Review of Policy Issues Associated with Water Quality Trading

This paper examines three key policy issues associated with water quality trading. Section 1 (which doubled as a summary of ongoing demonstration projects) contains some discussion of the permitting approach or compliance mechanism. Four other water quality trading programs are reviewed. Issues such as hot spot avoidance, liability, defining noncompliance are viewed in the context of the compliance mechanism. The general or watershed-based permit is found to be much more conducive to trading than individual permits because of its simplicity.

Section 2 (pg. 21) explores the issue of trading unused capacity. The problem of trading unused capacity is directly linked to the problem of establishing WWTP wasteload allocations. These problems must be addressed before proceeding to study various trading scenarios. A trading scenario is built on the assumption of certain allocations; how these allocations are set merits scrutiny.

Section 3 (pg. 29) recognizes the effect of model uncertainty on a trading program, and reviews the topic of communicating model uncertainty to the public. Since the public might be more concerned with the overall process of trading, and not just model uncertainty, it concludes with a strategy for conducting a public meeting on the trading project. Issues of regulator accountability, transparency, the extent of market regulation, and concerns for environmental justice are raised.

Section 1 -

Ideas for water quality trading in New Jersey:

Looking at successful examples from other states

Introduction

Water quality trading is potentially an effective tool to achieve better water quality in New Jersey at lower cost than the traditional regulatory approach. In addition to reduced costs for point sources (factories, wastewater treatment plants, etc.) to comply with water quality standards, water quality trading can encourage reduction of rampant nonpoint source pollution such as agriculture and urban land use, which are not regulated by the Clean Water Act.

Water quality trading has happened in many other states around the country – There have been 40 trading projects across 17 states, in every region of the US. However, only a handful of these projects have achieved success. This summary will look at 4 successful projects, and review the pros and cons of each to determine what aspects would be applicable for a New Jersey trading project.

Outline

- Acronym list
- Pros and Cons of Four Successful Water Quality Trading Projects
    - North Carolina, Tar-Pamlico River Basin program – Nutrient (N&P) Trading
    - North Carolina, Neuse River Basin program – Nitrogen Trading
    - Connecticut, Long Island Sound Nitrogen Trading Program
    - Michigan, Kalamazoo River Phosphorus Trading Demonstration Program (1997-2000)
- Conclusions: Implications for Water Quality Trading in New Jersey
- Further details of each trading project mentioned above

Acronym list

BMP: best management practice

CTDEP: Connecticut Department of Environmental Protection

DMR: discharge monitoring report

DO: dissolved oxygen

DSWC: Division of Soil and Water Conservation

N: Nitrogen

NCAB: Nitrogen Credit Advisory Board

NCDWQ: North Carolina Division of Water Quality

NGO: non government organization

NJDEP: New Jersey Department of Environmental Protection

NPDES: national pollutant discharge elimination system

NPS: nonpoint source

P: phosphorus

PS: point source

TMDL: total maximum daily load

TN: total nitrogen

TP: total phosphorus

USEPA: US Environmental Protection Agency

WWTP: wastewater treatment plant

Pros and Cons of Four Successful Water Quality Trading Projects

1. *North Carolina, Tar-Pamlico River Basin program – Nutrient (N&P) Trading*

Pros

- PS dischargers formed an Association to meet a collective nutrient cap
- Informal trading between PS dischargers
- Reduced PS loading at much lower cost
- Association dischargers have installed nutrient removal as they expand
- State established required rules for NPS reduction
- Use of 2 agricultural NPS load accounting tools
- Able to regain endorsement of environmental NGOs for latest phase of program (Phase 3; 2005-2014)

Cons

- Determining actual NPS load reduction (nationwide problem)
- Issues with life and cost of credits; credit value does not account for inflation
- Low number of real PS/NPS trades; Because dischargers have not exceeded cap, NPS have received less funding than expected for BMPs.
- Farmers dissatisfied with Phase 2 (1995-2004) changes to trading program.

2. *North Carolina, Neuse River Basin program – Nitrogen Trading*

Pros

- PS dischargers formed an Association to meet a collective nitrogen cap; Association secured group NPDES permit
- Informal trading between PS dischargers
- Formal point to point trading between Association members and non-members
- Reduced PS loading of TN at much lower cost
- Hot spot avoidance: Association penalizes members who do not meet individual TN allocations, regardless of collective cap compliance
- Indirect PS/NPS trading with Wetlands Restoration Fund addresses local watershed concern (intensifying land development)

- State maintains individual PS enforcement, despite "bubble" approach.
- Transport factors incentivize PSs with most harmful discharges to reduce load
- Higher rates for new or expanding dischargers control growth in watershed

<u>Cons</u>

- Low number of real PS/NPS trades; Because dischargers have not exceeded cap, NPS have not received offset payments.
- Farmers might be unhappy with being shut out of PS/NPS trades.
- Uncertainty of quantifying NPS load reduction through restoring wetlands
- Hot spots: TMDL and transport factors only consider water quality at the endpoint. However, hot spots could occur *between* the PS and endpoint

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3. *Connecticut, Long Island Sound Nitrogen Trading Program*

<u>Pros</u>

- Simple to execute and required minimal manpower, while achieving significant TN discharge reduction at low cost
- The General Permit has been an effective and simple tool to frame the program
- Involves huge number of PSs – 79 WWTPs.
- Effective tracking of trades
- The program incentivizes PSs to improve beyond their requirement
- Equivalence ratios incentivize PSs with most harmful discharges to reduce load
- EPA considers this a model program
- Credit value is reset annually; credit value and life issues are clearly stated
- The use of a credit advisory board instead of a free market is meant to protect poor communities

<u>Cons</u>

- The state bears the risk of paying out money each year
- Hot spots: TMDL and equivalence ratios only consider water quality at the endpoint. However, hot spots could occur *between* the PS and endpoint
- No current NPS involvement in trading

4. *Michigan, Kalamazoo River Phosphorus Trading Demonstration Program (1997-2000)*

Pros

- Valuable lessons learned on how to engage farmers in trading
- Service Agreement established contractual, non-permit, obligation for NPS participants. This makes NPS accountable for their part of the transaction without using a command and control approach.
- Cautious approach to avoid hot spots

Cons

- No actual trades occurred
- Lengthy approval process for trades reduced the program credibility
- Need to modify individual PS NPDES permits slows the process

Conclusions: *Implications for water quality trading in New Jersey*

- Simplicity and efficiency are key elements to making trading work. Tracking of trades must be easy and transparent.
- A group permit approach is more efficient than individual permits for the pollutant being traded. The group permit avoids reviews of each trade which can take a lot of time, delay the process, and cause stakeholders to lose faith in the program. A group permit approach allows informal trading between point source dischargers. It can also allow indirect point to nonpoint trades.
    - In the Passaic Water Quality Trading Project, an association of WWTP dischargers is already in place – the Passaic Basin Alliance. *The Passaic River Basin Alliance should consider working with NJDEP to obtain a group permit for total phosphorus, which would facilitate efficient and cost effective water quality trading.*
- NPS can be held accountable for their reductions through simple service agreements, as in the Kalamazoo program.
- There are a variety of methods to calculate credit value and credit life. Consider resetting credit value on an annual basis.
- Hot spot avoidance: The state should maintain the authority to enforce against individual dischargers, even under a bubble approach. The state should inspect PS and NPS participants in the trading program to ensure real pollutant reductions are occurring. Regular monitoring and reporting should continue. If dischargers have formed an association, they could penalize members who do not meet individual allocations, regardless of collective cap compliance.
- See lessons learned from the Kalamazoo program (p. 16) regarding involving farmers in a trading program – very valuable insights.
- Tailor the program to the watershed. PS/NPS trades can fund a variety of NPS controls such as wetland restoration, agricultural BMPs, or urban stormwater management.
- Building trust is crucial between stakeholders of varied interests. All stakeholders must be involved in program design from the early stages to foster trust.

North Carolina Tar-Pamlico River Basin program – Nutrient (N&P) Trading

Details

Watershed area: 5450 sq miles

Land cover: 2% urban, 23% agriculture, 55% forest, 20% water

Population density: 80/sq mi; 2 towns > 50,000 persons

Problem: Algal blooms and fish kills in upper Pamlico estuary were linked to excessive nutrient levels in Tar-Pamlico River, and exceedance of chlorophyll-*a* water quality standard.

Pollutants traded: Nitrogen and Total Phosphorus

Accomplishment: 1991-2003: total nutrient loading declined 33% while flow increased 48%. Net cost of program was less than $2 million, compared to estimated cost of command and control approach of 50 to 100 million dollars. The loading reduction has been achieved mostly through the "bubble" approach which set a collective cap for dischargers, allowing informal PS/PS trading; little PS/NPS trading has occurred.

TMDL: There is not a TMDL for the Tar-Pam River. There is a TMDL for nitrogen and phosphorus for Tar-Pamlico Estuary. However this was a very early TMDL and predated the current TMDL process. (Michelle Woolfolk, personal communication, March 1, 2005).

Trading framework: This is not a standard trading program where individual PS and NPS trade directly with each other. The program is similar to an exceedance tax on an association of point sources, the proceeds of which are applied to more cost-effective NPS controls like BMPs.

In phase 1 (1991-1994) PS dischargers formed an association to meet a collective and declining cap for nutrients. In phase 2 (1995-2004) the collective cap changed from a declining to a steady cap. Phase 2 also set NPS reduction requirements. Phase 3 (2005-2014) maintains the steady cap principle and adjusts the numbers to reflect current Association membership.

The Association framework gives PS dischargers flexibility to find cost-effective ways to reduce collective nutrient discharge and meet the cap. Association members can trade freely among themselves to meet the collective cap. If the Association exceeds collective cap, they must fund NPS controls. In Phase 2, a buyer could choose to fund agricultural or non-agricultural NPS controls. The first 2 years of Phase 3 will target agricultural NPS controls, after which non-agricultural NPS will be reconsidered as an option.

The program reports annually to the state Department of Environmental Management (DEM).

Risk Allocation: The Association bears the risk to meet the collective cap. The State bears the risk to ensure Association payments get translated into NPS load reductions.

Cost of credit: Phase 1 cost of credit was $56/kg of nutrient. Phase 2 cost of credit reduced to $29/kg of nitrogen, its value to be revisited every 2 years. Cost was calculated based on removing 1 kg of nutrient per year via BMP, and includes a safety factor. In Phase 1, the Association made additional minimum payments to the BMP cost share program fund. Currently the credit life is 3-10 years, depending on the type of NPS control funded. Phase 1 credits were carried over to Phase 2. Phase 3 will set separate credit values for nitrogen and phosphorus, and fine tune the formula to calculate credit value.

Permits: The Association does not have a group permit. Instead it has a legally binding agreement with NC DWQ and EPA. Each discharger has a NPDES permit. Association members' permits do not include limits for nitrogen or phosphorus. Individual Association members' nutrient limits were waived since they are subject to a collective cap. PSs not in Association are subject to separate limits.

PS involvement: PS dischargers formed the Tar-Pamlico Basin Association in 1989 to meet goals of state nutrient strategy. This allowed the facilities to operate within a "bubble". 15 dischargers are now in the Association, equaling about 99% of all PS flows to the river. To date, the Association has paid about $1.2M through trading.

NPS involvement: Phase 2 included NPS reduction goals. Based on unsatisfactory results of NPS load monitoring, state established a set of required NPS rules addressing agriculture, urban stormwater, fertilizer management across all land uses, and riparian buffer protection. Farmer implementation of NPS rules is overseen by Basin Oversight Committee and Local Advisory Committee. Farmers were dissatisfied with the Phase 2 changes to trading program. The farmers disliked the required NPS reductions and NPS load accounting uncertainty, while the BMP cost share program received less money from the Association than in Phase 1 and the credit value decreased almost 50%. Phase 3 addresses the farmers' grievance by targeting the funding of agricultural BMPs and DSWC staffing as the main options available to a credit buyer. Funding of non-agricultural NPS controls will be revisited after 2 years of Phase 3.

NGO involvement: Discharger association Phase 1 trading proposal was endorsed by Environmental Defense Fund and Pamlico Tar River Foundation. Although these NGOs did not endorse Phase 2, they will endorse Phase 3.

Hot spot avoidance: DWQ reserves right to require nutrient removal of a facility to eliminate a hot spot.

Liability: Once PS have purchased credits, they are no longer liable. State assumes responsibility for monitoring and verification of BMPs.

Monitoring: PS dischargers conduct weekly sampling and annual reporting to DEM. NPS programs are reviewed every 5 years by DSWC. Soil and Water Conservation District inspect at least 5% of contracts annually.

Sources

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Neuse River Basin program – Nitrogen Trading

Details

Watershed area: 6192 sq miles

Land cover: 8% urban, 23% agriculture, 56% forest, 10% water

Population density: 211 persons/sq. mi.

Problem: Excess nutrient loading and eutrophication; Need to reduce TN loading to Neuse River Estuary

Pollutants traded: Nitrogen

Accomplishment: Compliance Association of PS dischargers has met its collective nitrogen cap at lower cost than command and control approach; Larger facilities reduced N loads by approx. 50%.

TMDL: Phase II TMDL for TN in Neuse River estuary approved in 2002. Set allocations for each PS in the watershed, using transport factors based on distance from each PS to endpoint.

Trading framework: Like the Tar-Pamlico program, the main feature of the Neuse program is more like an exceedance tax on a group of dischargers than a direct trading program. Compliance Association members can informally trade point to point with each other to meet the collective TN cap. If the Association exceeds their collective cap for TN, they must make offset payments to the Wetlands Restoration Fund, representing an indirect PS/NPS trade. Association members can also trade directly with non-member PSs. Annual report includes detailed summary of all Association transactions.

Risk Allocation: The Association bears the risk to meet the collective cap. The State bears the risk to ensure Association payments get translated into NPS load reductions.

Cost of credit: $11/lb of nitrogen per year, representing a 2:1 trading ratio compared to least cost-effective nutrient BMPs. “New and expanding dischargers that acquire allocation must pay 200% of that rate and purchase 30 years’ allocation prior to applying for an NPDES permit” [Breetz (2004) et al., p.222].

Permits: Compliance Association of PS dischargers was established in 2002. Association has 22 members, as of 2002. Association received a NPDES permit in 2003 which sets a collective cap for TN load to the estuary. If the Association exceeds the cap, it must make offset payments to the Wetlands Restoration Fund. This offsets intensifying land development in the watershed.

Association members have individual TN allocations. A member is in compliance: if the Association does not exceed the cap, or if the Association does exceed the cap but the member has not exceeded its individual allocation. A member is in non-compliance and subject to State enforcement if: the Association exceeds the cap, and that member has exceeded its TN allocation. Regardless of cap exceedance, Association internally charges penalty fees to any member who exceeds its individual TN allocation, on a scale which increases annually.

Members continue to have NPDES permits for other parameters.

PS involvement: PS dischargers formed the Compliance Association to meet a collective TN cap, which is the sum of their individual TN allocations. Individual TN allocations are based on a transport factor, which considers distance of the PS to the estuary. Association members can either trade internally, or trade directly with non-member PSs. New or expanding dischargers can either negotiate allocation purchases from other PSs, or make offset payments to the Wetlands Restoration Fund at 200% the rate.

NPS involvement: Landowners voluntarily participate in the Wetlands Restoration Fund. Agricultural BMPs are not eligible for trading within this program. Trading with farmers was not authorized because of concern they could not meet their own 30% NPS reduction requirement and generate excess credits to sell.

NGO involvement: Involvement of Neuse River Foundation and Neuse Riverkeepers, both environmentalist organizations.

Hot spot avoidance: TMDL is based on improving water quality at the endpoint, the estuary. The TMDL sets transport factors for each PS. This establishes water quality equivalence parameters that only target water quality at endpoint. Hot spots could theoretically occur *between* the PS and endpoint, despite water quality being met at the endpoint.

As a solution, DWQ will continue observing the watershed and use adaptive management to compensate for TMDL uncertainty, in order to mitigate potential hot spots. In addition, the Association mechanism to penalize members who do not meet their individual allocations serves to avoid hot spots.

Liability: Association members are not liable for other members' non-compliance. State is responsible for ensuring Association offset payments result in NPS nitrogen reduction. In addition to offset payments, the Association is subject to penalties and other enforcement action for any exceedance.

Monitoring: Association members submit monthly DMR reports to DWQ. Association submits mid-year, year-end, and five-year reports.

Sources

Breetz HL, Fisher-Vanden K, Garzon L, Jacobs, H, Kroetz K, Terry R; Dartmouth College (2004). 'Water Quality Trading and Offset Initiatives in the US: A Comprehensive Survey'. Available at http://www.dartmouth.edu/%7Ekfv/waterqualitytradingdatabase.pdf

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Long Island Sound (CT) Nitrogen Trading Program

Details

Watershed area: Entire state of Connecticut; approx. 5000 sq. miles. (The Long Island Sound watershed comprises several states, but only CT is part of this trading program).

Land cover: Highly urban and suburban

Population density: approx. 620/sq mile

Problem: Hypoxia conditions, algal blooms in Long Island Sound due to excess nitrogen discharges from WWTPs.

Pollutants traded: Nitrogen

Accomplishment: Successful use of watershed permitting. EPA considers this a model program. In 2002-2003 the state purchased about $1.75 million in credits. Very few personnel run the program. The state expects to save $200 million, or 20%, over the life of the program by removing nitrogen via trading vs. command and control approach.

TMDL: TMDL to achieve Long Island Sound standard for DO approved in 2001. Nitrogen targeted as limiting nutrient causing algal blooms.

Trading framework: A declining cap for TN over 15 years sets the framework for annual PS allocations of TN in pounds/day. 79 WWTPs have individual TN allocations based on their percentage of the total load, and an equivalency factor which relates the plant distance to the endpoint. The equivalency factor makes nitrogen reductions closer to hypoxic zones more valuable. Thus, WWTPs with more unfavorable discharges are encouraged to remove nitrogen beyond their permit requirements and sell the credits.

The Nitrogen Credit Advisory Board, appointed by the state, oversees the program. WWTPs that discharge less than their allowance sell their credits to the Nitrogen Credit Exchange Program; WWTPs which discharge more than their allowance must purchase credits from the Nitrogen Credit Exchange Program.

Credits are bought and sold on an annual basis. TN allocations are also set annually.

The federal Clean Water Fund (CWF) is a critical resource for a system of state revolving loans and grants, which funds the construction of nitrogen removal upgrades for certain WWTPs. These upgrades are necessary to meeting the declining cap of nitrogen loading. Trading allows more flexible and efficient use of these funds. Reliable

CWF availability, along with trading, are both necessary to achieve the program's nitrogen targets.

Risk Allocation: State bears risk of paying out money. Dischargers bear risk of paying out money.

Cost of credit: CTDEP resets the cost of a credit annually. Price is based on capital and O&M costs of nitrogen removal each year, determined from annual review of plants' performance. Regarding credit life, credits do not carry over to the next year.

Permits: The basis is a watershed permitting approach. The state passed a rule (Public Act 01-180) which created the authority for a general permit. Subsequently, the General Permit took effect in 2002. The General Permit acts as an umbrella for WWTP nitrogen requirements; it replaces the need for separate and far more complex permits for each WWTP. The General Permit sets annual nitrogen limits for each WWTP, below its TMDL waste load allocation to ensure TMDL compliance, over a 5 year period. The General Permit outlines the requirements to buy or sell credits based on the WWTP's equalized nitrogen loading.

PS involvement: 79 WWTPs

NPS involvement: No current NPS involvement in trading. NPS nitrogen removal is currently considered more expensive than from PSs. TMDL does specify a goal of 10% NPS nitrogen reduction. As program continues, the price of PS credits is expected to rise. At that point trading with NPS may become favorable.

NGO involvement:

Hot spot avoidance: TMDL is based on improving water quality at the endpoint, the estuary. The TMDL sets transport factors for each PS. This establishes water quality equivalence parameters that only target water quality at endpoint. Hot spots could theoretically occur *between* the PS and endpoint, despite water quality being met at the endpoint.

As a solution, the State reserves the right to revoke or modify a PS's authorization under the General Permit for reasons necessary to protect human health or the environment, or to implement the TMDL. There is also a priority to use federal funds for nitrogen removal in distressed communities. Finally, the use of the NCAB instead of a free market is meant to protect poorer communities.

Liability: Any plant that exceeds its allocation and does not purchase credits is subject to enforcement.

Monitoring: WWTPs monitor and report flow and effluent on a regular basis. CTDEP inspects each of the General Permit plants at least once per year.

Sources

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Kalamazoo River Phosphorus Trading Demonstration Program (1997-2000)

Details

Watershed area: 2000 sq miles

Land cover: 57% cropland and pasture, 21% forest, 3% wetland, 8% urban, and 11% other.

Population density:

Problem: Local paper mill was seeking to expand while controlling treatment costs and discharge. State was concerned that increased phosphorus discharge would further impact a hypereutrophic lake downstream.

Pollutants traded: Phosphorus

Accomplishment: No actual trades occurred primarily because the main PS discharger, the paper company, went out of business. However the project did establish a trading framework, and implement voluntary NPS reductions.

TMDL: The trading program preceded the TMDL, which was completed in 2002.

Trading framework: This was a demonstration trading project which ran from 1997-2000. A Steering Committee directed the project. The Committee was composed of representatives from government, industry, agriculture, and environmental NGOs. The committee acted as a clearinghouse and banked all NPS credits. PS/NPS trades were essentially indirect because all trades were routed through the Committee.

Point-nonpoint trading: PSs purchased credits from the Committee by funding BMPs at a 2:1 trading ratio. A farmer had to meet minimum agricultural management standards to be eligible for the program, otherwise improvements to meet those standards were traded at a 4:1 ratio. Point-point trades had a 1.1:1 ratio.

An NPS landowner needed approval from the Steering Committee to receive funds for BMP implementation. The approval process was lengthy and took between 1-6 months.

Risk Allocation: The use of Service Agreements (see ‘Liability’ below) fairly allocates risk between the NPS and Steering Committee.

Cost of credit: Credit value was calculated based on trading ratio, cost per pound of phosphorus removal, and amortizing for the BMP life span.

Permits: PSs could purchase credits to accommodate growth but not to exceed their NPDES discharge limits. Point source use of the credits is at their discretion and must be accommodated through an NPDES permit modification prior to use.

PS involvement: Paper company, municipal discharger, and other small PSs.

NPS involvement: Farmers implementing agricultural BMPs and landowners installing streambank restoration controls. Farmers were generally reluctant to participate because they did not trust regulators, feared being targeted as polluters, and resisted making voluntary changes that might later become required. Steps which partially overcame this included informal meeting with farmers on the Steering Committee, providing anonymity through identifying sites by location rather than farmer's name, and using recognized and trusted agriculture contacts to work with the farmers.

> Approaches that stress what is in the best interest of the farm, the farmer and the landowner are likely to be well received. Anything else will be typically viewed as inappropriate and thus not likely successful. Agricultural improvements, potentially funded through outside sources, can provide financial benefits to on-farm operations as well as credits that become a marketable commodity. Commodities are well understood by agriculture. Publicity (good or bad) for the farming community, however, tends to make producers shy away from programs that are regulatory in nature, especially as they may pertain to their operations and defined environmental impacts. Private contracts with trading credit users, rather than the inclusion of the farmer in a point source permit, are a much preferred approach for agriculture to participate in trading (http://www.envtn.org/programs/kazoo.htm).

NGO involvement: Local environmental groups, and agriculture advocacy group

Hot spot avoidance: By not allowing PSs to exceed permitted discharge limits, there was no risk of hot spots. Additionally, trading was restricted to selected reaches of the Kalamazoo River whereby point source use of credits would not result in hot spots.

Liability: Payment for point-nonpoint trades were made in 3 stages per a Service Agreement, in order to verify actual implementation of the BMP. If the NPS partner failed to comply with the Service Agreement, they would have to refund the money to the Steering Committee. The Service Agreement was written simply but clearly to establish accountability between each participating NPS partner and the Steering Committee.

Monitoring: Agricultual BMP monitoring performed by the Natural Resource Conservation Service (NRCS); water quality monitoring performed by an environmental consulting company.

Sources:

Breetz HL, Fisher-Vanden K, Garzon L, Jacobs, H, Kroetz K, Terry R; Dartmouth College (2004). 'Water Quality Trading and Offset Initiatives in the US: A Comprehensive Survey'. Available at http://www.dartmouth.edu/%7Ekfv/waterqualitytradingdatabase.pdf

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Section 2 -

Trading Unused Capacity,
and Reasons Not to Regulate Discharge Concentration in a Trading Program

The problem of trading unused capacity is directly linked to the problem of establishing WWTP wasteload allocations. These problems must be addressed before proceeding to study various trading scenarios. A trading scenario is built on the assumption of certain allocations; how these allocations are set, particularly over a phase-in period, merits scrutiny.

It is also important to state up front that while NJDEP is considering having a total phosphorus (TP) concentration limit for each WWTP, the other two trading programs described below did *not* have concentration limits; only load limits were regulated and used for trading. The possibility of NJDEP regulating both concentration *and* load has negative implications for trading which will be stated later on.

Let us first define the problem of trading unused capacity, and then compare how the Long Island Sound (LIS) and Lower Minnesota River (LMR) trading programs addressed it, before considering options for the Passaic trading program.

What is meant by "trading unused capacity"? There are two scenarios associated with trading under a load-based cap, in which unused capacity could be used for profit or inaction.

Scenario 1: WWTP has a wasteload allocation (e.g. 1000 lbs of total phosphorus/year). The allocation is calculated based on *permitted* flow and a concentration target. Suppose the WWTP average flow is typically only 50% its permitted flow. If the WWTP meets its concentration target, it has only discharged 50% of its load allocation. So it has 50% of its allocation to sell as credits, even though it is only meeting its concentration target, and not discharging under its concentration target. Its unused capacity is the cause of its credits.

Scenario 2: Alternatively, the same WWTP in Scenario 1 could discharge at twice its concentration target, and still meet its wasteload allocation. In this case however it would violate its concentration limit, *assuming there is such a limit*.

How did the LIS and LMR trading programs address trading unused capacity, and the setting of wasteload allocations?

The Connecticut Long Island Sound system:

Only load is regulated, concentration is not; i.e., each plant has a lbs/day limit and no mg/l limit. Each plant's wasteload allocation is based on its average flow over 3 yrs (1997-1999 for each plant). Every wasteload allocation is proportional to the plant's average flow. However, its wasteload allocation is based on its *equalized* load to western Long Island Sound. Equalized load is a function of plant location and discharge attenuation. The discharge from plants located farther from the critical area (western LIS) is attenuated more than the discharge from plants located near the critical area. Therefore, two WWTPs with equal average flow - but different attenuation factors (due to different locations) - will receive the same TMDL *equalized* allocation; however their actual end of pipe allocations will **not** be the same; they will differ according to their attenuation factors. So the more distant WWTP can discharge at higher concentration than the nearer WWTP and still meet its discharge load requirement; concentration itself is not regulated.

Each plant's allocation is phased in at the same rate over the 15 year period.

The equity of this system is that plants of the same average flows get the same (*equalized*) allocations. The inequity is that **each plant effectively has a different target for discharge concentration**. The downstream plants, closer to western LIS, must discharge at lower concentrations to meet their load requirements.

The Lower Minnesota River system:

This also uses a phased in approach, but over 10 years instead of 15 years as in LIS.

As in LIS, the pollutant of concern (TP) is regulated by a general permit. The general permit only requires limits for load discharge; there are no limits for discharge concentration. The exception is that if a WWTP has an existing individual permit for concentration, that requirement remains in force in addition to its requirements under the general permit.

Method for calculating TMDL allocation: Each plant's allocation is based on meeting a 1.0 mg/l target at 75% of its wet weather design flow, or 5% above its dry weather design flow – whichever flow is higher. In contrast to LIS, allocations are not based on average flows, and allocations are based on WWTPs meeting the same concentration limit (1.0 mg/l).

The equity of this system is that plant allocations are based on meeting the same concentration limit (1.0 mg/l). The inequity is that allocations are not based on actual average flows, therefore trading unused capacity is possible. For example, suppose there are two plants that both discharge at 1.0 mg/l; one "low flow" plant operates at 50% of its wet weather design flow and the other "high flow" plant operates at 75% of its wet weather design flow. Because allocations are not based on average flows, the "low flow" plant has credits from unused capacity below 75%; the "high flow" plant is at 75% capacity and has no credits. Furthermore, because the general permit only regulates load and not concentration, the low flow plant can discharge at higher concentration than the high flow plant, and still be in compliance.

Another inequity of this system is that each plant's allocation is **not** phased in at the same rate over the 10 year period. Differences in plant technology receive consideration for at what rate each WWTP allocation is phased in. Effectively, every plant has the same formula for its allocation at Year 10; but different formulas are applied for each plant in Years 1-9.

Where does this leave us with Passaic trading?

Assumptions regarding the Passaic TMDL and discharge permitting:
1. The ultimate WLA, i.e. WLA at conclusion of TMDL phase in, for each plant is based on permitted flow and the same long-term average (LTA) concentration of 0.4 mg/l.
*The "ultimate WLA" is derived from modeling using *current* permitted flows. Therefore, a plant would not benefit by lobbying for a higher permitted flow; that would in turn decrease its concentration LTA.

2. NJDEP is currently aiming to regulate discharge concentration. This differs from LIS and Lower Minnesota where load but not concentration is regulated. **Trading will not work if NJDEP regulates discharge concentration; only load should be regulated**. **Examples 1-2c below will illustrate this point**.

Example 1: The TMDL cap is based on <u>permitted</u> flow, and a uniform LTA of 0.4 mg/l. Each plant is *permitted* to discharge at LTA of 0.4 mg/l. Additionally, each plant has a *permitted* annual load of total phosphorus, which functions as a cap for trading.

Suppose there are 2 WWTPs, both with the same permitted flow. WWTP #1 operates at 50% its permitted flow and discharges at LTA of 0.4 mg/l. WWTP #2 operates at 100% of its permitted flow and discharges at LTA of 0.4 mg/l.

<u>Problem A</u>: WWTP #1, by virtue of having unused capacity has an advantage over WWTP #2.

Add to this a WWTP #3. WWTP #3 has the same permitted flow as WWTPs #1 and #2. However, WWTP #3 operates at 50% of its permitted flow and discharges at LTA of *0.8* mg/l. In terms of its load permit, WWTP #3 is in compliance, however it is not in compliance with its concentration limit. In other words, WWTP #3 is meeting its load cap, but is in noncompliance due solely to its violation of a concentration limit.

<u>Problem B:</u> How many credits would WWTP #3 have to purchase? There is no answer; after all, it is meeting its load cap.

What if the WLAs were based on average flow instead of permitted flow? How would that change the situation? This is the focus of Example 2.

Example 2: The WLA for each plant is based on <u>average</u> flow (e.g., measured over 2000-2006), and a uniform LTA of 0.4 mg/l. Each plant is *permitted* to discharge at LTA of 0.4 mg/l. Additionally, each plant has a *permitted* annual load of total phosphorus, which functions as a cap for trading.

Suppose there are 2 WWTPs, both with the same average flow. Both discharge at 0.4 mg/l. In this case, both are in compliance with their load and concentration permits. In contrast to Example 1, WWTP #1 no longer has an advantage of trading unused capacity over WWTP #2, because each plant's cap is based on average flows. Each plant would have to reduce their discharge concentrations to below 0.4 mg/l LTA to generate credits.

Problem A is solved.

What about Problem B?

Add to this a WWTP #3. WWTP #3 has the same average flow as WWTPs #1 and #2. However, WWTP #3 discharges at LTA of *0.8* mg/l. WWTP #3 is in noncompliance with both its load and concentration limits. WWTP #3 is not meeting its cap, and needs to purchase credits. How many credits would WWTP #3 have to purchase? Enough to offset its discharge by 0.4 mg/l LTA. So, Problem B *appears* to be solved, by way of introducing a cap for each plant based on average flow. But in fact Problem B is not solved, as illustrated by the following example:

Example 2b: Just as in Example 2, the cap for each plant is based on average flow, and uniform LTA of 0.4 mg/l. Each plant is *permitted* to discharge at LTA of 0.4 mg/l. Additionally, each plant has a *permitted* annual load of total phosphorus, which functions as a cap for trading.

Example 2 assumes that each plant discharges at exactly its average flow. But that almost never happens; the average flow is just a number. Suppose that 2008 is a dry year. And in 2008, WWTP #3 operates at 50% of its *average* flow, and discharges at LTA of 0.8 mg/l. We are back to square one with Problem B. WWTP #3 is in compliance with its load limit, but in noncompliance with its concentration limit. There is no way to calculate how many credits it needs to purchase.

Example 2c: One suggestion to resolve the problem in Example 2b might be - Rather than base the WLA of each plant on its average flow as measured over an *extended* period such as 2000-2006, instead base the WLA on its *updated* average flow. In other words, in 2008 each WWTP should have a load limit based on its average flow in 2008, and a uniform LTA of 0.4 mg/l. And in 2009, each WWTP should have a load limit based on its average flow in 2009, and so on. Only in this way could load *and* concentration permitting be conducive to trading.

Problem C: The problem with this approach is that it deters efficiency and encourages growth. The higher the flow a WWTP discharges, the higher its load limit will be, *provided all plants are permitted at the same LTA concentration.* This approach is also problematic in long-term planning for NJDEP; they cannot easily set targets over a 5-year horizon if the load limits are subject to annual revision.

As seen in the LIS and LMR trading program descriptions and Table 1 below, **some type of inequity is inevitable** in setting wasteload allocations that potentially affect trading of unused capacity. The question is which types are acceptable and unacceptable. Our goals are a system where the WLAs are based on a uniform LTA concentration and where trading unused capacity is reduced.

A system that might work in the Passaic

Imagine that the TMDL cap is phased in over 15 years. In Year 15, at the conclusion of phase-in, each WWTP's allocation is based on its permitted flow and an LTA of 0.4 mg/l. How should the cap be set in the interim Years 1-14? For Years 1-5, the cap could be based on average flow from 2000-2006 and a uniform LTA of 0.75 mg/l. For Years 6-10, the cap could be based on flow midway between average flow from 2000-2006 and permitted flow, and a uniform LTA of 0.6 mg/l. In Years 11-14, the cap could be based on permitted flow and an LTA of 0.5 mg/l. The exact numbers would need to be refined. The point is that the overall cap will steadily decline over Years 1-15, concluding in the cap set by the TMDL. In each year, the allocation of each plant will be based on a uniform LTA concentration, as well as a standard approach to considering flow in allocation determination. Trading unused capacity will be reduced by basing allocations on average flows, wholly in Years 1-5 and partially in Years 6-10. Trading is compatible with this system, provided only load is permitted; permitting of concentration will not work due to the reasons cited in Problems B and C above. Use of the uniform LTA concentration is only a *guideline* to setting annual load allocations, and not meant to be a regulated amount. (Discharge concentration monitoring would still be conducted in order to report discharged load. In addition, regulated limits could be set for extreme instances of high concentration discharge, e.g., any discharge sample greater than 5 mg/l penalizes a WWTP's credits by 10%.).

The inequity in this system is: The share of each WWTP's allocation in the overall cap in Year 15 will not match the shares in Years 1-10. This is because every WWTP has a different percentage of its permitted flow that is being utilized for average flow. So if the TMDL determines that WWTP #1 has an allocation of 20% of the overall cap, based on its average flows that share could be lower or higher than 20% in Years 1-10.

A second inequity involves the case where a WWTP has expanded capacity through local municipal funds, and not through state funds. In this case, the WWTP is unfairly penalized by not being able to trade unused capacity in Years 1-5. However, it could begin to trade unused capacity, partially in Years 6-10 and wholly in Years 11-15, according to the proposed Passaic phase-in scheme above.

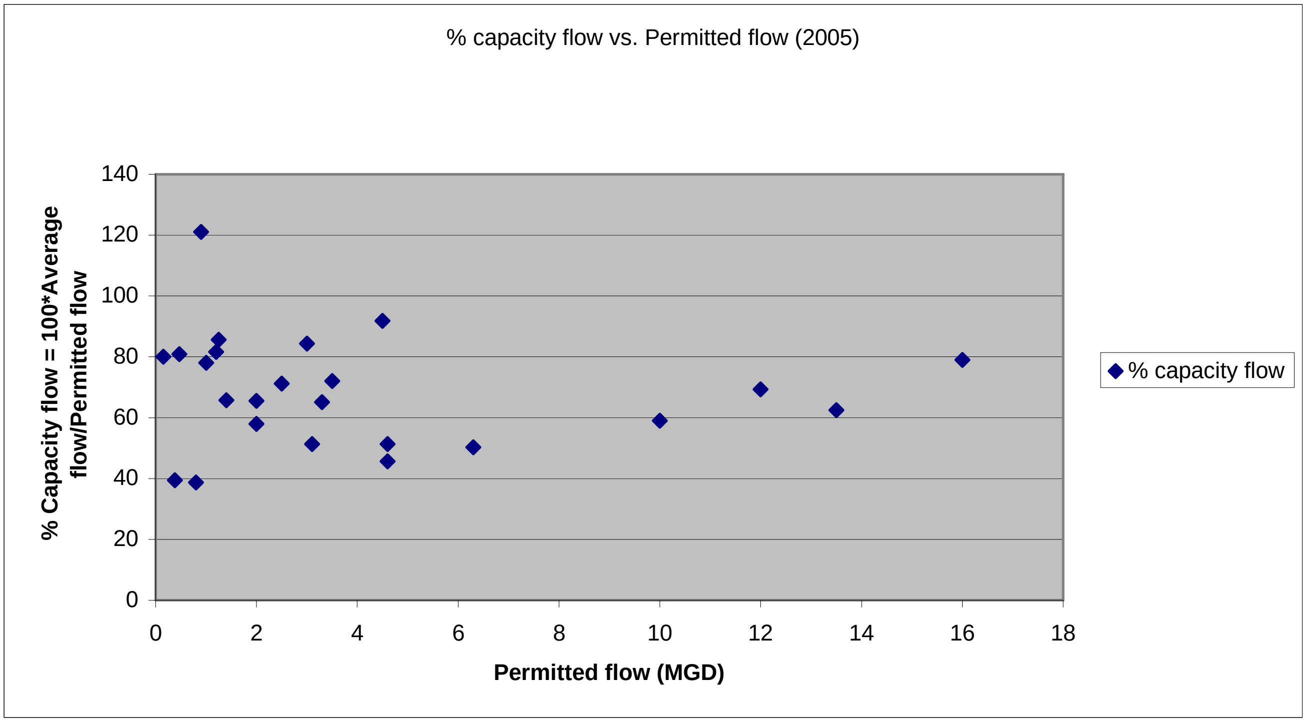
Table 1: Methods for Establishing WLAs (inequities highlighted in **bold)**

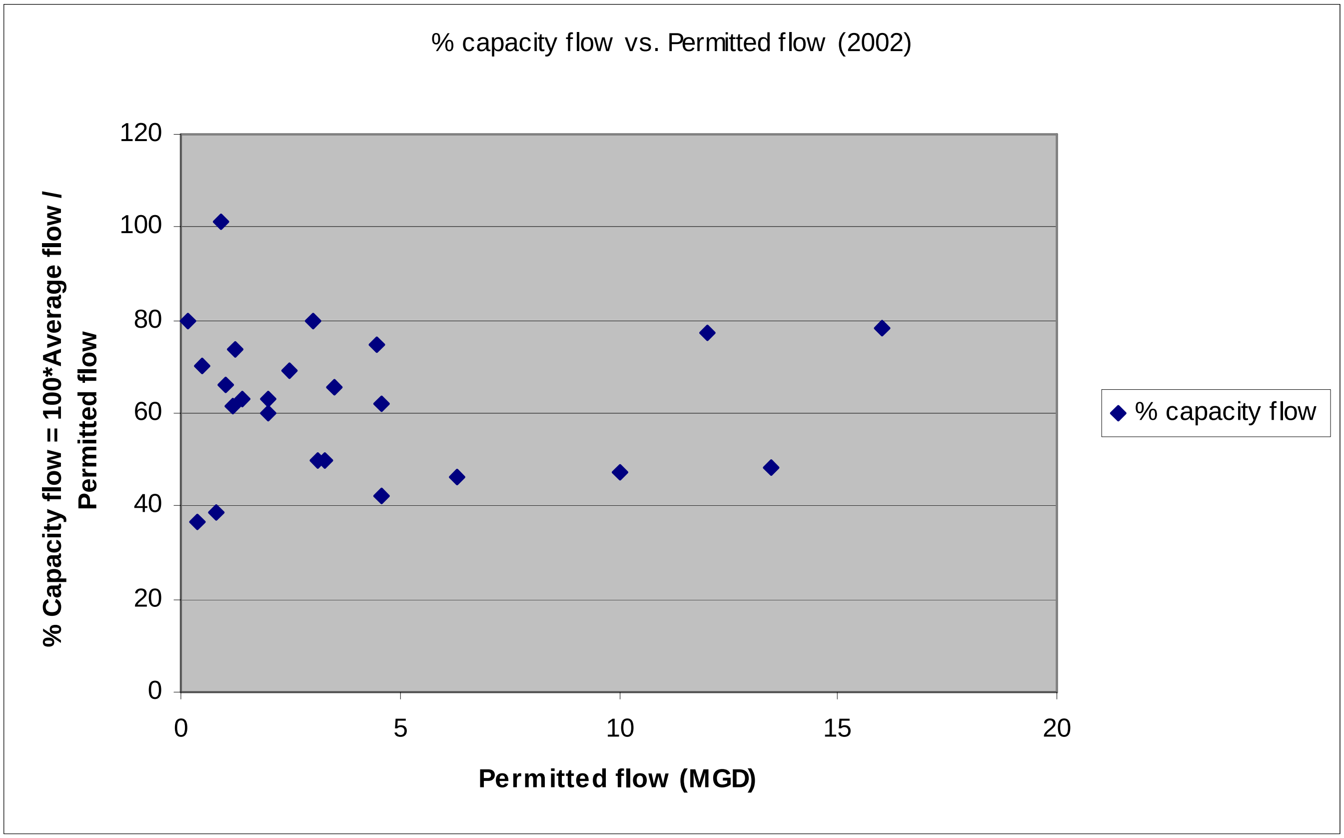
Trading program	*Flow*	*Discharge concentration*	*WLA as share of TMDL cap*
Long Island Sound	Based on average flow of each WWTP	**Different LTAs for each WWTP**	Consistent throughout phase-in period
Lower Minnesota River	Based on standard formula applied to each WWTP	Same LTA target for each WWTP	**Each WWTP allocation phased in at different rate**
Passaic River	Evolves from average flow to permitted flow over phase-in period?	Same LTA target for each WWTP?	**Each WWTP share of overall cap will fluctuate throughout phase-in?**

Appendix

Is unused capacity a real issue in the Passaic?

The graphs below show that there is wide variation in usage of capacity among the 24 main WWTPs. Percent capacity flow varied from 39% to 121% in 2005 and from 39% to 101% in 2002. Unused capacity is a real issue in this watershed which could provide major advantages to some WWTPs in a trading program.




% capacity flow vs. Permitted flow (2002)
% Capacity flow = 100*Average flow / Permitted flow
Permitted flow (MGD)
% capacity flow
0
20
40
60
80
100
120
0
5
10
15
20

Section 3 -
Communicating model uncertainty to the public

1. Introduction

The use of environmental models to inform policy and regulatory decisions in the U.S. has increased vastly in the past 25 years. Exponential growth in computer technology capability and data availability, combined with an increased understanding of environmental processes have allowed regulators and other stakeholders to further analyze the linkages of complex environmental problems and proposed policy options through the lens of environmental models. With respect to water pollution, the demand for water quality models has risen in response to the trend away from technology based standards toward water quality based effluent limits, and the need to develop numerous TMDLs (NRC, 2007).

Uncertainty analysis of environmental models plays a critical role in the dialogue between scientists and other stakeholders. As the influence of environmental models continues to grow and gain importance, the need for scientists to analyze and communicate about model uncertainty to other stakeholders becomes critical in maintaining or building trust in scientific findings.

2. Perspectives on models

The importance of communicating model uncertainty has become more apparent. The contemporary shift in environmental policy making from top-down decision making toward more stakeholder involvement in decision making has affected a change in the perception of what it takes to trust a model. “This not only involves the elements of model evaluation but also who will have a legitimate right to say whether they can trust the model and the decisions emanating from its application" (NRC, 2007, p.106). Communicating model uncertainty is very relevant to multi-stakeholder deliberations.

A related trend has been the change in perspectives on environmental models, especially within the modeling community. The perception of models has begun to transition from giving answers to offering insights. This reflects the acknowledgment that no matter how much more sophisticated modeling becomes, there can never be a perfect model that provides "the truth". Models, as abstractions of reality, fundamentally have uncertainty (NRC, 2007).

Two paradigms of models are present and in conflict amidst this period of transition. The first and newer paradigm regards the purpose of models as tools for deliberative problem solving among disparate stakeholders. In this paradigm, model uncertainty is an inevitable feature that needs to be explained. Model uncertainty does not necessarily undercut model reliability. Model evaluation centers on how well the model aided the problem solving process rather than its level of accuracy (Fisher et al., 2006). The fitness of a model's use is less dependent on eliminating uncertainty and more dependent on the transparency with which stakeholders reach decisions based on uncertain information (USEPA, 2003). In contrast, the second and older paradigm holds that the purpose of modeling is to prove that a regulation is supported by "sound science". According to this paradigm, model uncertainty is an undesirable feature that challenges the model's reliability and must be reduced. The model is primarily evaluated according to its level of accuracy. Modeling is strictly a scientific exercise in which public participation is inappropriate (Fisher et al., 2006).

3. Uncertainty in the science and policy arenas

There are differing views on the public reaction to model uncertainty. According to Fisher et al. (2006) the dominance of the latter paradigm has built an unrealistic public expectation that a scientifically sound model contains no uncertainty, and any sign of uncertainty is a flaw that renders the model unreliable and unfit for use. In a larger sense, DeClercy (2005) points out that the public expects its leaders to convey certainty on issues that affect them. In contrast, Frewer (2004) argues that "elite groups in the science and policy community have underestimated the ability of non-experts to understand uncertainty" (p. 394). These groups have acted under the assumption that information on uncertainty would increase public distrust in science and scientific institutions, and cause panic and confusion on the issue. However, Frewer et al. (2002) argue that the converse appears to be true; when information on uncertainty is withheld, the public is skeptical and distrusts the motives of regulators and scientific advisors. Communicating about uncertainty can actually increase the credibility of the communicator, which in turn reduces perceived risk (Frewer, 2004).

When uncertainty is considered, the fundamentally different contexts of science and policy can cause different responses to it. Science and policy have different 'evidentiary standards'. Depending on the situation at hand and the perceived costs of being wrong, the policy maker may employ either stricter or looser evidentiary standards than the scientist. Consequently, a policy maker might misinterpret the degree of certainty reported by the scientist; the scientist might fail to report information that could be useful to the policy maker, or even withdraw from confronting uncertainty so as not to lose the confidence of the policy maker. Ultimately the response to uncertainty involves a debate about public values that scientists, who tend to bias toward considering themselves objective, are susceptible to being unaware of (Kinzig and Starrett, 2003).

There are several reasons why environmental regulatory agencies might seek to avoid analyzing or reporting model uncertainty. Once uncertainty is acknowledged, stakeholders could expect that models be updated regularly as new information is learned and that regulatory decisions be modified accordingly (NRC, 2007). Model uncertainty could paralyze policy actions if some stakeholders seek to delay a decision until more information is gathered. Some environmental officials have worried that if environmental model uncertainties are reported more often than uncertainties in other sciences, the public might get the wrong impression that environmental issues contain more uncertainty. Other officials express concern that uncertainty can be used as an excuse to avoid giving definite answers (Wardekker et al., 2008). Finally, the acknowledgment of model uncertainty could expose the agency to legal challenges, although in the U.S. the courts have generally sided with the agency on such challenges and explicitly recognized that models are simplifications of reality and do not require perfect accuracy to support a regulatory decision (McGarity and Wagner, 2003).

There are however compelling reasons that an agency should report model uncertainty. It promotes transparency and accountability through providing stakeholders with an assessment of the degree of confidence associated with model results, as well as information about which aspects of the model have the largest impact on its results (NRC, 2007). It is responsible policy and good scientific practice to report model uncertainty when decisions are made based on limited scientific knowledge (Pascual, 2005; Wardekker et al., 2008). Misrepresentation of model uncertainty can lead to hugely embarrassing and damaging outcomes if and when the truth is exposed (Janssen et al., 2005). Finally, if important decisions that affect the public are made based on the information provided by models, it obstructs the democratic process to exclude information concerning model uncertainty (NRC, 1996).

4. Effective communication of model uncertainty

Once a scientist or agency decides to report its findings on model uncertainty, the effective communication of those findings is critical. If not done properly, other stakeholders could get confused by the information or lose confidence in the overall analysis, thereby complicating the decision making process (NRC, 2007). Effective communication of model uncertainty is vital when dealing with legal challenges to the model (Pascual, 2005). It also serves the broader purpose of building public trust in science through countering the prevailing trend of insulating scientific discourse from the public (Patt and Dessai, 2005). Interestingly, early communications from the Intergovernmental Panel on Climate Change (IPCC) to decision makers explicitly neglected to mention probabilistic results because they assumed the audience could not understand that type of information. This damaged the IPCC's credibility and later efforts have completely turned around with full disclosure of uncertainty deemed essential (Patt and Dessai, 2005).

Effective communication of model uncertainty depends first on identifying the target audience. Knowledge of their concerns, needs, comfort with technical information, and the overall policy context will shape what information is essential to include and what can be left out (Krupnick et al., 2006). Key elements to communicate include the basic model concept, model assumptions and limitations, a history of the model development and evaluation process, quality of the data used, the sources of uncertainty, the probabilities of various outcomes, and the likelihood and impacts of reducing uncertainty (Frewer, 2004; NRC, 2007). Acknowledgement should be made of what is known and not known and the consequent policy implications. Comments on the rigor of the uncertainty analysis, and mention of any similar studies should be given. The information should be conveyed in a simple and concise manner that uses plain language, avoids abstractions and technical jargon, and offers clear graphs and tables (Sandman, 1987a; USEPA, 2003). Web-based tools are a promising way to promote widespread and interactive means of understanding model uncertainty (NRC, 2007).

The manner in which uncertainty is presented affects how it is perceived and can influence decisions. “An option framed in terms of its probability of success is seen as more attractive than the same option presented in terms of its complementary probability of failure” (Krupnick et al., 2006, p. 173). Fox (1984) recommends giving a narrative containing qualitative assessments with quantitative technical support. Graphs and tables can be helpful if designed thoughtfully. Krupnick et al. (2006) reports that box and whisker plots, CDF plots, and PDF plots perform well with decision makers, while area and volume plots should be avoided. Depending on the audience, Finkel (2002) suggests giving a point estimate such as the median or 90th percentile rather than the entire PDF.

There are different opinions on whether verbal or numeric terms are more effective for communicating uncertainty. In addition to providing graphs, the IPCC (2001) used a seven point scale of verbal terms such as ‘likely’ and ‘very likely’ to distinguish levels of certainty. Words are easier to remember than numbers, however the disadvantage is that people subjectively define terms such as ‘likely’ or ‘very likely’ (Wardekker et al., 2008).

Comparisons can be an effective means of communicating uncertainty by helping to make the idea of probability less abstract (Patt and Dessai, 2005). Sandman (1987a) cautions that when making risk comparisons, the source of the risk comparison must be credible, the overall situation should not be heavily laden with emotion or hostility from stakeholders, the comparison must be conveyed with the intention of clarifying the issue rather than minimizing or dismissing it, and the comparison should acknowledge that factors other than relative risk are important.

The process through which communication takes place is vital to success. The most important, most obvious and yet easiest to ignore aspect of communication is that it is a two-way process. Early efforts at risk communication failed largely because scientists and agencies directed the public without being open to dialogue. Thus public values were not considered in expert assessments of risk and the public increasingly ignored their advice (Patt and Dessai, 2005). Attitudes have shifted somewhat. Several high profile reports (e.g., NRC (1994, 1996, 2004, 2007), CRAM (1997a,b)) have been released which espouse the merits of stakeholder involvement throughout the problem solving process in achieving effective communication. However if progress is to be judged by the state of adaptive management, a field that heavily advocates stakeholder involvement, major changes in social and institutional norms need to occur before agencies meaningfully collaborate or share power with diverse stakeholders from the beginning to end of a problem solving process (Allan and Curtis, 2005).

5. Lessons from risk communication: Outrage management

Risk assessment typically accounts for both the probability and severity in consequence of an outcome. For example, a highly severe highly probable event has more risk than an event of equal severity but less probability. The uncertainty analysis completed in this study is not a formal risk assessment, but its explicit consideration of the probability of outcomes and the magnitudes of difference between trade scenario and baseline outcomes has enough common ground with risk assessment that lessons from risk communication are relevant.

Practitioners of risk communication have come to realize that the public perception of risk is not just based on the technical data presented. Psychological factors can have a major influence on the perception of risk. For example involuntary risks tend to be overestimated while voluntary risks are underestimated (Sandman, 1994). Sandman (2003) uses the term "outrage" to describe the nontechnical component of risk; it refers to the assortment of nontechnical factors such as voluntariness, trust, control, fairness, dread, and responsiveness that combine to affect the overall perception of risk. "Outrage is the principal determinant of perceived hazard" (Sandman, 2003, p.26). It is such a real and important variable that Sandman (1987b) asserts that risk is the sum of hazard and outrage. Therefore successful risk communication consists of two tasks – to explain the technical risk and take actions to reduce the level of outrage. Sufficiently addressing outrage is a precondition to successfully conveying technical information on the hazard.

Water quality trading in the NTPRB is an issue that has provoked outrage among some local environmentalist NGOs. Judging from public comment #77 in the TMDL (NJDEP, 2008a) and an opinion expressed in a local media outlet (Tittel, 2008), their outrage stems from several factors. They claim that water quality trading will cause environmental harm, allow dischargers to get away with not upgrading pollution control technology, invite unrestrained and manipulative market forces to create economic and political inequities, and abandon the public to leave it unprotected. Outrage was also expressed at being excluded from the establishment of the trading system, the commoditization of a pollutant, and a distrust of government enforcement ability against violators. These complaints echo concerns in the literature about emissions trading (e.g., Solomon and Lee, 2000; Farrell and Lave, 2004; Berck and Helfand, 2005) pertaining to hot spots, threats to environmental justice, inequities, the immorality of commoditizing the environment, and market manipulation.

In a larger context, current political and economic conditions in the country might affect a wide-sweeping critique and reevaluation of water quality trading. Critics of water quality trading might argue that it is a Bush administration policy which seeks to deregulate environmental protection using a market-based approach. The severity of these charges would be amplified in light of the current financial crisis, which has increased public skepticism towards deregulation and unrestrained free markets. The lack of results in water quality trading activity nationwide, despite extensive efforts from EPA and USDA to promote it, renders WQT even more vulnerable to these potential charges. If these types of attacks are initiated, it would exacerbate the outrage of environmentalist NGOs opposed to WQT in the NTPRB.

Given these outrage factors, the communication of model uncertainty, i.e. the 'hazard' part of the risk equation, by itself will not be enough. Of course the communication of model uncertainty must be done effectively to prevent outrage from getting worse, but it cannot be the only component of a successful risk communication strategy.

Risk communication seeks a level of outrage that is commensurate with the level of hazard (Sandman, 2008a). In this case the hazard level is low, as demonstrated by Chapter 5 results which showed that under the most adverse conditions, there is no evidence to suggest that WQT in the NTPRB will lead to worse outcomes than a command and control approach that prohibits trading. Although the hazard level is low, the outrage level of some critics is very high. The risk communication strategy most appropriate to this situation is termed ‘outrage management’. Outrage management recognizes that when people are angry about an issue that is low in hazard, the problem is not that they do not understand the numbers, but rather are too angry or upset to calm down, trust the source that is conveying the technical information, and consider the data. In order to be listened to, the risk communicator must first do the listening and acknowledge why the stakeholder is entitled to be outraged. Only after the outrage is addressed can technical information be presented as trustworthy (Covello and Sandman, 2001). Essential outrage management methods include active listening, aiming for the middle ground position rather than the opposite extreme of the critic, acknowledging prior misbehavior and current problems, discussing achievements with humility, sharing control or at least being accountable, and subtly drawing out unvoiced concerns and motives (Sandman, 2008a).

It should be noted that the environmentalist NGOs who are opposed to WQT in the NTPRB may or may not represent a significant fraction of local environmentalist and citizen attitudes to the issue. Furthermore, WQT in the NTPRB appears to have the support of other stakeholders in the watershed, such as the WWTPs and NJDWSC. However, successful risk communication requires engaging with critics, no matter how intractable they may seem. If they are ignored rather than engaged, their outrage will grow and they will probably find other means to disrupt the process, such as broadcasting their views through the media and/or organizing other activists and citizens to support their cause. They may not be won over or convinced through engagement, but at least other stakeholders including moderate critics and neutral parties might perceive that the agency is making a serious effort at reasoned dialogue with its fiercest opponents, and thus be less likely to join the opposition (Sandman, 2003b).

6. Conclusion: Recommended strategy for a public meeting on water quality trading in the Non-Tidal Passaic River Basin

Applying the principles of outrage management and communication of model uncertainty might help NJDEP in its future public participation efforts on the Passaic water quality trading program. This section outlines a strategy for conducting a public meeting with outraged stakeholders and other groups. A public meeting is probably not the only form of outreach that NJDEP will spearhead. A more general public information campaign will also likely take place. However this section focuses on the public meeting component because that is where real outrage management can occur – and successful risk communication will be determined by successful outrage management.

Some of these steps might seem surprising, counterintuitive, or even naïve, especially given the long history of stakeholder conflict in this watershed. However, the impedance that outrage poses to risk communication is supported by an extensive body of research (e.g., Johnson et al., 1992; Sandman et al., 1993; Sandman et al., 1998), and the techniques of outrage management have been sought by a wide variety of public, private and non-profit organizations working in sectors such as biotechnology, petrochemicals, defense, law enforcement, mining, and public health (Sandman, 2008b). This should be kept in mind while reviewing the recommended steps below.

Since the purpose of the public meeting is outrage management, the target audience is the local environmentalist NGOs who are most outraged about the trading program. Other invitees should include moderate environmentalist NGOs and community leaders from poor and minority areas in the downstream portion of the watershed. If outrage management is executed effectively, the participation of the latter two groups at the meeting increases the chances that they will either remain neutral or side with the agency. Agency leaders should attend so that the audience will grasp how seriously their concerns are taken. Technical experts should attend, including Rutgers University professors that helped to design the trading program, in order to credibly communicate technical information. Agency personnel and technical experts should meet in advance to review their objectives and rehearse the messages they aim to convey. Supporters such as the WWTPs and NJDWSC should not be invited because they will probably disagree with the degree of empathy outrage management requires, and instead pressure the agency to fight back, further entrenching the conflict (Sandman, 2008a).

Ultimately the goal of the meeting is to listen to the outrage, seek to address it, and gain enough trust from enough participants that technical information describing the low hazard level can be received as objectively as possible.

NJDEP should consider allowing an outside facilitator to help conduct the meeting. Although many facilitators seek to avoid allowing a discussion where outrage is vented (Sandman, 2008a), for the purposes of this meeting, the facilitator should encourage venting of outrage before proceeding to guide a substantive discussion of the issues.

Be resigned to a long meeting. Trying to shorten the meeting implies there is something to hide. By allowing the audience to determine when the meeting will end, the agency shows that it takes their concerns seriously, and makes an important gesture of relinquishing control (Reeves, 2007).

The meeting should begin by letting the critics vent their outrage. Agency personnel should listen, empathize, and acknowledge their reasons for outrage. The reasons for outrage, having been already voiced in the TMDL public comments and local media, will probably include:

- Water quality trading will cause environmental harm,
- Dischargers will get away with not upgrading pollution control technology,
- Unrestrained and manipulative market forces will create economic and political inequities,
- It is immoral to commoditize the environment and a pollutant,
- The public will be abandoned and left unprotected,
- The government cannot be trusted to enforce against violators,
- Their organizations were excluded from the establishment of the trading system.

To address those concerns the following are offered as talking points, all of which reflect the most current understanding of the water quality trading program as it will be implemented, unless otherwise noted:

- NJDEP will closely regulate the Passaic water quality trading program in a transparent manner. The proposed trading program will not function as a free and unconstrained deregulated market. Proposed trades will require approval from NJDEP. NJDEP has the right to veto proposed trades, and environmental justice will be one of the evaluation criteria. Trades will be written into draft discharger permits; those permits will be subject to public comment. Public participation will be sought at each significant decision point in the process.
- NJDEP is responsible for closely monitoring discharges of trading partners so that trading commitments are fulfilled. NJDEP will annually verify that the trading obligations included in a discharge permit have been met. NJDEP will ensure that extensive water quality monitoring throughout the watershed occurs to ensure that trading does not create hot spots. All the data described in this bullet item will be made publicly available to demonstrate the transparency of the program.
    - Furthermore, to demonstrate accountability and a sincere effort to involve stakeholders, NJDEP should strongly consider inviting those local environmentalist NGOs most critical of the trading program along with a neutral third party (e.g., TMDL advisory panel) to have oversight of the data collection tasks described above. While this recommendation might seem unusual or infeasible, note that in outrage management, sharing power is the ultimate path to gaining trust. Realizing that most institutions would decline to do that, the next best thing to sharing power is being accountable. Offering the role of oversight to the NGO builds trust

without having to share power. Having a neutral third party also handle oversight ensures the NGO acts properly in its role (Sandman, 2002).

- In case of noncompliance by a trading partner, NJDEP may either bring enforcement proceedings or move to withdraw or modify a permit.
- An analysis by economists from Cornell University indicates the water quality trading program is expected to save up to 18% of the costs of a command and control approach (Boisvert et al., 2008). Those are costs that would otherwise be borne by the public. These savings are especially significant in a time of economic crisis.
- The water quality trading program was designed with numerous safety features, such as a management area approach with conservative trading ratios, to protect water quality under worst case conditions (Obropta et al., 2008).
- An extensive uncertainty analysis was done to investigate if water quality trading increases the chance of degradation compared to a command and control approach. Those results will be presented next.

Explaining those points in a calm and humble manner, as opposed to an agitated and pompous manner, should sufficiently address the stakeholder outrage that enough people attending the meeting would be willing to trust the information presented on model uncertainty (Sandman, 1994).

A sample fact sheet describing the model uncertainty analysis is provided. Note several features about the fact sheet which should be highlighted in the public discussion:

- Model uncertainty is normal and inevitable.
- The basic model concept and key assumptions are explained.

- The history of the model's development and evaluation with respect to this watershed are explained.
- The scope of the uncertainty analysis is described.
- The key sources of model uncertainty and their effects are described.
- An explanation is given of the methodology for comparing trade scenario to baseline scenario outcomes, along with simple instructions for how to interpret the graph.
- Clear maps are used to provide the context of potential hot spot locations, particularly with respect to environmental justice concerns.
- One simple table shows the results of the uncertainty analysis.
- A brief discussion sheds insight on the two outcomes where trading was not as good as the command and control approach.
- Future steps to reduce model uncertainty are mentioned.
- Nontechnical language is avoided as much as possible.

Proposed fact sheet on model uncertainty and the

Passaic water quality trading program

Background

Computer models are commonly used in efforts to understand the environment. For example, climate change models have been critical to understanding the relationship between greenhouse gas emissions and global warming. Models are a useful tool because often times, the environment being studied is so big (e.g., a watershed, global climate, aquifer) that it cannot possibly be isolated and studied in a laboratory. A model is "a simplification of reality that is constructed to gain insights into [a system]" (NRC, 2007, p. 31). Models are particularly useful for trying out different what-if scenarios; models make predictions which help stakeholders to decide on the best management strategy for an environmental problem.

Models by definition are not reality – they are just a useful and simple way to describe reality. Because models are not perfect copies of reality, a model prediction inevitably contains some uncertainty. Fortunately, scientists are able to analyze the uncertainty of a model, and estimate the impact it has on model forecasts. In this case, an uncertainty analysis was done on the water quality model that was used to predict outcomes of various trading scenarios.

The Passaic Water Quality Model

Four models were linked to study the impact of phosphorus on the Non-Tidal Passaic River Basin (NTPRB). One of the models dealt exclusively with the Wanaque Reservoir. The other 3 models (e.g., flow model, nonpoint source load model, and water quality model) were used for the rest of the watershed. Of the four models, only the uncertainty of the water quality model was analyzed. This was because it contains significantly more uncertainty and influence on the overall results than the other three models. In the field of model uncertainty analysis, it is common practice to limit the scope of the analysis, since it is often too complex or inefficient to look at all the uncertainties. The uncertainty analysis of the Passaic model followed these common practices and focused on what was considered to be the main source of uncertainty.

The water quality model used for the NTPRB is an application of an EPA model called Water Quality Analysis Simulation Program version 7.0 (WASP 7). WASP has been around since the 1970s and has been widely used in both the U.S. and other countries. WASP is designed to represent the dynamic processes that link nutrients, algae and dissolved oxygen (DO) in rivers and lakes. A simple schematic of WASP is shown in figure 1.

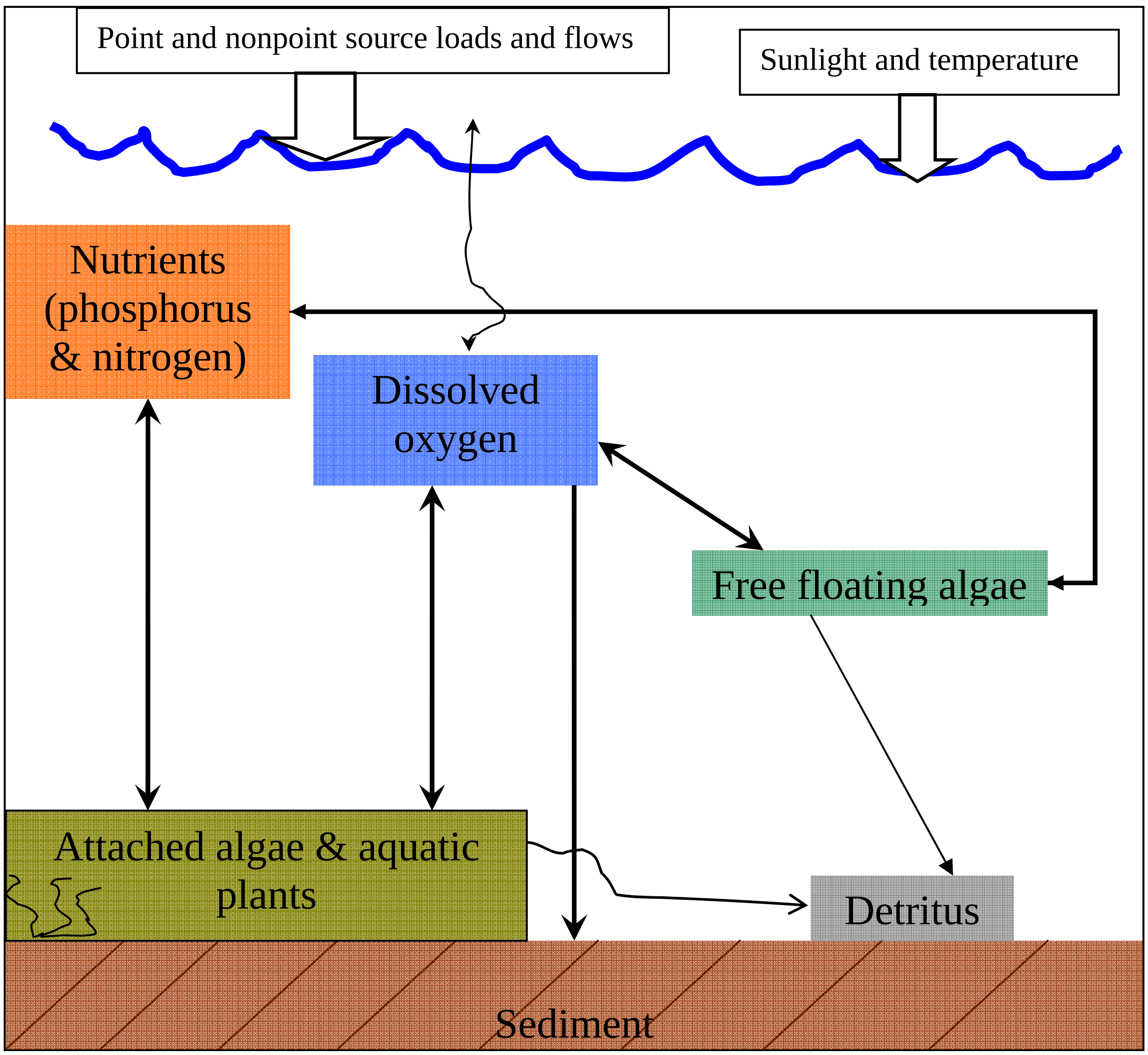


Figure 1: Simplified schematic of the WASP model

NJDEP contracted a private company (Omni Environmental Corp.) with modeling expertise to develop a WASP model of the NTPRB (Omni Environmental, 2007). An independent expert panel, the Rutgers EcoComplex TMDL advisory panel, reviewed the efforts of Omni Environmental and provided feedback and guidance as needed. The model results were evaluated against real watershed data collected from 1999-2003, and the model was judged to be state of the art. Model results were used to inform decisions in development of the Passaic TMDL for total phosphorus.

Uncertainty Analysis of the Passaic Water Quality Model

Like all models, the WASP model of the NTPRB contains uncertainties. A study determined that the uncertainty mainly comes from estimated rates of river processes (e.g., growth rate of algae) and the assumed pollutant content coming from wastewater treatment plants and upstream tributaries. The uncertainty analysis explicitly accounted for those sources of uncertainty because they greatly affect predictions of total phosphorus, algae, and DO levels. Other less important uncertainties which were not studied were a detailed portrayal of each algae and aquatic plant species, and all the ways that the water and sediment interact.

The uncertainty analysis was applied to model predictions of various trading scenarios. Specifically, the analysis examined if there was any evidence that water quality trading would create or exacerbate hot spots to any extent beyond the command and control approach. Model predictions of DO, total phosphorus, and free-floating algae from a range of worst-case trading scenarios were analyzed and compared to corresponding baseline scenarios in which trading did not occur. Standard statistical techniques were then used to determine if the trading scenario outcome was significantly worse than the baseline scenario outcome. (Worst-case trading scenarios were tested because if trading is ok under worst-case conditions, then it should be ok under less adverse conditions).

Here's an example. The graph below (figure 2) compares the range of likely outcomes for two scenarios: "[Trading] Scenario 3" and "Baseline 5". What's shown is the amount of phosphorus load that would be diverted from the Wanaque South intake to the Wanaque Reservoir over the course of an entire year. The less phosphorus that is diverted, the better it is for the Reservoir. Each line in the graph represents the prediction for a particular scenario; the blue line is the baseline scenario, and the purple line is the trading scenario. Where the blue line is to the right of the purple line, the baseline scenario has a higher phosphorus load than the trading scenario. Notice that both lines look very alike. That means that both scenarios contain very similar magnitudes of uncertainty, and very similar probabilities of achieving the same outcomes. A simple statistical test can tell us if one outcome is significantly higher than the other. If the trade scenario is significantly higher, then we conclude that trading would be worse than a command and control approach. However in this case, the statistical test tells us the trade scenario is **not** significantly higher, so we conclude that there is insufficient evidence (or "no evidence" since the test results are very clear) to claim that trading would be worse than a command and control approach.

This method was applied to look at several types of worst-case trade scenarios and their outcomes relative to a command and control approach at several potential hot spots throughout the watershed. Figures 3 and 4 depict the potential hot spot locations, overlaid on 2000 census tract information regarding income levels and minority populations.

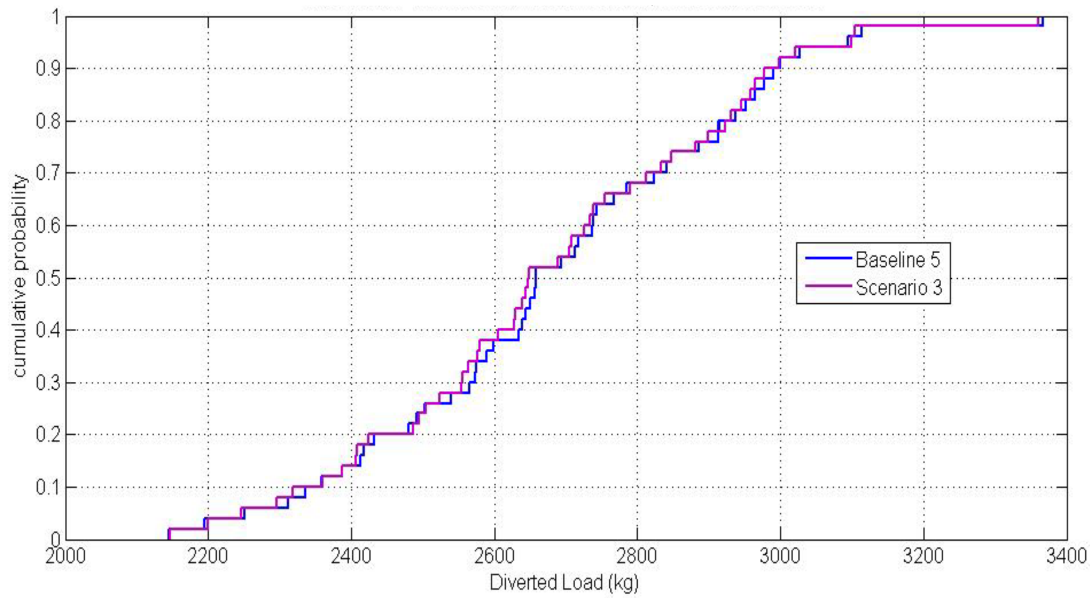


Figure 2: Comparison of uncertainty estimates for a trading and baseline approach. The graph shows diverted phosphorus load from the Wanaque South intake to the Wanaque Reservoir over the course of one year.

Table 1 shows the results of the uncertainty analysis on Passaic water quality trading. The results show that for almost all outcomes, there is no evidence to suggest that trading under the worst-case conditions will not be as good as the command and control approach. There were two worst-case outcomes that suggested a negative effect on diurnal DO swing at the Peckman River mouth and the Passaic River near Chatham; however in each of those particular cases trading also caused a positive effect at the Wanaque South intake, by reducing the phosphorus load diverted to the Wanaque Reservoir by 15-18%. The benefits of less phosphorus in the Wanaque Reservoir reach all residents in the watershed. It should also be noted that contrary to environmental justice concerns, of the two negatively affected locations, one is an affluent and predominantly white area – the Passaic River near Chatham. The precaution of additional monitoring of diurnal DO swings could be implemented at both the Peckman River mouth and Passaic River near Chatham in the event that trades are implemented near those locations.

Future steps

The uncertainty analysis has provided a guide to future data collection efforts that will support an adaptive management approach. Learning more about specific variables in the model will allow the uncertainty analysis to be updated. Model uncertainty might be reduced, but keep in mind models can never be totally free of uncertainty.

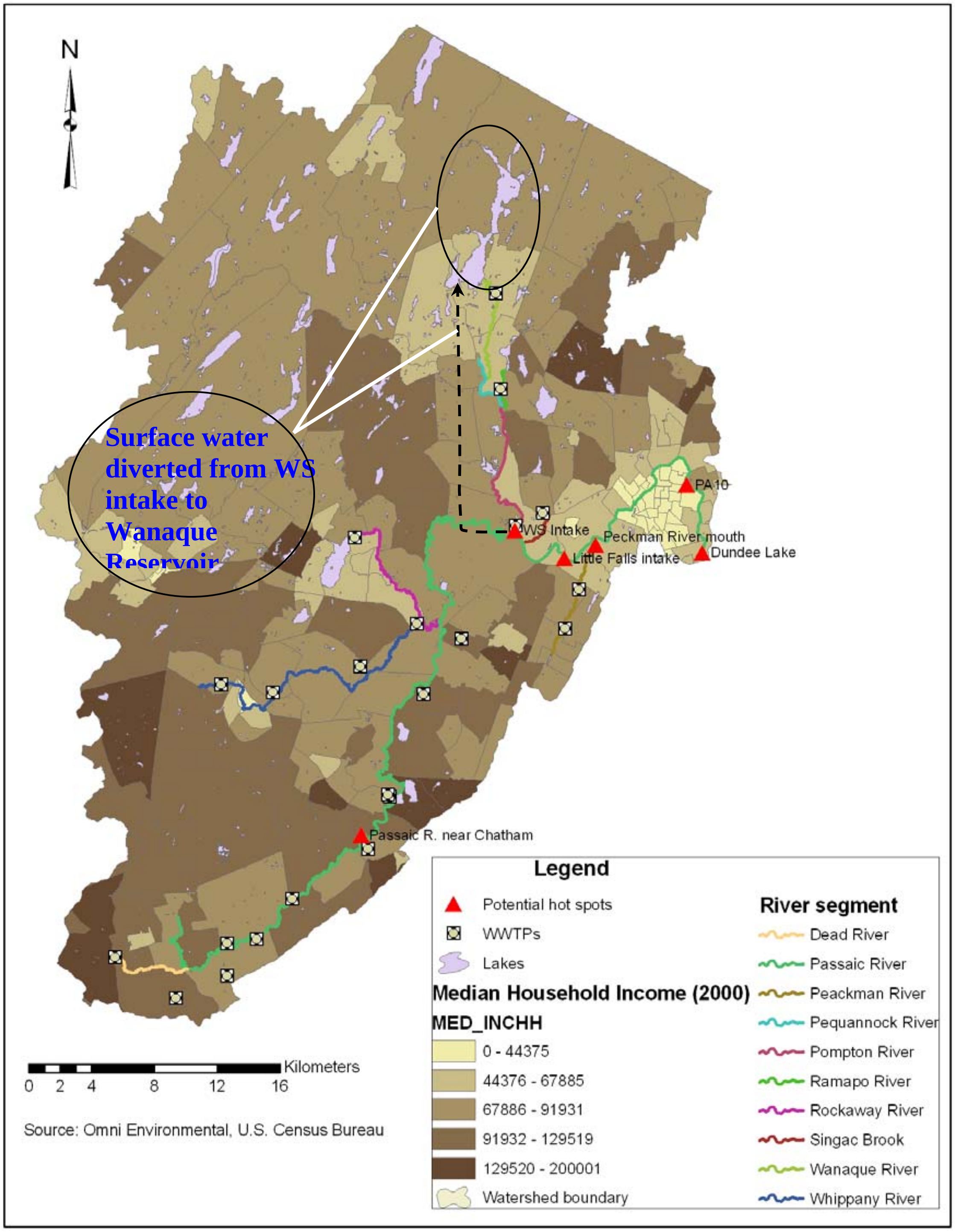


Figure 3: Potential hot spots in the Non-Tidal Passaic River Basin, overlaid with 2000 Census tract data on median household income

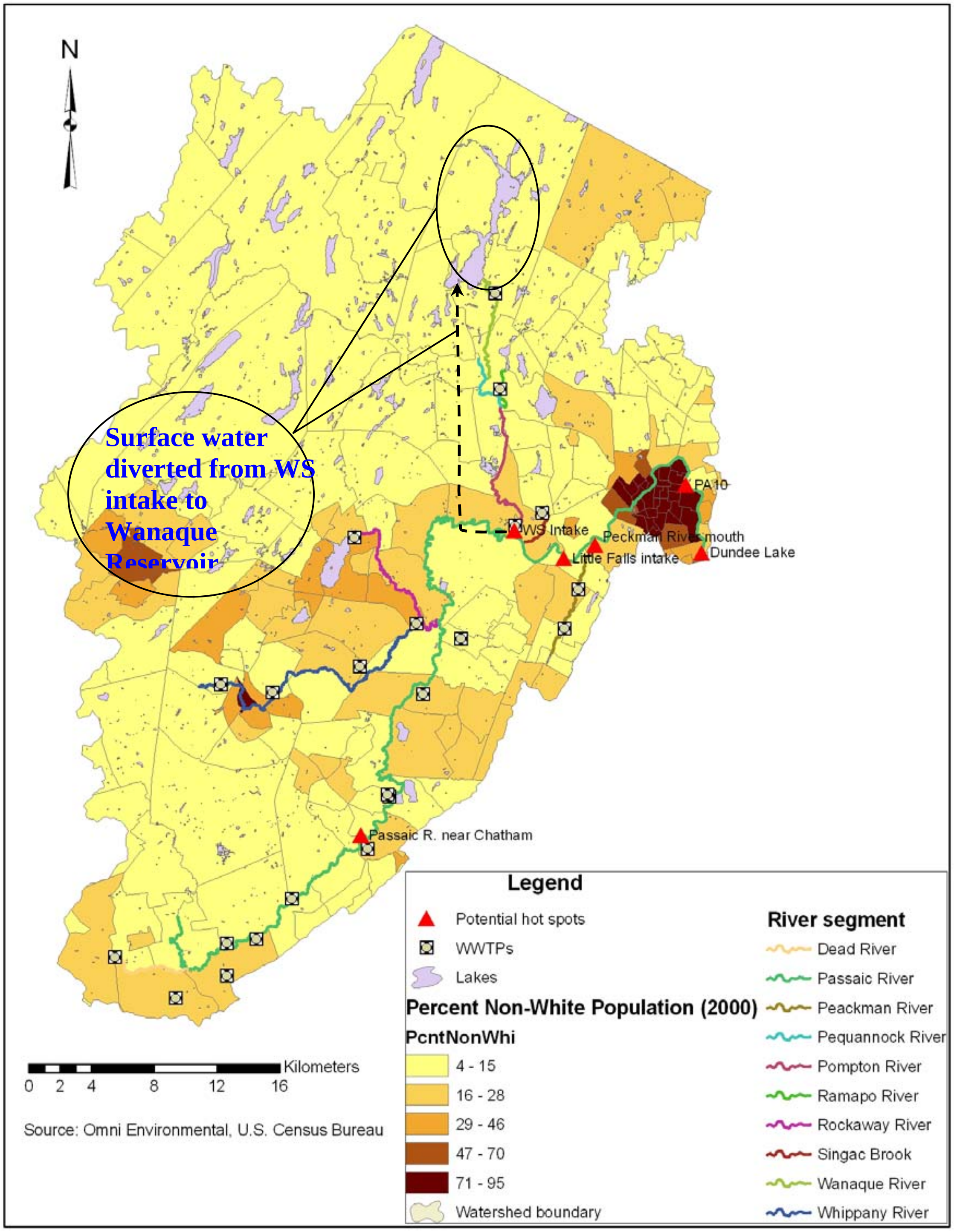


Figure 4: Potential hot spots in the Non-Tidal Passaic River Basin, overlaid with 2000 Census tract data on percentage minority population

Table 1: Results of uncertainty analysis on Passaic water quality trading

Location	Outcome	Is there evidence to claim that trading under worst-case conditions will not be as good as the command and control approach?	If there is evidence, what is the expected magnitude of degradation?
Wanaque South intake*	Annual diverted load of total phosphorus	No	-
Dundee Lake*	Seasonal average of chlorophyll-*a*	No	-
Dundee Lake*	Exceedance frequency of the daily average dissolved oxygen standard during the algae growing season	No	-
Peckman River mouth		No	-
Passaic River near Chatham		No	-
Station PA10		No	-
Dundee Lake*	Exceedance frequency of the minimum dissolved oxygen standard during the algae growing season	No	-
Peckman River mouth		No	-
Passaic River near Chatham		No	-
Station PA10		No	-
Dundee Lake*	Diurnal dissolved oxygen swing during the algae growing season	No	-
Peckman River mouth		Yes‡	11% (6.17 vs. 5.45 mg/L)
Passaic River near Chatham		Yes ^	10% (4.00 vs. 3.62 mg/L)
Station PA10		No	-
Little Falls intake	Annual average total phosphorus concentration	No	-

* Critical location as stated in TMDL (NJDEP, 2008a)
‡ Trading also caused an 18% improvement in phosphorus diverted to the Wanaque Reservoir
^ Trading also caused a 15% improvement in phosphorus diverted to the Wanaque Reservoir

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