EXECUTIVE SUMMARY

This document provides EPA's Economic Analysis of the Phase II Storm Water Rule, a regulatory action which requires small municipalities and construction sites to implement best management practices to control storm water discharges. This analysis updates the benefit-cost analysis prepared for the proposed rule. The analysis is based on the final rule. Revisions have been made in response to internal agency review and comments received during the public comment period.

ES.1 Environmental Concerns Addressed by the Rule

Storm water discharges have emerged as one of the leading causes of impairment of the Nation's surface waters (US EPA, 1998a). Several studies reveal that storm water runoff from urban areas and construction sites can include a variety of pollutants, such as sediment, bacteria, organic nutrients, hydrocarbons, zinc, copper, cadmium, mercury, iron, nickel, oil, and grease (Barret et al., 1996). In addition, the National Water Quality Inventory, 1996 Report to Congress, which summarizes state §305(b) reports, provides documentation of water quality impairment resulting from storm water discharges. The report shows that urban runoff/storm sewer discharges affect 13% of impaired rivers, 21% of impaired lakes, and 45% of impaired estuaries. Impaired waters are those waters not meeting water quality standards or designated beneficial uses such as drinking water supply, primary contact recreation, and aquatic life support. The report also documents impairment to rivers, lakes, and wetlands resulting from construction (e.g., land development, road construction).

Many studies provide documentation of the impacts of storm water discharges on humans, aquatic life, and other wildlife, including impacts to small streams. The potential impacts of these discharges include increased bacterial contamination, increased turbidity, increased toxic sediments, decreased dissolved oxygen concentrations, and alterations in stream channel morphology and habitat. In turn, these in-stream conditions can have a considerable impact on human health and the abundance and diversity of aquatic species. The level of impact is site-specific and depends on site imperviousness, the type of receiving waters, acreage of land disturbance, topography, soil type, and resource sensitivity. The nature of the impact also varies temporally throughout the land development process, with significant differences observed between the site clearing phase, construction phase and post development conditions.

ES.2 Statutory Background for the Rule

In the 1987 amendments to the Clean Water Act (CWA), Congress established a tiered approach for addressing certain industrial, municipal, and other storm water discharges. These amendments provided for a phased program to address the most significant contributors first (Phase I), and identify an appropriate second tier of sources at a later date. EPA published Phase I application requirements for categories of storm water discharges recognized as the most damaging to the environment in 1990 (55 Federal Register (FR) 47990, November 16, 1990). Generally, Phase I sources include storm water discharges associated with certain industrial activities, medium and large municipal separate storm sewer systems (MS4s), and large construction sites (greater than five acres).

Phase II storm water sources were to be identified based on EPA's findings as presented in its Report to Congress (US EPA, 1995a). Based on this report, EPA published a direct final Phase II storm water rule in 1995 (60 FR 40229, August 7, 1995). EPA published this rule in part to protect Phase II dischargers from CWA citizen suit liability. However, it was recognized that the Phase II regulatory program would undergo further development. The 1999 final rule, when promulgated, will replace the August 1995 direct final rule.

ES.3 Description of the Rule

The Phase II rule will require storm water discharges from small MS4s and small construction sites to be covered under a National Pollutant Discharge Elimination System (NPDES) permit. Small MS4s include incorporated places, counties, and other places under the jurisdiction of a governmental entity (including Tribal and Territorial governments) that are located in an urbanized area but are not included in Phase I. Phase I addresses larger and medium-sized MS4s serving populations of 100,000 and more. Phase II generally pertains to systems serving less than 100,000 people. Indian reservations located within urbanized areas and with a population of less than 1,000 persons are excluded. And, the permitting authority can waive MS4s that serve a population of less than 1,000 under certain conditions. Owners or operators of small MS4s would be required to develop and implement a storm water management program designed to reduce the discharge of pollutants to the maximum extent practicable and protect water quality. The storm water management program would need to include a requirement for post-construction runoff controls from new development and re-development.

Phase II small construction sites that will be designated by the rule are those that disturb between one and five acres of land. In addition, sites disturbing less than one acre would be subject to regulation if they are part of a larger common plan of development or sale. However, the NPDES permitting authority could waive permitting requirements under certain conditions. Small construction site owners or operators would be required to plan and implement appropriate erosion and sediment control best management practices (BMPs) to control storm water discharges.

ES.4 Baseline for the Analysis

Analysis of the incremental benefits and costs of the Phase II rule requires that EPA establish a baseline for similar storm water programs, population, construction starts, and water quality. EPA defined the universe of potentially affected municipalities as those located in urbanized areas and construction sites by excluding corresponding construction sites in states that have instituted erosion and sediment control programs in response to CZARA or other state ordinance. Population estimates are based on 1998 US Census Bureau estimates of population, households, urban population, and sewered population. To develop estimates of Phase II construction and land development activities, EPA used construction start data gathered in 14 municipalities across the country and 1994 US Census Bureau estimates of the number of building permits issued nationwide.

Finally, EPA characterized existing water quality and the relative impact of Phase II sources on water quality using the National Water Quality Inventory Report to Congress (US EPA, 1998_a), also referred to as "305(b) data". However, the 305(b) data characterize waters based on impairment of surveyed waterbodies. Therefore, to establish a baseline representing all waters

impaired by urban runoff/storm sewers, construction, and land use, EPA assumed that the 305(b) survey data characterize 100% of all US waters. EPA approximated the proportion of impairment specifically attributable to Phase II sources by multiplying the percentage impairment by the percentage of the municipal population and construction activities (starts) regulated under the rule.

ES.5 Potential Costs for Municipalities

EPA estimated annual per household program costs for automatically designated municipalities using data from a 1998 survey conducted by the National Association of Flood and Stormwater Management agencies which sought to identify current storm water spending levels in Phase II municipalities (see Section 4.2.1). EPA also estimated an average annual per household administrative cost for municipalities to address application, record keeping, and reporting requirements of the final rule. The average per household cost of the rule is expected to be $9.16.

To determine potential national level costs for municipalities, EPA multiplied the number of households (32.5 million) by the per household compliance cost ($9.16)[1]. The annual estimated national Phase II municipal cost is approximately $297.3 million.

ES.6 Potential Costs for Construction Operators

EPA developed a national level cost estimate for implementing erosion and sediment controls on sites that disturb between one and 5 acres. EPA estimated a per site compliance cost for sites of one, three, and five acres and multiplied the cost by the total number of Phase II construction starts expected to incur incremental cost in these size categories to obtain a national cost estimate. EPA used construction start data from fourteen municipalities and 1994 Census Bureau construction permit data to estimate the number of construction starts disturbing between one and five acres of land. Of the estimated 129,675 construction starts likely to incur incremental costs, EPA expects that 110,223 (85%) will require erosion and sediment controls to comply with the regulation.

EPA used standard cost estimates from R.S. Means (R.S. Means, 1997a and 1997b) and the WEF database to estimate construction BMP costs for 27 model sites of typical site conditions in the United States. The model sites included three different site sizes (one, three, and five acres), three slope variations (3%, 7%, and 12%), and three soil erosivity conditions (low, medium, and high). EPA used the WEF database to determine BMP combinations appropriate to the model site conditions. For example, sites with shallow slopes and a low erosivity require few BMPs, while larger, steeper, and more erosive sites required more BMPs. Detailed site plans, assumptions, and BMPs that could be used are presented in Appendices B–2 and B–3. Based on the assumption that any combination of site factors is equally likely to occur on a given site, EPA averaged the matrix of estimated costs to develop an average cost for one-, three-, and five-acre starts for all soil erodibilities and slopes.

[1]Per household cost can be converted to per capita cost using the national average of 2.6246 persons per household.

EPA then estimated administrative costs per construction site for the following elements required under the Phase II rule: submittal of a notice of intent (application) for permit coverage; notification to municipalities; development of a storm water pollution prevention plan (SWPPP); record retention; and submittal of a notice of termination. The average total administrative cost per site is estimated to be $937.

Summing the average BMP costs and the administrative costs yields a total compliance cost of $2,143 for sites disturbing between one and two acres of land, $5,535 for sites disturbing between two and four acres of land, and $9,646 for sites disturbing between four and five acres of land. To estimate national level incremental annual costs for Phase II construction starts, EPA multiplied the total costs of compliance for one to two acre, two to four acre, and four to five acre sites by the total number of Phase II construction starts within each of those size categories. This yielded an estimated annual compliance cost of approximately $499.8 million (based on 110,223 construction starts in 1998).

EPA anticipates that 19,452 (15%) of the estimated Phase II incremental construction universe will qualify for a waiver from program requirements by meeting one of two conditions. Construction sites can be waived if they are either located in areas with low rainfall potential or if water quality analyses show that there is no need for regulation. EPA estimates the incremental administrative cost associated with preparing and submitting a waiver to be approximately $665,000 (1998). Total costs (national compliance and waiver costs) resulting from implementation of the Phase II erosion and sediment control provision are estimated to be $500.4 million.

EPA also estimated incremental costs attributable to the post-construction runoff control measure. The Phase II municipal program requires municipalities to develop, implement, and enforce a program that addresses storm water runoff from new development and redevelopment sites on which land disturbance is greater than one acre and that discharge into a regulated MS4. To develop a cost estimate associated with this measure, EPA estimated a per site BMP cost, including operation and maintenance, for 12 model sites of varying size (1, 3, 5, and 7 acres) and imperviousness (35%, 65%, and 85%). The per site BMP cost was then multiplied by the total number of multi-family, institutional, and commercial construction starts that are located in Phase II urbanized areas to obtain a national cost estimate. Using this total of 13,364 post-construction starts, EPA estimated a range of national costs associated with this measure from $44.6 to $178.3 million (see Appendix B–4).

EPA estimates total annual costs to construction operators, including implementation of erosion and sediment controls and post-construction controls, to be between $545.0 – $678.7 million.

ES.7 Potential Costs for Federal and State Program Administrators

EPA estimated incremental costs associated with program administration for states that possess NPDES permitting authority and for EPA within non-NPDES authorized states and territories. The storm water permitting authority must review and manage the application, certification, reporting and notice requirements for municipalities and construction sites. The estimated annual incremental Federal and State administrative costs are estimated to be $5.3 million.
The permitting authority must also develop municipal designation criteria and use the criteria to determine whether municipalities that are not automatically designated should be regulated by

the Phase II rule. The costs associated with developing and applying these criteria are not included in the annual administrative cost estimates because they are considered a one-time-only start up cost. However, these costs and other administrative start-up costs are considered in the sensitivity analysis, referred to as Scenario Six, in Section 4.6 of Chapter 4.

ES.8 Summary of Potential Costs

A summary of the potential costs from implementing the Phase II municipal measures and construction site erosion and sediment controls is presented in Exhibit ES–1. Once the Phase II storm water rule is fully implemented, EPA expects the total range of annual costs for implementing the rule to be $848 to $981 million.

Exhibit ES–1. Potential Annual Costs for Phase II Storm Water Regulation

Phase II Element	Universe	Estimated Total National Annual Costs (millions of 1998 dollars)
Municipal	32,458,000 Households	$297,318,623
Construction	129,675 Erosion & Sediment Control Starts and 13,364 Post-Construction Starts *	$545,000,539 – $678,692,291
Federal/State Administration	53 States and Territories	$5,318,668
Total		$847,637,830 – $981,329,582

* The total number of construction starts potentially affected by the Phase II construction program is not the sum of 129, 675 and 13, 364. This is because the E&S provision affects all 1–5 acres starts nationwide, while the PCRC provision affects starts under 10 acres in Phase II municipalities only.

ES.9 Pollutant Loading Reductions from Municipalities

EPA developed estimates of municipal pollutant loading reductions for the final Phase II rulemaking using estimates of national municipal loading reductions for total suspended solids (TSS) based on the National Urban Runoff Program (NURP) study (US EPA, 1997c). Although these estimates for TSS do not capture the full extent of potential loading reductions that result from implementing municipal storm water controls, they provide a minimum estimate of the reductions that may result from the Phase II rule. EPA also anticipates that the rule will result in reductions in oil and grease, nitrogen, phosphorus, pathogens, lead, copper, zinc, and other metals.

Partial TSS loadings reductions may range from 639,115 tons/year (assuming 20% BMP efficiency) to 4.1 million tons/year (assuming 80% BMP efficiency). EPA anticipates that municipalities will strive to achieve 80% effectiveness when implementing their storm water programs.

ES.10 Reduced Sediment Delivery from Phase II Construction Starts

To estimate reduced sediment delivery from Phase II construction starts, the US ACE developed a model based on EPA's 27 model sites to estimate sediment loads from construction starts with and without Phase II controls (US ACE, 1998). The US ACE model uses the construction site version of the Revised Universal Soil Loss Equation (RUSLE) to generate sediment delivery estimates for 15 climatic regions with each of the following variations: three site sizes (one,

three, and five acres), three soil erodibility levels (low, medium, and high), three slopes (3%, 7%, and 12%), and the BMP combinations from EPA's 27 model sites. The 15 climatic regions represent the various rainfall and temperature conditions throughout the United States. Sediment delivery represents the quantity of sediment that BMPs placed at the base of the hill slope are unable to capture. EPA estimated that the average reduction in soil loss from the model sites implementing BMPs would be 89.6 tons per site.

ES.11 Cost Effectiveness

Cost effectiveness is typically defined as the incremental annualized cost of a pollution control option per incremental pound of pollutant removed annually by the control option. Cost-effectiveness analysis can thus be used to compare pollutant removal costs across regulatory alternatives and across different industries. This type of analysis is limited for the Phase II rule because EPA was only able to quantify potential reductions in TSS loadings (the reduced sediment delivery from construction starts would contribute to the reduced loadings from municipalities). EPA also anticipates that the rule will result in reductions of other pollutants.

Based on the total cost of the rule and the estimated reduction in TSS from Phase II municipalities, EPA estimates that Phase II municipalities may experience costs of between $0.04 (80% BMP efficiency; high end reduction) and $0.18 (20% BMP efficiency; low end reduction) per pound of TSS removed.[2] While EPA anticipates 80% effectiveness at reducing pollutant loading following program implementation, both low and high end reduction costs are very low compared to the $0.70 (1998 dollars) established for POTWs to remove BOD and TSS; thus, the requirements of the final Phase II rule may be cost effective.[3] This is particularly true since EPA's analysis of cost-effectiveness is based solely on removal of one of many pollutants believed present in storm water discharges.

ES.12 Anticipated Benefits of the Phase II Rule

Storm water runoff from construction sites and urban areas can adversely affect aquatic systems. Runoff from these areas can include litter, chemicals, metals, nutrients, pesticides, organics, bacteria, and sediment. These pollutants can have a variety of detrimental effects on humans, aquatic ecosystems, and wildlife. For example, bacterial contamination of waters used for swimming can threaten the health of swimmers. Sediment related pollution can degrade and destroy benthic habitat and organisms, decrease photosynthetic activity, and reduce the viability of aquatic biota. Sediment can particularly detrimental to smaller streams, altering channel morphology and threatening critical aquatic habitat as well as human safety and property. Other pollutants such as metals, organics, pesticides, and nutrients can have chronic or acute effects on aquatic organisms and lead to bioaccumulation or eutrophication.

Estimation of Benefits

[2]Cost effectiveness is based on the total cost of the rule because the municipal component includes construction activity within the watershed.

[3]The technologies used for secondary treatment at POTWs removes both BOD and TSS at the same time. Therefore, estimating the tons of TSS removed from secondary treatment is not possible.

In the economic analysis for the proposed rule, a top-down approach was used to estimate economic benefits. Under this approach, the combined economic benefits for all wet weather programs were estimated first, and then were divided among various water programs on the basis of expert opinion. The use of an expert opinion in this manner rendered the benefits estimates for an individual program uncertain. In addition, the approach was inconsistent with the bottom-up approach used to estimate the cost of the proposed storm water rule, which aggregated costs across municipalities and construction starts. Researchers normally prefer to base cost and benefits analysis on a similar structure. Therefore, EPA decided to change the benefits analysis for the Phase II rule. To adequately reflect the quantifiable benefits of the rule, EPA used two different approaches, one that relied on a national water quality model and another that relied on the 305(b) national water quality assessment. Both approaches estimate benefits based on expected water quality improvements of the Phase II rule. Despite the difference in the estimates, both approaches show that benefits potentially exceed costs.

National Water Quality Model Approach

To estimate the benefits of the Phase II municipal and construction site controls, EPA used the National Water Pollution Control Assessment Model (NWPCAM). This model estimates water quality and associated use support for the 632,000 miles of rivers and streams in the EPA Reach File Version 1 (RF1), which covers the continental United States. The model analyzes water quality by stream reach based on point source and nonpoint source pollution loadings and geographic and hydrologic conditions. The water quality parameters modeled in the NWPCAM are biological oxygen demand (BOD), total suspended solids (TSS), dissolved oxygen (DO), and fecal coliforms (FC). The model simulates the impact of loadings on water quality immediately below a point source in the down stream segment of a reach.

The model projects improvements in water quality by comparing the simulation results of a baseline loadings scenario with results for a scenario based on Phase II municipal and construction site controls. These improvements are characterized as changes in modeled water quality classifications between four water quality use support categories: no support, boatable, fishable, and swimmable. To calculate the economic benefits of change in water quality, the model overlays the water quality changes with estimates of households in the proximity of the affected stream reach. The household estimates are based on the 1990 Census of Populated Places and Minor Civil Divisions, and updated 1998 population levels. Economic benefits are calculated multiplying number of households by household willingness-to-pay (WTP) values for water quality improvements. The WTP values are based on a national valuation survey (Carson and Mitchell, 1993). The benefits are separately estimated for local and nonlocal waters on the basis of WTP values.

Definition of Baseline Conditions

To estimate economic benefits, NWPCAM compares given baseline pollution loadings conditions to compliance with the Phase II program. The baseline conditions are described below.

- All combined sewer overflows (CSOs) are controlled by detention basins and assume 85% capture of the runoff (the 85% capture is based on NEEDS Survey assumptions)

- Detention basin controls are at each of the 1,723 individual NWPCAM Phase I urban sites and assume 85% capture of the runoff

- Construction start BMPs are in place based on existing state programs

- Construction start BMPs are in place at sites greater than five acres.

Definition of Scenario Conditions—Phase II Controls in Place

The Phase II conditions include the baseline conditions and are assumed to further impose:

- Detention basin controls at each of the 5,038 individual NWPCAM Phase II urban sites that assume 85% capture of the runoff[4]

- Construction starts BMPs are in place at sites between one and five acres.

The model normally requires an engineering surrogate for treatment of specific pollutants contained in discharges, whereas the Phase II program includes both structural and nonstructural controls. The model uses detention basins as a proxy to represent the impact of the municipal program.

EPA applied Carson and Mitchell's (1993) estimates of household WTP for incremental water quality improvements to the improvements simulated using NWPCAM. Carson and Mitchell estimate the WTP for three minimum levels of fresh water quality: boatable, fishable, and swimmable. EPA adjusted the WTP amounts to account for inflation, growth in real per capita income, and increased attitudes towards pollution control. The adjusted WTP amounts for improvements in fresh water quality are $210 for boatable, $158 for fishable, and $177 for swimmable.

The NWPCAM valuation analysis assumes that households place a higher value on local water quality improvements than on nonlocal water quality improvements. Thus, if improvement occurs in waters that are not close to population centers, the economic value is lower. Benefits are estimated for local and nonlocal waters, separately by apportioning the WTP between local and nonlocal waters. Mitchell and Carson (1986) asked respondents to apportion each of their stated WTP values between achieving the water quality goals in their own state and achieving those goals in the nation as a whole. On average, respondents allocated 67% of their values to achieving in-state water quality goals and the remainder to the nation as a whole. Mitchell and Carson argue that for valuing local (substate) water quality changes 67% of the WTP value is a reasonable upper bound for the local multiplier and 33% of the value is for nonlocal water quality changes. For the purposes of this analysis, the locality is defined as urban sites and associated populations linked into the NWPCAM framework Using this methodology, the total benefits of Phase II controls are estimated to be $1.63 billion per year. The summary of the local and nonlocal benefits due to Phase II controls are presented in ES–2.

[4]The benefits analysis used 5,038 municipalities instead of 5,040 used for the cost analysis.

Exhibit ES–2. Annual Local and Nonlocal Benefits Estimates Due to Phase II Controls

Use Support	Local Benefits ($million)	Nonlocal Benefits[1] ($million)	Total Benefits ($million)
Swimming, Fishing, and Boating	306.2	60.6	366.8
Fishing and Boating	395.1	51.9	447.0
Boating	700.1	114.6	814.7
Total	1401.4	227.1	1628.5

[1] To estimate nonlocal willingness to pay per household, the 33% of WTP is multiplied by the fraction of previously impaired national waters (in each use category) that attain the beneficial use as a result of the Phase II rule. To estimate the aggregate nonlocal benefits, nonlocal WTP is multiplied with the total number of households in the United States.

Sensitivity Analysis

The benefit estimates are derived using conservative assumptions of the pollution control effectiveness of the municipal component of the Phase II rule. The Phase I and Phase II urban runoff controls used in this analysis employ pollutant removals that would be characteristic of detention basins. To determine the impact of the alternative assumptions a sensitivity analysis is conducted. Alternative analysis assumes different levels of control, such as 60% or 80% pollutant removals in the storm water run off from municipal sources. Supplemental sensitivity analysis in conjunction with the controls in the 60% to 80% range shows that the economic benefits in NWPCAM increase by $200 million to $300 million from the estimate of $1.63 billion, respectively.

The benefit estimates can be considered quite robust because model sensitivity analyses have consistently shown that the estimates are stable, even under assumptions of large changes in model input values. As an example, a sensitivity analysis was conducted assuming that the construction starts loads are 25% higher and lower. The local economic benefits estimates change by only +/– 5%. Moreover, a statistical groundtruthing of the model to storage and retrieval ambient water quality data indicates that the NWPCAM produces reliable baseline estimate can be considered as a reasonable predictor of the actual use support for 1990s.

National Water Quality Assessment

This approach to estimating the benefits of the Phase II rule estimated benefits separately for the municipal minimum measure and the soil erosion control provisions. Furthermore, it estimated partial benefits associated with marine water quality improvements. Each component is described separately below and aggregate benefits are reported at the end of this section.

Potential Value of the Benefits of Municipal Measures—Fresh Waters

Runoff from Phase II municipalities contribute loadings of nutrients, metals, oil and grease, and litter that result in impairment of the nation's rivers and streams, lakes, reservoirs, Great Lakes, estuaries, and oceans. The benefits of implementation of the Phase II municipal minimum measures to remove impairment depend on a number of factors, including the number, intensity, and duration of wet weather events; the success of the municipal programs; the site-specific water quality and physical conditions; the current and potential uses of the receiving waters; and the existence of nearby "substitute" sites of unimpaired waters. Because all these factors will vary substantially from municipality to municipality, data and information are not available with which to develop estimates of benefits measure by measure and water body by water body.

EPA applied Carson and Mitchell's (1993) estimates of the household WTP for incremental water quality improvements to estimates of waters impaired by urban storm water discharges as reported by states in their 305(b) reports. Carson and Mitchell's 1993 study reports the results of their 1983 national survey of WTP for incremental improvements in fresh water quality. Carson and Mitchell estimate the WTP for three minimum levels of fresh water quality: boatable, fishable, and swimmable. EPA adjusted the WTP amounts to account for inflation, growth in real per capita income, and increased attitudes towards pollution control. The adjusted WTP amounts for improvements in fresh water quality are $210 for boatable, $158 for fishable, and $177 for swimmable.

To develop estimates for the potential value of the municipal measures (except storm water runoff controls for construction sites), EPA apportioned the WTP estimates for the different water quality levels based on the baseline level of water quality impairment potentially associated with Phase II municipalities. However, although the Carson and Mitchell estimates apply to all fresh water, it is not clear how these values would be apportioned among rivers, lakes, and Great Lakes. The 305(b) data indicate that lakes are the most impaired by urban runoff/storm sewers, followed closely by Great Lakes, and then rivers. Therefore, EPA applied the WTP values to the categories separately and assumed that the higher resulting value for lakes represents the high end of the range (i.e., assuming that lake impairment is more indicative of national fresh water impairment) and that the lower resulting value for impaired rivers represents the low end of a value range for all fresh waters (i.e., assuming that river impairment is more indicative of national fresh water impairment).

Summing the benefits across the water quality levels yields a low estimate of benefits ranging from approximately $120.2 million to $145.2 million per year and a high estimate of benefits ranging from approximately $270.1 million to $372.8 million per year, assuming 80% program effectiveness. The fresh water benefit analysis does not include the prospective benefits that are expected to accrue from the post-construction runoff control provision of the Phase II Storm Water rule. This is because the benefit analysis was based on current water quality impairment

levels in the 305(b) report. The post-construction runoff control provision will mitigate future impairment to water bodies by controlling contaminated storm water runoff from sites that are developed or redeveloped in the future. This would happen because development increases the amount of impervious surface. Such increases in imperviousness alter runoff patterns and reduces the effectiveness of natural water quality improvement mechanisms, such as groundwater infiltration and wetlands filtration. Furthermore, development introduces new sources of contamination to a watershed. Without this provision, national water quality impairment from Phase II would increase relative to the impairment levels currently reported in the 305(b). EPA estimated that annual benefits of avoided water quality impacts would range from $1.7 million to $5.4 million. This analysis is based on projections of current impairment levels reported in the 305(b) that use disturbed area estimates for the affected construction starts as a proxy for potential long-term future water quality impacts.

Potential Value of the Benefits of Municipal Measures—Marine Waters

The Phase II rule will impact all types of waters, fresh waters as well as marine. In addition to the fresh water benefits captured by the Carson and Mitchell study, EPA anticipates benefits as a result of improvements to marine waters. Sufficient methods have not been developed to quantify benefits for commercial or recreation fishing. EPA used beach closure data and visitation estimates from its Beach Watch Program to estimate potential reductions in marine swimming visits due to storm water runoff contamination events in 1997. The estimated 86,100 trips that did not occur because of beach closures in coastal Phase II communities is a lower bound because it represents only those beaches that report both closures and visitation data. Using average consumer surplus value of $30 per day per trip (in 1998 dollars) from applicable studies, which were summarized in two meta-analyses (Walsh et al., 1990 and Freeman, 1993), EPA estimated potential swimming benefits for the rule as $2.6 million. Assuming 80% program effectiveness, the benefit estimate is $2.1 million.

EPA developed an analysis of potential benefits associated with avoided health impacts from exposure to contaminants in storm sewer effluent. Based on a study of incremental illnesses found among people who swam within one yard of storm drains in Santa Monica Bay, EPA estimated a range of incremental illnesses (Haile et al., 1996). The Santa Monica Bay study reported attributable illnesses for several health symptoms. The attributable illnesses characterized incremental cases of illness found among those swimming close to the storm drains compared to a control group swimming at least 400 yards away from the drains. The benefits analysis applied values to two of the symptom categories. A WTP estimate of $24 per case was multiplied by the additional cases of significant respiratory disease (SRD) (US EPA, 1997d), in 1998 dollars. Assuming that each case was accompanied by one mild restricted activity day, and additional $47 was multiplied by each case (US EPA, 1997d), in 1998 dollars. Cases of highly credible gastroenteritis two were valued using a cost of illness value of $244, which was estimated by Mauskopf and French (1991), in 1998 dollars for mild cases of salmonellosis—an illness with symptoms similar to those in the Santa Monica Bay study. Depending on assumptions made about number of exposures to contaminants and contaminant concentrations, benefits ranged from $8.7 million to $37.4 million. Assuming 80% program effectiveness, the benefit range is $7.0 million to $29.9 million.

Potential Value of the Benefits of Construction Site Controls

Development activities increase the amount and types of contaminants that degrade water quality. During construction, soil erosion from disturbed areas increases sediment loads in water bodies, which leads to a variety of habitat impairments, increases flooding risks, and adds to dredging costs. In addition to sediment, construction activities also yield pollutants such as pesticides, petroleum products, and solvents. The national benefits of construction site storm water runoff controls will depend on a number of factors, including the number, intensity, and duration of wet weather events; the effectiveness of the selected construction site BMPs; the site-specific water quality and physical conditions of receiving waters; the current and potential uses of receiving waters; and the existence of nearby "substitute" sites of unimpaired waters. Again, because these factors will vary substantially from site to site, data are not available with which to develop estimates of benefits for each site.

Nonetheless, a survey of North Carolina residents (Paterson et al., 1993) indicated that households are willing to pay for erosion and sediment controls similar to those contained in the Phase II program. Paterson et al.'s (1993) analysis of the survey results indicated a mean WTP of $25 per year (in 1998 dollars). This study provides one way to develop national-level benefits estimates of the rule and, therefore, EPA chose to use benefit transfer methodology to apply the study results. Paterson et al's. (1993) study is applicable to the construction component of the Phase II rule not only because North Carolina's program requires similar controls, but also because the median income of North Carolina residents is just below the median income for the United States. The similarity of the median incomes indicates that the WTP estimates developed by Paterson et al. (1993) may be appropriate for transfer to residents elsewhere in the United States.

The impact of Phase II construction sites on overall construction soil erosion damages to water quality is uncertain. EPA developed a benefit range based on high and low impact assumptions. For the high impact assumption, EPA multiplied the updated mean WTP of $25 by the percentage of Phase II construction sites and the number of households in each state. For the low impact assumption, EPA used the percentage of total construction site perimeter affected by the Phase II rule rather than the percentage of total sites. Summing the low and high estimates across all states indicates that the WTP for the erosion and sediment controls of the Phase II rule may be approximately $487.7 million to $622.4 million per year. This range reflects the potential benefits of erosion and sediment control programs that protect all lakes, rivers, and streams. However, because construction can be especially harmful to small stream habitat, EPA is interested in the benefits that may be attributable to improvements in small stream ecology. Based on inventory data reported in state 305(b) reports and the distribution of streams by stream order (Leeden, 1990), approximately 2% of all water bodies are first order streams. This suggests that approximately $9.8 to $12.4 million of the total annual benefits from erosion and sediment controls may reflect a desire to protect small streams.

Summary of Monetized Benefits: National Water Quality Assessment

A summary of the potential benefits resulting from implementation of the Phase II municipal measures and erosion and sediment controls for construction sites is presented in Exhibit ES–3. Total benefits from municipal measures and construction site controls are expected to be $671.5 million to $1,096.2 million per year (assuming 80% effectiveness of municipal programs), including benefits of approximately $10.8 million to $13.7 million per year associated with small

stream improvements. The largest portion of benefits are associated with erosion and sediment controls for construction sites.

As shown in the exhibit, some categories of benefits are not included in the WTP estimates from the research used. In particular, benefits for improving marine water quality such as fishing and passive use benefits are not included in the values used to estimate the potential benefits of the municipal minimum measures (excluding construction sites controls), and they are not estimated separately.

Exhibit ES–3. Potential Annual Benefits of the Phase II Storm Water Rule (Millions of 1998 dollars)

Benefit Category	Annual WTP
Municipal Minimum Measures[1]	
Fresh Water Use and Passive Use[2]	$121.9 – $378.2
Marine Recreational Swimming	$2.1
Human Health (Marine Waters)	$7.0 – $29.9
Other Marine Use and Passive Use	+
Erosion and Sediment Controls for Construction Sites	
Fresh Water and Marine Use and Passive Use[3]	$540.5 – $686.0
Total Phase II Program	
Total Use and Passive Use (Fresh Water and Marine)	>$671.5 – >$1,096.2

+ = positive benefits expected but not monetized

[1] Includes water quality benefit of municipal programs, based on 80% effectiveness of municipal programs.

[2] Based on research by Carson and Mitchell (1993). Fresh water value only. Does not include commercial fishery, navigation, or diversionary (e.g.,municipal drinking water cost savings or risk reductions) benefits. May not fully capture human health risk reduction or ecologic values.

[3] Based on research by Paterson et al. (1993). Although the survey's description of the benefits of reducing soil erosion from construction sites included reduced dredging, avoided flooding, and water storage capacity benefits, these benefit categories may not be fully incorporated in the WTP values. Small streams may account for over 2% of total benefits.

ES.13 Benefits Estimation Comparison

The two approaches to estimating the potential benefits of the rule generate a wide range of benefits. The NWPCAM approach obtained a higher overall benefit estimate of $1.6 billion compared to the range for the national water quality assessment approach ($671.5 million to $1.1 billion). Both approaches are based on expected water quality improvements of the rule and both show that the benefits are likely to exceed costs.

ES.14 Comparison of Benefits and Costs

Exhibit ES–4 provides an annual comparison of benefits and costs for a representative year in which the rule is implemented, one in which benefits from the minimum measures and construction controls are accruing. Because there is not an initial outlay of capital costs with benefits accruing in the future (i.e., benefits and costs are almost immediately at a steady state), it is not necessary to discount costs in order to account for a time differential. In addition, EPA did not vary the factors that comprise the benefits and costs to account for market changes over

time. Therefore, the benefits and costs presented in Exhibit ES–4 reflect a constant and steady stream of annual benefits and costs.

Exhibit ES–4. Comparison of Annual Benefits to Costs for the Phase II Storm Water Rule

Monetized Benefits[1]	**Millions of 1998 dollars**[2]
National Water Quality Model **Total Annual Benefits**	 **$1,628.5**
National Water Quality Assessment Municipal Minimum Measures Controls for Construction Sites[3] **Total Annual Benefits**	 $131.0 – $410.2 $540.5 – $686.0 **$671.5 – $1096.2**
Costs	**Millions of 1998 dollars**[2]
Municipal Minimum Measures Controls for Construction Sites[3] Federal/State Administrative Costs **Total Annual Costs**	$297.3 $545.0 – $678.7 $5.3 **$847.6 – $981.3**

[1]National level benefits are not inclusive of all categories of benefits that can be expected to result from the regulation.
[2]Detail may not add to total due to independent rounding.
[3] Controls evaluated include both erosion and sediment and post-construction controls.

ES.15 Impact on Small Entities

Because EPA revised its cost analysis, it reviewed the economic impact analyses for small entities in its initial screening analysis. The small entities affected by the rule include almost 4,500 municipalities with populations below 50,000 and potentially more than 180,000 building construction businesses with revenues below $17 million. EPA revised its revenue test for small municipalities using the updated municipal cost estimates, and concluded that its original finding that the rule would not have a significant impact on a substantial number of small entities was consistent with the analysis.

EPA also updated its proxy for a sales test for small construction companies by comparing its revised per home compliance cost estimates for single family detached to the median and mean cost of a new home. Compliance costs of approximately $400 to $650 per home equaled 0.22% to 0.43% of the price of a new home, and EPA concluded that it was unlikely that such costs would have a significant impact on a substantial number of small construction companies.

Finally, EPA added similar analyses of costs for multi-family residential developments and commercial developments to evaluate the potential impacts of indirect costs such as those estimated for the post-construction runoff control element of the municipal program provision. For multi-family developments, the per-site compliance costs was compared with the estimated revenues from constructing condominiums or apartments on the site. The revenue estimates were determined by multiplying the estimated number of units per site by the median

condominium price and mean apartment price, respectively. Compliance costs equaled 0.17% to 0.91% of anticipated sales revenues. For commercial sites, the per-site compliance costs were compared to the estimated revenue from a commercial office development. Compliance costs ranged from 0.38% to 0.47% of sales. Based on the results from these three screening analyses, EPA concluded that typical construction firms, which build and sell residential or commercial sites, are unlikely to incur compliance costs which exceed 1% of expected sales.

ES.16 No Exposure

The Storm Water Phase II rule includes a conditional exclusion for no exposure for all categories of industrial activity covered by the Phase I program that can certify a condition of no exposure, except for discharges from construction and individually designated sources. "No exposure" means all industrial materials or activities are protected by a storm resistant shelter so that the materials or are not exposed to rain, snow, snowmelt, or runoff. EPA estimates that approximately 181,885 facilities are eligible to take advantage of the no exposure provision. Potential cost savings are provided to these facilities in the form of avoided costs. These forgone costs include the development and implementation of storm water pollution prevention plans that range from $3,661 to $24,147 annually, visual and analytical monitoring costs that vary, notice of intent costs of $3.25 annually, notification of municipalities cost of $3.25 annually, and record keeping costs of $91 annually. An annual no exposure certification cost of approximately $1.2 million is expected for the 181,885 facilities. After this certification cost is subtracted from total industrial avoided costs, the resulting net cost savings range from $317.6 million to $1.86 billion annually.