Perry's ChE Handbook	$16,191,900
TOTAL PROJECT COST				**$78,000,000**

Table 4-4. Reverse Osmosis/Deep Well Operations and Maintainance Costs (20 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ITEM	COST	UNITS	OPERATING TIME HRS/WK	OPERATING POWER kW	UNITS/ YR	TOTAL COST	COMMENTS
Labor	$30	$/hr	336	--	17,472	$524,000	Crew of 2, continuous coverage
Electrical	$0.07	$/kW-h	168	306	8,760	$190,000	3 Stage pump system at 30, 60, and then 20 psig
Membrane Replacement	$800	$/unit	--	--	670	$536,000	20% replacement per year
Solids Disposal	$30	$/ton	--	--	408	$12,000	
Maintenance Costs	3%					$778,420	Based on Process Equipment Cost including 2% Deepwell
				TOTAL ANNUAL O&M COSTS:		$2,100,000	

Table 4-5. Reverse Osmosis/Deep Well Capital Costs (50 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

PARAMETER	SIZE OF UNIT	DESCRIPTION	COST BASIS	TOTAL COST (ROUNDED)
SITE WORK & PROCESS BUILDING				
Building	7,688 ft^2	Pre-engineered steel, includes site work + foundation	Previous quotations	$961,007
Compressed Air System	1 lot	Instrumentation/process air	ENVIRON Estimate	$100,000
Potable Water Connection	1 lot	One bathroom/shower facility	ENVIRON Estimate	$50,000
Potable Water Distribution	1 lot		ENVIRON Estimate	$50,000
SUBTOTAL				$1,161,007
PROCESS EQUIPMENT				
Stage 1 RO Feed Pumps	6,866 gpm	Centrifugal, includes 1 installed spare	Perry's ChE Handbook	$949,000
Stage 1 RO Membrane Units	38,118 ft^2	Based on GE Water PRO Series 450 Unit	Previous Quotations	$24,304,000
Stage 2 RO Membrane Units	38,118 ft^2	Based on GE Water PRO Series 450 Unit	Previous Quotations	$5,488,000
				$30,741,000
TOTAL EQUIPMENT COSTS (rounded)				**$31,903,000**
Electrical	10%	Assumed at 10% of equipment purchase cost	Perry's ChE Handbook	$3,075,000
Field Instrumentation	10%	Assumed at 10% of equipment purchase cost	Perry's ChE Handbook	$3,075,000
Electrical Infrastructure	10%	Substations, transmission lines, etc.	ENVIRON Assumption	$3,075,000
PLC Programming	10%	Assumed at 10% of equipment purchase cost	ENVIRON Assumption	$3,075,000
Fire Protection System	Lot		Previous quotations	$20,000
Piping/Valves	30%	Assumed at 30% of equipment purchase cost	Perry's ChE Handbook	$9,223,000
Subtotal				**$21,543,000**
TOTAL DIRECT COSTS				**$53,446,000**
Indirect Costs	35%		ENVIRON Estimate	$18,710,000
Contractor Overhead/Profit	20%		ENVIRON Estimate	$10,690,000
Deep Wells and Monitoring Wells	5 MGD	Based on ENVIRON experience includes all direct costs	Previous Quotations	$50,000,000
Subtotal				**$79,400,000**
TOTAL DIRECT + INDIRECT COSTS				**$132,846,000**
Engineering	15%		ENVIRON Estimate	$19,926,900
Contingency	30%		Perry's ChE Handbook	$39,853,800
TOTAL PROJECT COST				**$190,000,000**

Table 4-6. Reverse Osmosis/Deep Well Operations and Maintainance Costs (50 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ITEM	COST	UNITS	OPERATING TIME HRS/WK	OPERATING POWER kW	UNITS/ YR	TOTAL COST	COMMENTS
Labor	$30	$/hr	672	--	34,944	$1,048,000	Crew of 4, continuous coverage
Electrical	$0.07	$/kW-h	168	765	8,760	$470,000	
Membrane Replacement	$800	$/unit	--	--	1,642	$1,313,000	20% replacement per year
Solids Disposal	$30	$/ton	--	--	1,020	$31,000	
Maintenance Costs	3%					$1,922,230	Based on Process Equipment Cost including 2% Deepwell
				TOTAL ANNUAL O&M COSTS:		$4,800,000	

Table 4-7. Deep Well Capital Costs (5 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

PARAMETER	SIZE OF UNIT	DESCRIPTION	COST BASIS	TOTAL COST (ROUNDED)
SITE WORK & PROCESS BUILDING				
Building	297 ft^2	Pre-engineered steel, includes site work + foundation	Previous quotations	$37,138
Potable Water Connection	1 lot	One bathroom/shower facility	ENVIRON Estimate	$7,428
Potable Water Distribution	1 lot		ENVIRON Estimate	$7,428
SUBTOTAL				$51,993
PROCESS EQUIPMENT				
Deep Well and Monitoring Wells	5.0 MGD	Based on ENVIRON experience	Previous Quotations	$50,000,000
				$50,000,000
TOTAL DIRECT + INDIRECT COSTS				**$50,051,993**
Engineering	15%		ENVIRON Estimate	$7,507,799
Contingency	30%		Perry's ChE Handbook	$15,015,598
TOTAL PROJECT COST				**$73,000,000**

Table 4-8. Deep Well Operations and Maintainance Costs (5 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ITEM	COST	UNITS	OPERATING TIME HRS/WK	OPERATING POWER kW	UNITS/ YR	TOTAL COST	COMMENTS
Labor	$30	$/hr	168	--	8,736	$262,000	Crew of 1, continuous coverage
Electrical	$0.07	$/kW-h	168	29	8,760	$18,000	67% of design flow at 20 psi
Solids Disposal	$30	$/ton	--	--	0	$0	
Maintenance Costs	2%					$1,000,000	2% of Deepwell
				TOTAL ANNUAL O&M COSTS:		$1,300,000	

Table 4-9. Deep Well Capital Costs (20 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

PARAMETER	SIZE OF UNIT	DESCRIPTION	COST BASIS	TOTAL COST (ROUNDED)
SITE WORK & PROCESS BUILDING				
Building	2,048 ft^2	Pre-engineered steel, includes site work + foundation	Previous quotations	$255,959
Potable Water Connection	1 lot	One bathroom/shower facility	ENVIRON Estimate	$17,064
Potable Water Distribution	1 lot		ENVIRON Estimate	$17,064
SUBTOTAL				$290,087
PROCESS EQUIPMENT				
Deep Well and Monitoring Well	20 MGD	Based on ENVIRON experience	Previous Quotations	$200,000,000
				$200,000,000
TOTAL DIRECT + INDIRECT COSTS				**$200,290,087**
Engineering	15%		ENVIRON Estimate	$30,043,513
Contingency	30%		Perry's ChE Handbook	$60,087,026
TOTAL PROJECT COST				**$290,000,000**

Table 4-10. Deep Well Operations and Maintainance Costs (20 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ITEM	COST	UNITS	OPERATING TIME HRS/WK	OPERATING POWER kW	UNITS/ YR	TOTAL COST	COMMENTS
Labor	$30	$/hr	336	--	17,472	$524,000	Crew of 2, continuous coverage
Electrical	$0.07	$/kW-h	168	115	8,760	$71,000	67% of design flow at 20 psi
Solids Disposal	$30	$/ton	--	--	0	$0	
Maintenance Costs	2%					$4,000,000	2% of Deepwell
				TOTAL ANNUAL O&M COSTS:		$4,600,000	

Table 4-11. Deep Well Capital Costs (50 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

PARAMETER	SIZE OF UNIT	DESCRIPTION	COST BASIS	TOTAL COST (ROUNDED)
SITE WORK & PROCESS BUILDING				
Building	7,688 ft^2	Pre-engineered steel, includes site work + foundation	Previous quotations	$961,007
Potable Water Connection	1 lot	One bathroom/shower facility	ENVIRON Estimate	$29,569
Potable Water Distribution	1 lot		ENVIRON Estimate	$29,569
SUBTOTAL				$1,020,146
PROCESS EQUIPMENT				
Deep Wells and Monitoring Wells	50 MGD	Based on GE Water RCC Series Unit	Previous Quotations	$500,000,000
				$500,000,000
TOTAL DIRECT + INDIRECT COSTS				**$501,020,146**
Engineering	15%		ENVIRON Estimate	$75,153,022
Contingency	30%		Perry's ChE Handbook	$150,306,044
TOTAL PROJECT COST				**$730,000,000**

Table 4-12. Deep Well Operations and Maintainance Costs (50 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ITEM	COST	UNITS	OPERATING TIME HRS/WK	OPERATING POWER kW	UNITS/ YR	TOTAL COST	COMMENTS
Labor	$30	$/hr	672	--	34,944	$1,048,000	Crew of 4, continuous coverage
Electrical	$0.07	$/kW-h	168	288	8,760	$180,000	67% of design flow at 20 psi
Solids Disposal	$30	$/ton	--	--	0	$0	
Maintenance Costs	2%					$10,000,000	2% of Deepwell
				TOTAL ANNUAL O&M COSTS:		$11,300,000	

TABLE 4-13. Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination Capital Cost (5 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

Item No.	Element	Units	Quantity	Unit Price	EQUIP. COST	COST TO INSTALL	TOTAL COST
	SITE WORK & PROCESS BUILDING						
1	Sodium Hypochlorite Tote Secondary Container						
2	Tank Walls	yd^3	55.98	$ 500	$ 27,990	$ 1,788	$ 29,778
3	**Subtotal**						**$ 29,778**
4	Sodium Sulfite Tote Secondary Container						
5	Tank Walls	yd^3	55.98	$ 500	$ 27,990	$ 1,788	$ 29,778
6	**Subtotal**						**$ 29,778**
7	Sodium Hydroxide Tote Secondary Container						
8	Tank Walls	yd^3	37.26	$ 500	$ 18,630	$ 1,192	$ 19,822
9	**Subtotal**						**$ 19,822**
10	Hydrochloric Acid Tote Secondary Container						
11	Tank Walls	yd^3	37.26	$ 500	$ 18,630	$ 1,192	$ 19,822
12	**Subtotal**						**$ 19,822**
13							
14	**Concrete Subtotal**						**$ 99,000**
15							
16	**Installed Equipment**						
17	**Chemical Treatment**						
18	Chlorination-Dechlorination Tanks	Each	1	$656,338	$ 656,338	$ 1,000	$ 657,338
19	Effluent Tank	Each	1	$ 54,695	$ 54,695	$ 1,000	$ 55,695
20	Tank Mixers	Each	10	$ 10,000	$ 100,000	$ 2,000	$ 102,000
21	Hypochlorite/Sulfite Feed Pumps	Each	2	$ 1,576	$ 3,152	$ 500	$ 3,652
22	NaOH Feed Pumps	Each	2	$ 7,880	$ 15,759	$ 500	$ 16,259
23	Acid Feed Pumps	Each	2	$ 7,880	$ 15,759	$ 500	$ 16,259
24	Effluent Discharge Pumps	Each	2	$102,435	$ 204,869	$ 1,000	$ 205,869
25	Iron Addition Tanks	Each	1	$ 54,695	$ 54,695	$ 1,000	$ 55,695
26	Sand Filters	Each	20	$112,180	$2,243,600	$1,121,800	$ 3,365,400
27	Thickener	Each	1	$ 41,944	$ 41,944	$ 6,292	$ 48,236
28	Filter Press	Each	1	$118,552	$ 118,552	$ 17,783	$ 136,335
29	**Subtotal Installed Equipment**						**$ 4,663,000**
30							
31	**Subtotal**						**$ 4,762,000**
32							
33	**Other Direct Costs**						
34	Electrical	%	10				$ 476,000
35	Instrumentation	%	10				$ 476,000
36	Control System / Panels / Programming	%	10				$ 476,000
37	Fire Protection		1				$ 20,000
38	Piping	%	30				$ 1,429,000
39	**Subtotal**						**$ 2,877,000**
40							
41	**Total Direct Cost**						**$ 7,639,000**
42							
43	**Contractor Indirect Expenses**	%	35	N/A			**$ 2,674,000**
44							
45	**Subtotal Contractor Cost**						**$ 10,313,000**
46							
47	**Contractor Overhead & Profit**	%	20	N/A			**$ 2,063,000**
48							
49	**Total Construction Cost**						**$ 12,376,000**
50							
51	**Engineering**	%	15				**$ 1,856,000**
52							
53	**Subtotal Project Cost**						**$ 14,232,000**
54							
55	**Contingencies**	%	30	N/A			**$ 4,270,000**
56	**TOTAL PROBABLE PROJECT COST**						**$ 19,000,000**

TABLE 4-14. Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination Operations and Maintainance Cost (5 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ITEM	COST	UNITS	OPERATING TIME (HRS/WK)	OPERATING POWER (KW)	UNITS/ YR (#)	TOTAL COST ($)	COMMENTS
Labor	$30	$/hr	160	--	8,320	$249,600	Operators 3 for 24/7 Operation plus a Maintainance Operator
Electrical	$0.07	$/kW-h	168	33	8,736	$20,000	Effluent and Metering Pumps (estimated) and Mixers for 67% of design flow
Sodium Hypochlorite Cost	$0.85	$/gal	168	--	425,197	$361,000	Estimate
Sodium Sulfite Cost	$3.50	$/gal	168	--	117,653	$412,000	Estimate
Hydrochloric Acid Cost	$0.40	$/gal				$100,000	Estimated Cost
Caustic Cost	$1.15	$/gal				$100,000	Estimated Cost
Iron Cost	$0.65	$/lb Fe	168		51,023	$33,000	Estimate
Solids Disposal	$30	$/ton			102	$3,060	Assumed 50% moisture content
Maintenance Costs	3%					$139,890	3% of Process Equipment Costs

TOTAL ANNUAL O&M COSTS: $1,500,000

TABLE 4-15. Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination Capital Cost (20 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

Item No.	Element	Units	Quantity	Unit Price	EQUIP. COST	COST TO INSTALL	TOTAL COST
	Civil						
1	Sodium Hypochlorite Tote Secondary Container						
2	Tank Walls	yd^3	223.92	$ 500	$ 111,960	$ 1,788	$ 113,748
3	**Subtotal**						**$ 113,748**
4	Sodium Sulfite Tote Secondary Container						
5	Tank Walls	yd^3	223.92	$ 500	$ 111,960	$ 1,788	$ 113,748
6	**Subtotal**						**$ 113,748**
7	Sodium Hydroxide Tote Secondary Container						
8	Tank Walls	yd^3	149.04	$ 500	$ 74,520	$ 1,192	$ 75,712
9	**Subtotal**						**$ 75,712**
10	Hydrochloric Acid Tote Secondary Container						
11	Tank Walls	yd^3	149.04	$ 500	$ 74,520	$ 1,192	$ 75,712
12	**Subtotal**						**$ 75,712**
13							
14	**Concrete Subtotal**						**$ 379,000**
15							
16							
17							
18	**Installed Equipment**						
19	**Chemical Treatment**						
20	Chlorination-Dechlorination Tanks	Each	1	$1,507,868	$1,507,868	$ 1,000	$ 1,508,868
21	Effluent Tank	Each	1	$ 125,656	$ 125,656	$ 1,000	$ 126,656
22	Tank Mixers	Each	10	$ 60,342	$ 603,418	$ 2,000	$ 605,418
23	Hypochlorite/Sulfite Feed Pumps	Each	2	$ 3,621	$ 7,241	$ 500	$ 7,741
24	NaOH Feed Pumps	Each	2	$ 18,103	$ 36,205	$ 500	$ 36,705
25	Acid Feed Pumps	Each	2	$ 18,103	$ 36,205	$ 500	$ 36,705
26	Effluent Discharge Pumps	Each	2	$ 235,333	$ 470,666	$ 1,000	$ 471,666
27	Iron Addition Tanks	Each	1	$ 125,656	$ 125,656	$ 1,000	$ 126,656
28	Sand Filters	Each	80	$ 112,180	$8,974,400	$4,487,200	$13,461,600
29	Thickener	Each	1	$ 110,168	$ 110,168	$ 16,525	$ 126,693
30	Filter Press	Each	1	$ 118,552	$ 118,552	$ 17,783	$ 136,335
31	**Subtotal Installed Equipment**						**$16,645,000**
32							
33	**Subtotal**						**$17,024,000**
34							
35	**Other Direct Costs**						
36	Electrical	%	10				$ 1,702,000
37	Instrumentation	%	10				$ 1,702,000
38	Control System / Panels / Programming	%	10				$ 1,702,000
39	Fire Protection		1				$ 20,000
40	Piping	%	30				$ 5,107,000
41	**Subtotal**						**$10,233,000**
42							
43	**Total Direct Cost**						**$27,257,000**
44							
45	**Contractor Indirect Expenses**	%	35	N/A			**$ 9,540,000**
46							
47	**Subtotal Contractor Cost**						**$36,797,000**
48							
49	**Contractor Overhead & Profit**	%	20	N/A			**$ 7,359,000**
50							
51	**Total Construction Cost**						**$44,156,000**
52							
53	**Engineering**	%	15				**$ 6,623,000**
54							
55	**Subtotal Project Cost**						**$50,779,000**
56							
57	**Contingencies**	%	30	N/A			**$15,234,000**
58	**TOTAL PROBABLE PROJECT COST**						**$66,000,000**

TABLE 4-16. Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination Operations and Maintainance Cost (20 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ITEM	COST	UNITS	OPERATING TIME (HRS/WK)	OPERATING POWER (KW)	UNITS/ YR (#)	TOTAL COST ($)	COMMENTS
Labor	$30	$/hr	280	--	14,560	$436,800	Operators 6 for 24/7 Operation plus a Maintainance Operator
Electrical	$0.07	$/kW-h	168	132	8,736	$81,000	Effluent and Metering Pumps (estimated) and Mixers
Sodium Hypochlorite Cost	$0.85	$/gal	168	--	1,700,787	$1,446,000	Estimate
Sodium Sulfite Cost	$3.50	$/gal	168	--	470,611	$1,647,000	Estimate
Hydrochloric Acid Cost	$0.40	$/gal				$400,000	Estimated Cost
Caustic Cost	$1.15	$/gal				$400,000	Estimated Cost
Iron Cost	$0.65	$/lb Fe	168		204,093	$133,000	Estimate
Solids Disposal	$30	$/ton			408	$12,240	Assumed 50% moisture content
Maintenance Costs	3%					$499,350	3% of Process Equipment Costs

TOTAL ANNUAL O&M COSTS: $5,100,000

TABLE 4-17. Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination Capital Cost (50 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

Item No.	Element	Units	Quantity	Unit Price	EQUIP. COST	COST TO INSTALL	TOTAL COST
	Civil						
1	Sodium Hypochlorite Tote Secondary Container						
2	Tank Walls	yd^3	559.80	$ 500	$ 279,900	$ 1,788	$ 281,688
3	**Subtotal**						**$ 281,688**
4	Sodium Sulfite Tote Secondary Container						
5	Tank Walls	yd^3	559.80	$ 500	$ 279,900	$ 1,788	$ 281,688
6	**Subtotal**						**$ 281,688**
7	Sodium Hydroxide Tote Secondary Container						
8	Tank Walls	yd^3	372.60	$ 500	$ 186,300	$ 1,192	$ 187,492
9	**Subtotal**						**$ 187,492**
10	Hydrochloric Acid Tote Secondary Container						
11	Tank Walls	yd^3	372.60	$ 500	$ 186,300	$ 1,192	$ 187,492
12	**Subtotal**						**$ 187,492**
13							
14	**Concrete Subtotal**						**$ 938,000**
15							
16							
17	**Installed Equipment**						
18	**Chemical Treatment**						
19	Chlorination-Dechlorination Tanks	Each	1	$2,612,928	$ 2,612,928	$ 1,000	$ 2,613,928
20	Effluent Tank	Each	1	$ 217,744	$ 217,744	$ 1,000	$ 218,744
21	Tank Mixers	Each	10	$ 39,811	$ 398,107	$ 2,000	$ 400,107
22	Hypochlorite/Sulfite Feed Pumps	Each	2	$ 6,274	$ 12,548	$ 500	$ 13,048
23	NaOH Feed Pumps	Each	2	$ 31,369	$ 62,738	$ 500	$ 63,238
24	Acid Feed Pumps	Each	2	$ 31,369	$ 62,738	$ 500	$ 63,238
25	Effluent Discharge Pumps	Each	2	$ 407,799	$ 815,599	$ 1,000	$ 816,599
26	Iron Addition Tanks	Each	1	$ 217,744	$ 217,744	$ 1,000	$ 218,744
27	Sand Filters	Each	200	$ 112,180	$ 22,436,000	$ 11,218,000	$ 33,654,000
28	Thickener	Each	1	$ 110,168	$ 110,168	$ 16,525	$ 126,693
29	Filter Press	Each	1	$ 118,552	$ 118,552	$ 17,783	$ 136,335
30	**Subtotal Installed Equipment**						**$ 38,325,000**
31							
32	**Subtotal**						**$ 39,263,000**
33							
34	**Other Direct Costs**						
35	Electrical	%	10				$ 3,926,000
36	Instrumentation	%	10				$ 3,926,000
37	Control System / Panels / Programming	%	10				$ 3,926,000
38	Fire Protection		1				$ 20,000
39	Piping	%	30				$ 11,779,000
40	**Subtotal**						**$ 23,577,000**
41							
42	**Total Direct Cost**						**$ 62,840,000**
43							
44	**Contractor Indirect Expenses**	%	35	N/A			**$ 21,994,000**
45							
46	**Subtotal Contractor Cost**						**$ 84,834,000**
47							
48	**Contractor Overhead & Profit**	%	20	N/A			**$ 16,967,000**
49							
50	**Total Construction Cost**						**$ 101,801,000**
51							
52	**Engineering**	%	15				**$ 15,270,000**
53							
54	**Subtotal Project Cost**						**$ 117,071,000**
55							
56	**Contingencies**	%	30	N/A			**$ 35,121,000**
57	**TOTAL PROBABLE PROJECT COST**						**$ 150,000,000**

TABLE 4-18. Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination Operations and Maintainance Cost (50 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ITEM	COST	UNITS	OPERATING TIME (HRS/WK)	OPERATING POWER (KW)	UNITS/ YR (#)	TOTAL COST ($)	COMMENTS
Labor	$30	$/hr	440	--	22,880	$686,400	Operators 9 for 24/7 Operation plus two Maintainance Operators
Electrical	$0.07	$/kW-h	168	331	8,736	$202,000	Effluent and Metering Pumps (estimated) and Mixers
Sodium Hypochlorite Cost	$0.85	$/gal	168	--	4,251,967	$3,614,000	Estimate
Sodium Sulfite Cost	$3.50	$/gal	168	--	1,176,526	$4,118,000	Estimate
Hydrochloric Acid Cost	$0.40	$/gal				$1,000,000	Estimated Cost
Caustic Cost	$1.15	$/gal				$1,000,000	Estimated Cost
Iron Cost	$0.65	$/lb Fe	168		510,232	$332,000	Estimate
Solids Disposal	$30	$/ton			1,020	$30,600	Assumed 50% moisture content
Maintenance Costs	3%					$1,149,750	3% of Process Equipment Costs

TOTAL ANNUAL O&M COSTS: $12,200,000

Table 4-19. Reverse Osmosis/Zero Liquid Discharge Capital Costs (5 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

PARAMETER	SIZE OF UNIT	DESCRIPTION	COST BASIS	TOTAL COST (ROUNDED)
SITE WORK & PROCESS BUILDING				
Building	1,337 ft^2	Pre-engineered steel, includes site work + foundation	Previous quotations	$167,119
Compressed Air System	1 lot	Instrumentation/process air	ENVIRON Estimate	$100,000
Potable Water Connection	1 lot	One bathroom/shower facility	ENVIRON Estimate	$50,000
Potable Water Distribution	1 lot		ENVIRON Estimate	$50,000
SUBTOTAL				$367,119
PROCESS EQUIPMENT				
Stage 1 RO Feed Pumps	597 gpm	Centrifugal, includes 1 installed spare	Perry's ChE Handbook	$109,000
Stage 1 RO Membrane Units	38,118 ft^2	Based on GE Water PRO Series 450 Unit	Previous Quotations	$2,744,000
Stage 2 RO Membrane Units	38,118 ft^2	Based on GE Water PRO Series 450 Unit	Previous Quotations	$784,000
Brine Concentrators	150 gpm	Based on GE Water RCC Series Unit	Previous Quotations	$7,406,000
Crystallizers	15 gpm	Based on GE Water RCC Series Unit	Previous Quotations	$3,319,000
				$14,362,000
TOTAL EQUIPMENT COSTS (rounded)				**$14,730,000**
Electrical	10%	Assumed at 10% of equipment purchase cost	Perry's ChE Handbook	$1,437,000
Field Instrumentation	10%	Assumed at 10% of equipment purchase cost	Perry's ChE Handbook	$1,437,000
Electrical Infrastructure	10%	Substations, transmission lines, etc.	ENVIRON Assumption	$1,437,000
PLC Programming	10%	Assumed at 10% of equipment purchase cost	ENVIRON Assumption	$1,437,000
Fire Protection System	Lot		Previous quotations	$20,000
Piping/Valves	30%	Assumed at 30% of equipment purchase cost	Perry's ChE Handbook	$4,309,000
Subtotal				**$10,077,000**
TOTAL DIRECT COSTS				**$24,807,000**
Indirect Costs	35%		ENVIRON Estimate	$8,680,000
Contractor Overhead/Profit	20%		ENVIRON Estimate	$4,960,000
Subtotal				**$13,640,000**
TOTAL DIRECT + INDIRECT COSTS				**$38,447,000**
Engineering	15%		ENVIRON Estimate	$5,767,050
Contingency	30%		Perry's ChE Handbook	$11,534,100
TOTAL PROJECT COST				**$56,000,000**

Table 4-20. Reverse Osmosis/Zero Liquid Discharge Operations and Maintainance Costs (5 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ITEM	COST	UNITS	OPERATING TIME HRS/WK	OPERATING POWER kW	UNITS/ YR	TOTAL COST	COMMENTS
Labor	$30	$/hr	168	--	8,736	$262,000	Crew of 1, continuous coverage
Electrical	$0.07	$/kW-h	168	1,753	8,760	$1,070,000	
Membrane Replacement	$800	$/ea	--	--	194	$156,000	20% replacement per year
Solids Disposal	$30	$/ton	--	--	3,265	$98,000	
Maintenance Costs	3%					$430,860	
					TOTAL ANNUAL O&M COSTS:	$2,100,000	

Table 4-21. Reverse Osmosis/Zero Liquid Discharge Capital Costs (20 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

PARAMETER	SIZE OF UNIT	DESCRIPTION	COST BASIS	TOTAL COST (ROUNDED)
SITE WORK & PROCESS BUILDING				
Building	4,437 ft^2	Pre-engineered steel, includes site work + foundation	Previous quotations	$554,578
Compressed Air System	1 lot	Instrumentation/process air	ENVIRON Estimate	$100,000
Potable Water Connection	1 lot	One bathroom/shower facility	ENVIRON Estimate	$50,000
Potable Water Distribution	1 lot		ENVIRON Estimate	$50,000
SUBTOTAL				$754,578
PROCESS EQUIPMENT				
Stage 1 RO Feed Pumps	2,779 gpm	Centrifugal, includes 1 installed spare	Perry's ChE Handbook	$479,000
Stage 1 RO Membrane Units	38,118 ft^2	Based on GE Water PRO Series 450 Unit	Previous Quotations	$9,800,000
Stage 2 RO Membrane Units	38,118 ft^2	Based on GE Water PRO Series 450 Unit	Previous Quotations	$2,352,000
Brine Concentrators	500 gpm	Based on GE Water RCC Series Unit	Previous Quotations	$15,251,000
Crystallizers	23 gpm	Based on GE Water RCC Series Unit	Previous Quotations	$4,289,000
				$32,171,000
TOTAL EQUIPMENT COSTS (rounded)				**$32,926,000**
Electrical	10%	Assumed at 10% of equipment purchase cost	Perry's ChE Handbook	$3,218,000
Field Instrumentation	10%	Assumed at 10% of equipment purchase cost	Perry's ChE Handbook	$3,218,000
Electrical Infrastructure	10%	Substations, transmission lines, etc.	ENVIRON Assumption	$3,218,000
PLC Programming	10%	Assumed at 10% of equipment purchase cost	ENVIRON Assumption	$3,218,000
Fire Protection System	Lot		Previous quotations	$20,000
Piping/Valves	30%	Assumed at 30% of equipment purchase cost	Perry's ChE Handbook	$9,652,000
Subtotal				**$22,544,000**
TOTAL DIRECT COSTS				**$55,470,000**
Indirect Costs	35%		ENVIRON Estimate	$19,410,000
Contractor Overhead/Profit	20%		ENVIRON Estimate	$11,090,000
Subtotal				**$30,500,000**
TOTAL DIRECT + INDIRECT COSTS				**$85,970,000**
Engineering	15%		ENVIRON Estimate	$12,895,500
Contingency	30%		Perry's ChE Handbook	$25,791,000
TOTAL PROJECT COST				**$125,000,000**

Table 4-22. Reverse Osmosis/Zero Liquid Discharge Operations and Maintainance Costs (20 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ITEM	COST	UNITS	OPERATING TIME HRS/WK	OPERATING POWER kW	UNITS/ YR	TOTAL COST	COMMENTS
Labor	$30	$/hr	336	--	17,472	$524,000	Crew of 2, continuous coverage
Electrical	$0.07	$/kW-h	168	7,011	8,760	$4,300,000	
Membrane Replacement	$800	$/ea	--	--	670	$536,000	20% replacement per year
Solids Disposal	$30	$/ton	--	--	15,200	$456,000	
Maintenance Costs	3%					$965,130	
				TOTAL ANNUAL O&M COSTS:		$6,800,000	

Table 4-23. Reverse Osmosis/Zero Liquid Discharge Capital Costs (50 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

PARAMETER	SIZE OF UNIT	DESCRIPTION	COST BASIS	TOTAL COST (ROUNDED)
SITE WORK & PROCESS BUILDING				
Building	11,828 ft^2	Pre-engineered steel, includes site work + foundation	Previous quotations	$1,478,473
Compressed Air System	1 lot	Instrumentation/process air	ENVIRON Estimate	$100,000
Potable Water Connection	1 lot	One bathroom/shower facility	ENVIRON Estimate	$50,000
Potable Water Distribution	1 lot		ENVIRON Estimate	$50,000
SUBTOTAL				$1,678,473
PROCESS EQUIPMENT				
Stage 1 RO Feed Pumps	6,866 gpm	Centrifugal, includes 1 installed spare	Perry's ChE Handbook	$949,000
Stage 1 RO Membrane Units	38,118 ft^2	Based on GE Water PRO Series 450 Unit	Previous Quotations	$24,304,000
Stage 2 RO Membrane Units	38,118 ft^2	Based on GE Water PRO Series 450 Unit	Previous Quotations	$5,488,000
Brine Concentrators	3,500 gpm	Based on GE Water RCC Series Unit	Previous Quotations	$32,614,000
Crystallizers	58 gpm	Based on GE Water RCC Series Unit	Previous Quotations	$7,472,000
				$70,827,000
TOTAL EQUIPMENT COSTS (rounded)				**$72,506,000**
Electrical	10%	Assumed at 10% of equipment purchase cost	Perry's ChE Handbook	$7,083,000
Field Instrumentation	10%	Assumed at 10% of equipment purchase cost	Perry's ChE Handbook	$7,083,000
Electrical Infrastructure	10%	Substations, transmission lines, etc.	ENVIRON Assumption	$7,083,000
PLC Programming	10%	Assumed at 10% of equipment purchase cost	ENVIRON Assumption	$7,083,000
Fire Protection System	Lot		Previous quotations	$20,000
Piping/Valves	30%	Assumed at 30% of equipment purchase cost	Perry's ChE Handbook	$21,249,000
Subtotal				**$49,601,000**
TOTAL DIRECT COSTS				**$122,107,000**
Indirect Costs	35%		ENVIRON Estimate	$42,740,000
Contractor Overhead/Profit	20%		ENVIRON Estimate	$24,420,000
Subtotal				**$67,160,000**
TOTAL DIRECT + INDIRECT COSTS				**$189,267,000**
Engineering	15%		ENVIRON Estimate	$28,390,050
Contingency	30%		Perry's ChE Handbook	$56,780,100
TOTAL PROJECT COST				**$270,000,000**

Table 4-24. Reverse Osmosis/Zero Liquid Discharge Operations and Maintainance Costs (50 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ITEM	COST	UNITS	OPERATING TIME HRS/WK	OPERATING POWER kW	UNITS/ YR	TOTAL COST	COMMENTS
Labor	$30	$/hr	672	--	34,944	$1,048,000	Crew of 4, continuous coverage
Electrical	$0.07	$/kW-h	168	17,526	8,760	$10,750,000	
Membrane Replacement	$800	$/ea	--	--	1,642	$1,313,000	20% replacement per year
Solids Disposal	$30	$/ton	--	--	37,550	$1,127,000	
Maintenance Costs	3%					$2,124,810	
					TOTAL ANNUAL O&M COSTS:	$16,000,000	

Table 5-1. Reverse Osmosis/Deep Well Mulit-Media Impacts (5 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ADDITIONAL SOLID WASTE		ADDITIONAL ELECTRICAL							
Generated (dry tons/yr)	Landfill Space (yd^3/yr)	Usage (kW-hr/yr)	Equivalent Population[1] Residential Customers	Equivalent Population[1] People	Equivalent CO_2 Emissions[2] (ton/yr)	Equivalent SO_X Emissions[3] (ton/yr)	Equivalent NO_X Emissions[4] (ton/yr)	Equivalent Hg Emissions[5] (lb/yr)
51	100	642,000	50	175	450	1	0.7	0.1

Notes:
1. Equivalent population based on 1.47 kW/residential customer with an average of 3.5 people per residence.
2. CO_2 emissions based on a factor of 1.4 lbs of CO_2/kW-hr[(a)] based on coal fired utility plant.
3. SO_X emissions based on a factor of 0.0039 lbs of SO_X/kW-hr[(a)] based on coal fired utility plant.
4. NO_X emissions based on a factor of 0.0022 lbs of NO_X/kW-hr[(a)] based on coal fired utility plant.
5. Hg emissions based on average value of 0.21 ppm Hg and 1.02 kW-hr/lb coal.

[(a)]Value reported for the Florida Reliability Coordinating Council for 2005 to the USEPA (document USEPA eGRID2007 Version 1.1).

Table 5-2. Reverse Osmosis/Deep Well Multi-Media Impacts (20 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ADDITIONAL SOLID WASTE		ADDITIONAL ELECTRICAL							
Generated (dry tons/yr)	Landfill Space (yd^3/yr)	Usage (kW-hr/yr)	Equivalent Population[1] Residential Customers	People	Equivalent CO_2 Emissions[2] (ton/yr)	Equivalent SO_X Emissions[3] (ton/yr)	Equivalent NO_X Emissions[4] (ton/yr)	Equivalent Hg Emissions[5] (lb/yr)
204	500	2,680,000	209	730	1,900	5.2	2.9	0.6

Notes:
1. Equivalent population based on 1.47 kW/residential customer with an average of 3.5 people per residence.
2. CO_2 emissions based on a factor of 1.4 lbs of CO_2/kW-hr[(a)] based on coal fired utility plant.
3. SO_X emissions based on a factor of 0.0039 lbs of SO_X/kW-hr[(a)] based on coal fired utility plant.
4. NO_X emissions based on a factor of 0.0022 lbs of NO_X/kW-hr[(a)] based on coal fired utility plant.
5. Hg emissions based on average value of 0.21 ppm Hg and 1.02 kW-hr/lb coal.

[(a)]Value reported for the Florida Reliability Coordinating Council for 2005 to the USEPA (document USEPA eGRID2007 Version 1.1).

Table 5-3. Reverse Osmosis/Deep Well Multi-Media Impacts (50 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ADDITIONAL SOLID WASTE		ADDITIONAL ELECTRICAL						
Generated (dry tons/yr)	Landfill Space (yd^3/yr)	Usage (kW-hr/yr)	Equivalent Population[1] Residential Customers	Equivalent Population[1] People	Equivalent CO_2 Emissions[2] (ton/yr)	Equivalent SO_X Emissions[3] (ton/yr)	Equivalent NO_X Emissions[4] (ton/yr)	Equivalent Hg Emissions[5] (lb/yr)
510	1,300	6,700,000	530	1,900	4,700	13	7.2	1.4

Notes:

1. Equivalent population based on 1.47 kW/residential customer with an average of 3.5 people per residence.
2. CO_2 emissions based on a factor of 1.4 lbs of CO_2/kW-hr[(a)] based on coal fired utility plant.
3. SO_X emissions based on a factor of 0.0039 lbs of SO_X/kW-hr[(a)] based on coal fired utility plant.
4. NO_X emissions based on a factor of 0.0022 lbs of NO_X/kW-hr[(a)] based on coal fired utility plant.
5. Hg emissions based on average value of 0.21 ppm Hg and 1.02 kW-hr/lb coal.

[(a)]Value reported for the Florida Reliability Coordinating Council for 2005 to the USEPA (document USEPA eGRID2007 Version 1.1).

Table 5-4. Deep Well Multi-Media Impacts (5 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ADDITIONAL SOLID WASTE		ADDITIONAL ELECTRICAL						
Generated (dry tons/yr)	Landfill Space (yd^3/yr)	Usage (kW-hr/yr)	Equivalent Population[1]		Equivalent CO_2 Emissions[2] (ton/yr)	Equivalent SO_X Emissions[3] (ton/yr)	Equivalent NO_X Emissions[4] (ton/yr)	Equivalent Hg Emissions[5] (lb/yr)
			Residential Customers	People				
0	0	252,000	20	70	177	0.5	0.27	0.05

Notes:
1. Equivalent population based on 1.47 kW/residential customer with an average of 3.5 people per residence.
2. CO_2 emissions based on a factor of 1.4 lbs of CO_2/kW-hr[(a)] based on coal fired utility plant.
3. SO_X emissions based on a factor of 0.0039 lbs of SO_X/kW-hr[(a)] based on coal fired utility plant.
4. NO_X emissions based on a factor of 0.0022 lbs of NO_X/kW-hr[(a)] based on coal fired utility plant.
5. Hg emissions based on average value of 0.21 ppm Hg and 1.02 kW-hr/lb coal.

[(a)]Value reported for the Florida Reliability Coordinating Council for 2005 to the USEPA (document USEPA eGRID2007 Version 1.1).

Table 5-5. Deep Well Multi-Media Impacts (20 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ADDITIONAL SOLID WASTE		**ADDITIONAL ELECTRICAL**							
Generated (dry tons/yr)	**Landfill Space (yd^3/yr)**	**Usage (kW-hr/yr)**	**Equivalent Population[1]**		**Equivalent CO_2 Emissions[2] (ton/yr)**	**Equivalent SO_X Emissions[3] (ton/yr)**	**Equivalent NO_X Emissions[4] (ton/yr)**	**Equivalent Hg Emissions[5] (lb/yr)**
			Residential Customers	**People**				
0	0	1,010,000	79	280	710	2.0	1.1	0.2

Notes:
1. Equivalent population based on 1.47 kW/residential customer with an average of 3.5 people per residence.
2. CO_2 emissions based on a factor of 1.4 lbs of CO_2/kW-hr[(a)] based on coal fired utility plant.
3. SO_X emissions based on a factor of 0.0039 lbs of SO_X/kW-hr[(a)] based on coal fired utility plant.
4. NO_X emissions based on a factor of 0.0022 lbs of NO_X/kW-hr[(a)] based on coal fired utility plant.
5. Hg emissions based on average value of 0.21 ppm Hg and 1.02 kW-hr/lb coal.

[(a)]Value reported for the Florida Reliability Coordinating Council for 2005 to the USEPA (document USEPA eGRID2007 Version 1.1).

Table 5-6. Deep Well Mulit-Media Impacts (50 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ADDITIONAL SOLID WASTE		ADDITIONAL ELECTRICAL							
Generated (dry tons/yr)	Landfill Space (yd^3/yr)	Usage (kW-hr/yr)	Equivalent Population[1]		Equivalent CO_2 Emissions[2] (ton/yr)	Equivalent SO_X Emissions[3] (ton/yr)	Equivalent NO_X Emissions[4] (ton/yr)	Equivalent Hg Emissions[5] (lb/yr)
			Residential Customers	People				
0	0	2,520,000	196	690	1,770	4.9	2.7	0.5

Notes:

1. Equivalent population based on 1.47 kW/residential customer with an average of 3.5 people per residence.
2. CO_2 emissions based on a factor of 1.4 lbs of CO_2/kW-hr[(a)] based on coal fired utility plant.
3. SO_X emissions based on a factor of 0.0039 lbs of SO_X/kW-hr[(a)] based on coal fired utility plant.
4. NO_X emissions based on a factor of 0.0022 lbs of NO_X/kW-hr[(a)] based on coal fired utility plant.
5. Hg emissions based on average value of 0.21 ppm Hg and 1.02 kW-hr/lb coal.

[(a)]Value reported for the Florida Reliability Coordinating Council for 2005 to the USEPA (document USEPA eGRID2007 Version 1.1).

TABLE 5-7. Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination Multi-Media Impacts Evaluation (5 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ADDITIONAL SOLID WASTE		ADDITIONAL ELECTRICAL							
Generated (dry tons/yr)	Landfill Space (yd^3/yr)	Usage (kW-hr/yr)	Equivalent Population[1] Residential Customers	Equivalent Population[1] People	Equivalent CO_2 Emissions[2] (ton/yr)	Equivalent SO_X Emissions[3] (ton/yr)	Equivalent NO_X Emissions[4] (ton/yr)	Equivalent Hg Emissions[5] (lb/yr)
51	130	290,000	30	110	203	0.6	0.3	0.1

Notes:
1. Equivalent population based on 1.47 kW/residential customer with an average of 3.5 people per residence.
2. CO_2 emissions based on a factor of 1.4 lbs of CO_2/kW-hr[(a)] based on coal fired utility plant.
3. SO_X emissions based on a factor of 0.0039 lbs of SO_X/kW-hr[(a)] based on coal fired utility plant.
4. NO_X emissions based on a factor of 0.0022 lbs of NO_X/kW-hr[(a)] based on coal fired utility plant.
5. Hg emissions based on average value of 0.21 ppm Hg and 1.02 kW-hr/lb coal.

[(a)]Value reported for the Florida Reliability Coordinating Council for 2005 to the USEPA (document USEPA eGRID2007 Version 1.1).

TABLE 5-8. Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination Multi-Media Impacts Evaluation (20 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ADDITIONAL SOLID WASTE		ADDITIONAL ELECTRICAL							
Generated (dry tons/yr)	Landfill Space (yd^3/yr)	Usage (kW-hr/yr)	Equivalent Population[1] Residential Customers	Equivalent Population[1] People	Equivalent CO_2 Emissions[2] (ton/yr)	Equivalent SO_X Emissions[3] (ton/yr)	Equivalent NO_X Emissions[4] (ton/yr)	Equivalent Hg Emissions[5] (lb/yr)
204	500	1,161,000	91	319	814	2.3	1.2	0.2

Notes:
1. Equivalent population based on 1.47 kW/residential customer with an average of 3.5 people per residence.
2. CO_2 emissions based on a factor of 1.4 lbs of CO_2/kW-hr[(a)] based on coal fired utility plant.
3. SO_X emissions based on a factor of 0.0039 lbs of SO_X/kW-hr[(a)] based on coal fired utility plant.
4. NO_X emissions based on a factor of 0.0022 lbs of NO_X/kW-hr[(a)] based on coal fired utility plant.
5. Hg emissions based on average value of 0.21 ppm Hg and 1.02 kW-hr/lb coal.

[(a)]Value reported for the Florida Reliability Coordinating Council for 2005 to the USEPA (document USEPA eGRID2007 Version 1.1).

TABLE 5-9. Multi-Step Chemical Precipitation/Filtration/Breakpoint Chlorination/Dechlorination Multi-Media Impacts Evaluation (50 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ADDITIONAL SOLID WASTE		ADDITIONAL ELECTRICAL							
Generated	Landfill Space	Usage	Equivalent Population[1]		Equivalent CO_2 Emissions[2]	Equivalent SO_X Emissions[3]	Equivalent NO_X Emissions[4]	Equivalent Hg Emissions[5]
(dry tons/yr)	(yd^3/yr)	(kW-hr/yr)	Residential Customers	People	(ton/yr)	(ton/yr)	(ton/yr)	(lb/yr)
510	1,300	2,902,000	226	791	2,034	5.7	3.1	0.6

Notes:
1. Equivalent population based on 1.47 kW/residential customer with an average of 3.5 people per residence.
2. CO_2 emissions based on a factor of 1.4 lbs of CO_2/kW-hr[(a)] based on coal fired utility plant.
3. SO_X emissions based on a factor of 0.0039 lbs of SO_X/kW-hr[(a)] based on coal fired utility plant.
4. NO_X emissions based on a factor of 0.0022 lbs of NO_X/kW-hr[(a)] based on coal fired utility plant.
5. Hg emissions based on average value of 0.21 ppm Hg and 1.02 kW-hr/lb coal.

[(a)]Value reported for the Florida Reliability Coordinating Council for 2005 to the USEPA (document USEPA eGRID2007 Version 1.1).

Table 5-10. Reverse Osmosis/Zero Liquid Discharge Multi-Media Impacts (5 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ADDITIONAL SOLID WASTE		ADDITIONAL ELECTRICAL							
Generated (dry tons/yr)	Landfill Space (yd^3/yr)	Usage (kW-hr/yr)	Equivalent Population[1]		Equivalent CO_2 Emissions[2] (ton/yr)	Equivalent SO_X Emissions[3] (ton/yr)	Equivalent NO_X Emissions[4] (ton/yr)	Equivalent Hg Emissions[5] (lb/yr)
			Residential Customers	People				
3,300	8,000	15,400,000	1,200	4,200	10,800	30	17	3.2

Notes:

1. Equivalent population based on 1.47 kW/residential customer with an average of 3.5 people per residence.
2. CO_2 emissions based on a factor of 1.4 lbs of CO_2/kW-hr[(a)] based on coal fired utility plant.
3. SO_X emissions based on a factor of 0.0039 lbs of SO_X/kW-hr[(a)] based on coal fired utility plant.
4. NO_X emissions based on a factor of 0.0022 lbs of NO_X/kW-hr[(a)] based on coal fired utility plant.
5. Hg emissions based on average value of 0.21 ppm Hg and 1.02 kW-hr/lb coal.

[(a)]Value reported for the Florida Reliability Coordinating Council for 2005 to the USEPA (document USEPA eGRID2007 Version 1.1).

Table 5-11. Reverse Osmosis/Zero Liquid Discharge Multi-Media Impacts (20 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ADDITIONAL SOLID WASTE		ADDITIONAL ELECTRICAL						
Generated (dry tons/yr)	Landfill Space (yd^3/yr)	Usage (kW-hr/yr)	Equivalent Population[1] Residential Customers	Equivalent Population[1] People	Equivalent CO_2 Emissions[2] (ton/yr)	Equivalent SO_X Emissions[3] (ton/yr)	Equivalent NO_X Emissions[4] (ton/yr)	Equivalent Hg Emissions[5] (lb/yr)
15,000	37,000	61,000,000	4,800	16,800	43,000	119	66	12.6

Notes:

1. Equivalent population based on 1.47 kW/residential customer with an average of 3.5 people per residence.
2. CO_2 emissions based on a factor of 1.4 lbs of CO_2/kW-hr[(a)] based on coal fired utility plant.
3. SO_X emissions based on a factor of 0.0039 lbs of SO_X/kW-hr[(a)] based on coal fired utility plant.
4. NO_X emissions based on a factor of 0.0022 lbs of NO_X/kW-hr[(a)] based on coal fired utility plant.
5. Hg emissions based on average value of 0.21 ppm Hg and 1.02 kW-hr/lb coal.

[(a)]Value reported for the Florida Reliability Coordinating Council for 2005 to the USEPA (document USEPA eGRID2007 Version 1.1).

Table 5-12. Reverse Osmosis/Zero Liquid Discharge Multi-Media Impacts (50 MGD)
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

ADDITIONAL SOLID WASTE		**ADDITIONAL ELECTRICAL**						
Generated (dry tons/yr)	**Landfill Space (yd^3/yr)**	**Usage (kW-hr/yr)**	**Equivalent Population[1]**		**Equivalent CO_2 Emissions[2] (ton/yr)**	**Equivalent SO_X Emissions[3] (ton/yr)**	**Equivalent NO_X Emissions[4] (ton/yr)**	**Equivalent Hg Emissions[5] (lb/yr)**
			Residential Customers	**People**				
38,000	90,000	154,000,000	12,000	42,000	108,000	300	166	32

Notes:

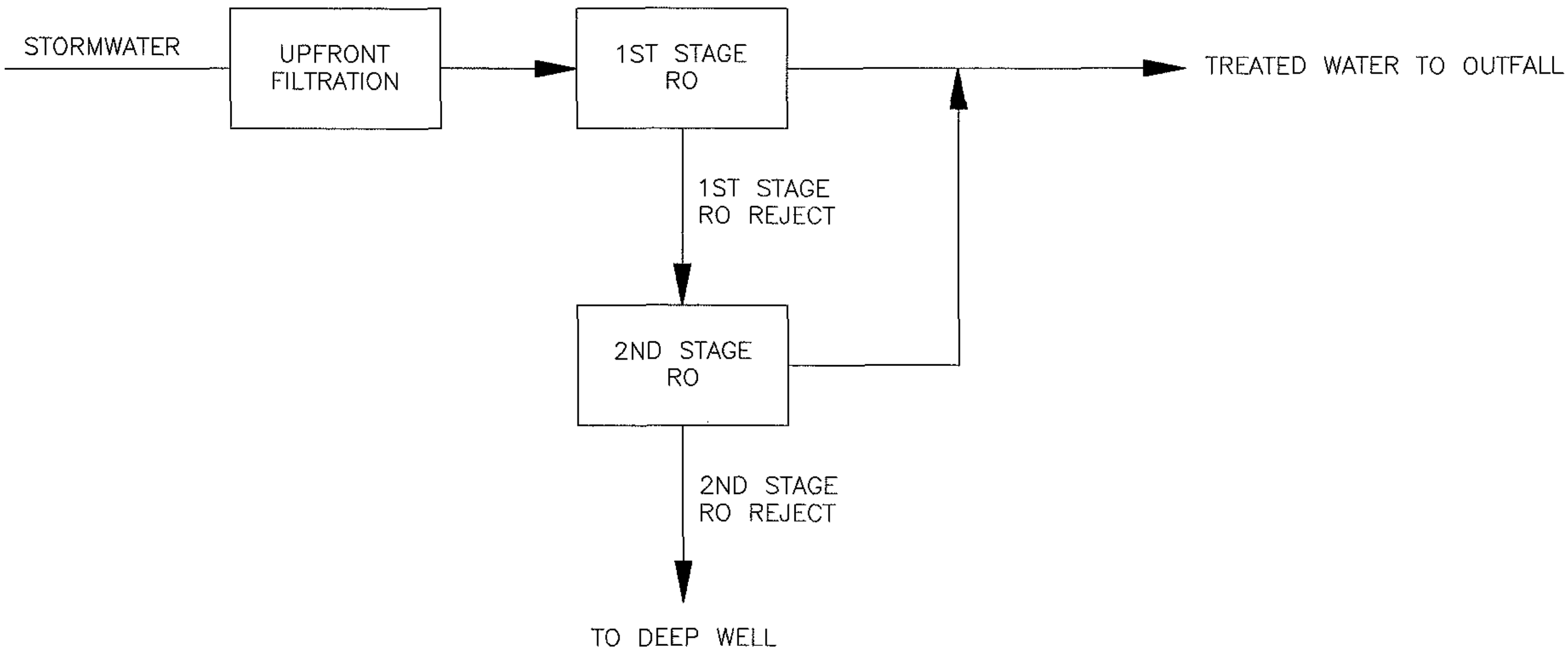
1. Equivalent population based on 1.47 kW/residential customer with an average of 3.5 people per residence.
2. CO_2 emissions based on a factor of 1.4 lbs of CO_2/kW-hr[(a)] based on coal fired utility plant.
3. SO_X emissions based on a factor of 0.0039 lbs of SO_X/kW-hr[(a)] based on coal fired utility plant.
4. NO_X emissions based on a factor of 0.0022 lbs of NO_X/kW-hr[(a)] based on coal fired utility plant.
5. Hg emissions based on average value of 0.21 ppm Hg and 1.02 kW-hr/lb coal.

[(a)]Value reported for the Florida Reliability Coordinating Council for 2005 to the USEPA (document USEPA eGRID2007 Version 1.1).

TABLE 6-1 Statewide Compliance Costs and Multi-media Impacts Summary
Assessment of Financial Impact on Phosphate Mining and Mineral Processing:
Complying with EPA's Proposed Nutrient Water Quality Standards for Florida

Outfall	Minerals/ Concentrates	FLOW			CAPTIAL COST	O+M COST	MULTI-MEDIA EFFECTS - ELECTRICAL						
							POWER	EQUIVALENT POPULATION		EQUIVALENT CO2 EMISSIONS	EQUIVALENT SOx EMISSIONS	EQUIVALENT NOx EMISSIONS	EQUIVALENT Hg EMISSIONS
		50%	80%	90%	Dollars	Dollars	(kW-hr/yr)	Customers	People	(ton/yr)	(ton/yr)	(ton/yr)	(lb/yr)
001	Concentrates	0.3	0.58	1	$5,200,000	$143,000	84,000	3	9	24	0.07	0.04	0.01
002	Concentrates	2	3	4.8	$14,000,000	$738,000	174,000	14	48	123	0.34	0.19	0.04
003	Concentrates	1.8	3	4	$14,000,000	$738,000	174,000	14	48	123	0.34	0.19	0.04
004	Concentrates	0	0	1.7	$0	$0	0	0	0	0	0.00	0.00	0.00
005	Concentrates	0	0	1.2	$0	$0	0	0	0	0	0.00	0.00	0.00
006	Concentrates	2.7	4.7	5.6	$18,300,000	$1,156,000	273,000	21	75	193	0.54	0.29	0.06
007	Concentrates	4	5.41	6.8	$19,900,000	$1,331,000	314,000	25	86	222	0.62	0.33	0.07
008	Concentrates	0	6.5	7.7	$22,200,000	$1,599,000	377,000	29	103	267	0.74	0.40	0.08
009	Concentrates	0	0	0	$0	$0	0	0	0	0	0.00	0.00	0.00
010	Concentrates	0	0	0	$0	$0	0	0	0	0	0.00	0.00	0.00
011	Concentrates	0	0	0	$0	$0	0	0	0	0	0.00	0.00	0.00
012	Concentrates	0	0	0	$0	$0	0	0	0	0	0.00	0.00	0.00
013	Concentrates	41	no data	no data	$133,200,000	$10,085,000	2,380,000	186	652	1,681	4.68	2.53	0.50
014	Concentrates	2.1	no data	no data	$11,300,000	$517,000	122,000	10	33	86	0.24	0.13	0.03
015	Concentrates	2.7	no data	no data	$13,100,000	$664,000	157,000	12	43	111	0.31	0.17	0.03
016	Concentrates	2.6	no data	no data	$12,800,000	$640,000	151,000	12	41	107	0.30	0.16	0.03
017	Concentrates	3.5	no data	no data	$15,300,000	$861,000	203,000	16	56	144	0.40	0.22	0.04
018	Concentrates	14.9	no data	no data	$35,300,000	$3,665,000	865,000	68	237	611	1.70	0.92	0.18
019	Concentrates	18	no data	no data	$62,000,000	$4,428,000	1,045,000	82	286	738	2.06	1.11	0.22
020	Concentrates	5.4	no data	no data	$19,900,000	$1,328,000	313,000	24	86	221	0.62	0.33	0.07
021	Concentrates	14.9	no data	no data	$35,300,000	$3,665,000	865,000	68	237	611	1.70	0.92	0.18
022	Minerals	0	30	60	$190,000,000	$4,880,000	6,698,000	529	1,888	4,700	13	7.2	1.4
023	Minerals	0	27.2	37.8	$93,800,000	$2,655,000	3,643,000	288	1,027	2,557	7	3.9	0.8
024	Minerals	0	0	0	$0	$0	0	0	0	0	0	0.0	0.0
025	Minerals	0	4.6	13.7	$20,900,000	$449,000	616,000	49	174	432	1	0.7	0.1
026	Minerals	0	0	15.9	$0	$0	0	0	0	0	0	0.0	0.0
027	Minerals	0	0	15.9	$0	$0	0	0	0	0	0	0.0	0.0
028	Minerals	25	50	100	$190,000,000	$4,880,000	6,698,000	529	1,888	4,700	13	7.2	1.4
029	Minerals	0	0	0.8	$0	$0	0	0	0	0	0	0.0	0.0
030	Minerals	0	4.27	8.21	$20,000,000	$417,000	572,000	45	161	401	1	0.6	0.1
031	Minerals	0	0.19	0.88	$4,000,000	$28,000	39,000	3	11	27	0	0.0	0.0
032	Minerals	0	0	4.4	$0	$0	0	0	0	0	0	0.0	0.0
033	Minerals	0	4.57	16.67	$20,900,000	$446,000	612,000	48	173	430	1	0.7	0.1
034	Minerals	0	0	0.56	$0	$0	0	0	0	0	0	0.0	0.0
035	Minerals	0	9.6	13	$32,800,000	$937,000	1,286,000	102	363	902	3	1.4	0.3
036	Minerals	0	4.86	9.72	$21,600,000	$474,000	651,000	51	184	457	1	0.7	0.1
037	Minerals	1.23	1.23	2.4	$9,500,000	$120,000	165,000	13	46	116	0	0.2	0.0
038	Minerals	0	0.69	2.4	$6,700,000	$67,000	92,000	7	26	65	0	0.1	0.0
039	Minerals	2.5	5.1	7.66	$22,300,000	$498,000	683,000	54	193	479	1	0.7	0.1
040	Minerals	3.43	22	44.7	$82,600,000	$2,147,000	2,947,000	233	831	2,068	6	3.2	0.6
041	Minerals	3.02	9.61	12.81	$32,600,000	$938,000	1,287,000	102	363	903	3	1.4	0.3
042	Minerals	6.26	18.78	37.5	$75,100,000	$1,833,000	2,516,000	199	709	1,765	5	2.7	0.5
043	Minerals	0	2.39	4.67	$14,800,000	$253,000	347,000	27	98	243	1	0.4	0.1
044	Minerals	0	9.34	15	$32,000,000	$912,000	1,251,000	99	353	878	2	1.3	0.3
045	Minerals	0	0	0	$0	$0	0	0	0	0	0	0.0	0.0
046	Minerals	1	6	9.8	$24,500,000	$586,000	804,000	63	227	564	2	0.9	0.2
047	Minerals	12.8	21.98	22.98	$82,500,000	$2,145,000	2,944,000	232	830	2,066	6	3.2	0.6
048	Minerals	5.14	15.42	30.8	$66,700,000	$1,505,000	2,066,000	163	582	1,449	4	2.2	0.4
049	Minerals	3	no data	no data	$16,200,000	$293,000	402,000	32	113	282	1	0.4	0.1
050	Minerals	6.3	no data	no data	$25,300,000	$615,000	844,000	67	238	592	2	0.9	0.2
051	Minerals	1.3	no data	no data	$9,800,000	$127,000	174,000	14	49	121	0	0.2	0.0
TOTALS		187	291	521	$1,660,000,000	$59,000,000	46,000,000	4,000	13,000	31,000	100	50	10

Figures



ASSESSMENT OF FINANCIAL IMPACT ON PHOSPHATE MINING AND MINERAL PROCESSING: COMPLYING WITH EPA'S PROPOSED NUTRIENT WATER QUALITY STANDARDS FOR FLORIDA

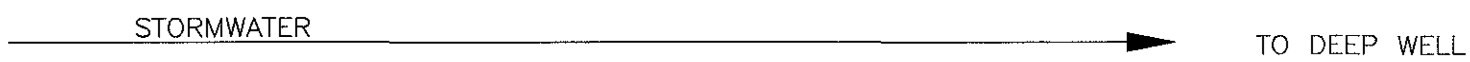
Prepared By:

ENVIRON

INTERNATIONAL CORPORATION
NASHVILLE, TENNESSEE, USA

FIGURE 4-1
REVERSE OSMOSIS/DEEP WELL INJECTION CONCEPTUAL PROCESS SCHEMATIC

SCALE	N.T.S.	DRAWN BY:	TJY	APPR. BY:		DATE	04/14/10
CONTRACT NO.	20-24190A	SKETCH NO.	FIGURE 4-1	REV.:	A		



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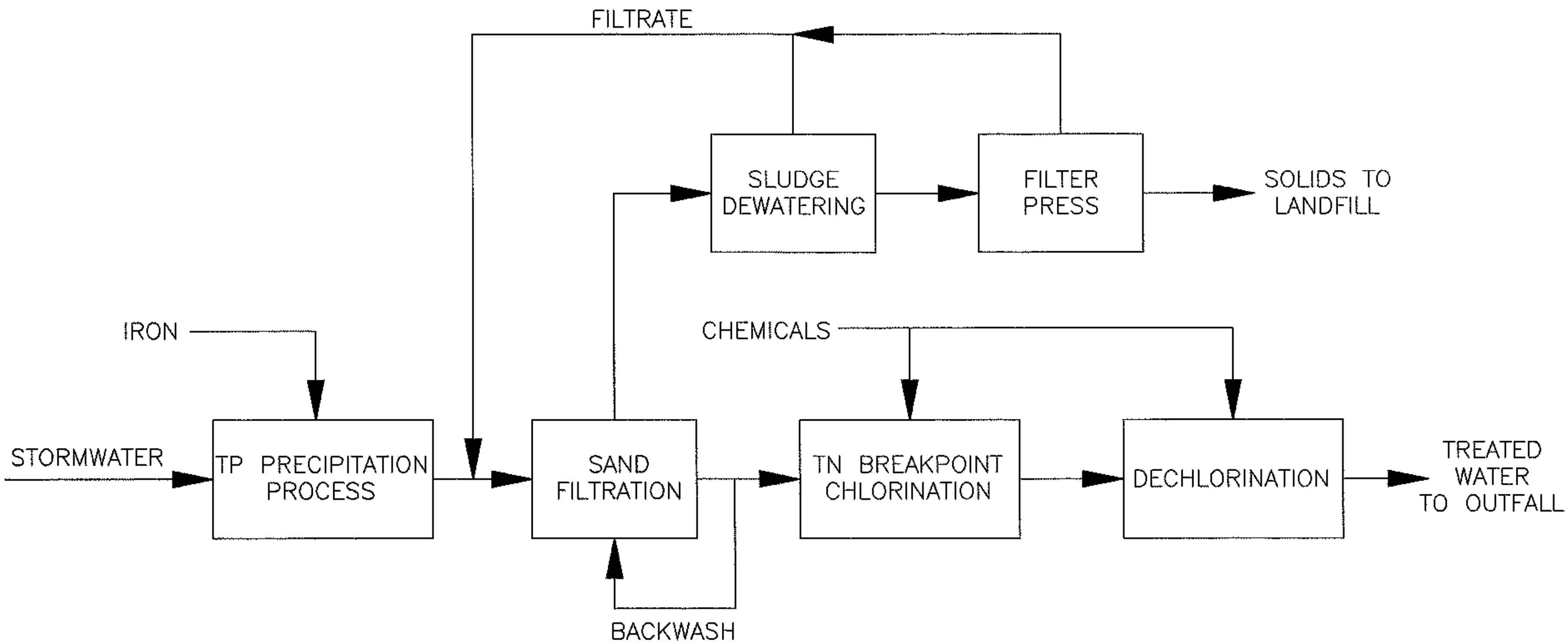
NASHVILLE, TENNESSEE, USA

FIGURE 4-2
DEEP WELL INJECTION
CONCEPTUAL PROCESS SCHEMATIC

SCALE	N.T.S.	DRAWN BY:	TJY	APPR. BY:		DATE	04/14/10
CONTRACT NO.	20-24190A	SKETCH NO.		FIGURE 4-2		REV.:	A



ASSESSMENT OF FINANCIAL IMPACT ON PHOSPHATE MINING AND MINERAL PROCESSING: COMPLYING WITH EPA'S PROPOSED NUTRIENT WATER QUALITY STANDARDS FOR FLORIDA

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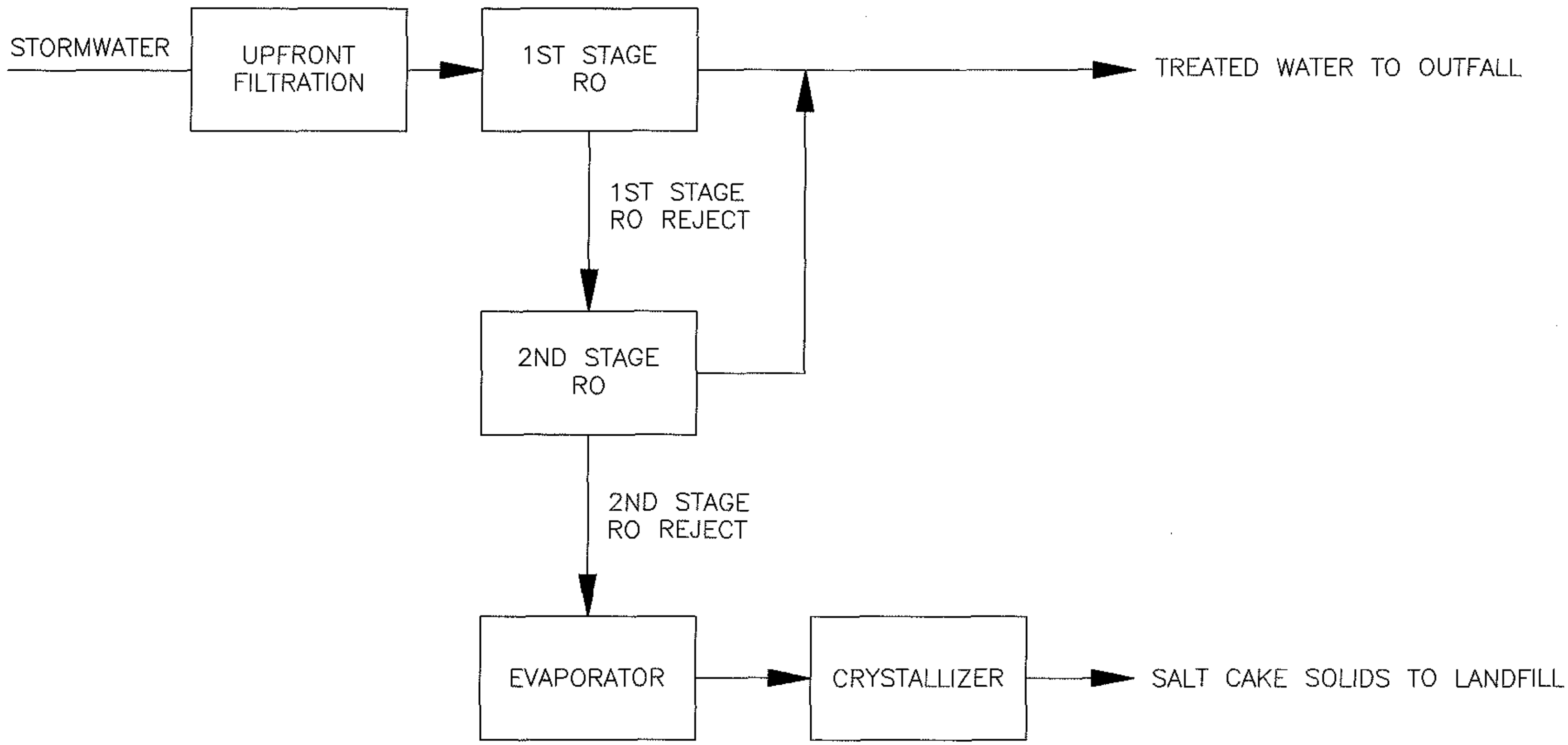
NASHVILLE, TENNESSEE, USA

FIGURE 4-3
MULTI-STEP CHEMICAL PRECIPITATION/ FILTRATION/BRKPNT./CHOR./DECHLOR. CONCEPTUAL PROCESS SCHEMATIC

SCALE	N.T.S.	DRAWN BY:	TJY	APPR. BY:		DATE	04/14/10
CONTRACT NO.	20-24190A	SKETCH NO.		FIGURE 4-3		REV.	A



ASSESSMENT OF FINANCIAL IMPACT ON PHOSPHATE MINING AND MINERAL PROCESSING: COMPLYING WITH EPA'S PROPOSED NUTRIENT WATER QUALITY STANDARDS FOR FLORIDA

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NASHVILLE, TENNESSEE, USA

FIGURE 4-4
REVERSE OSMOSIS/ZERO LIQUID DISCHARGE CONCEPTUAL PROCESS SCHEMATIC

SCALE	N.T.S.	DRAWN BY:	TJY	APPR. BY:		DATE	04/14/10
CONTRACT NO.	20-24190A	SKETCH NO.		FIGURE 4-4		REV.	A