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WATER QUALITY TRADING ASSESSMENT HANDBOOK

Can Water Quality Trading Advance Your Watershed's Goals?

November 2004

III. Financial Attractiveness

Purpose

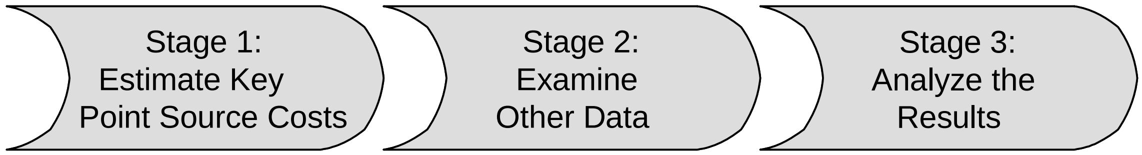
Financial attractiveness is the second major consideration in assessing water quality trading potential in your watershed. This chapter reviews the financial relationships affecting the viability of trading. The potential economic gains associated with trading are influenced by factors specific to the watershed as well as factors external to the watershed. Because the relevant financial relationships are often nuanced and dynamic, this section can offer only the foundation needed to begin examining current financial relationships in the watershed and their sensitivity to different assumptions. This chapter will help answer the following questions:

- What makes water quality trading financially attractive?
- How can I measure financial attractiveness?
- Where can I find the data?
- What could the analysis mean for my watershed?

In analyzing financial attractiveness it is not necessary to estimate costs for all possible trades in a watershed. This chapter discusses how to identify "Alpha Trades," those trades with sufficient economic return to be viable even after water quality ratios are applied. Analyzing these trades should provide a good indication of trading viability in your watershed; if the watershed can support several Alpha Trades, trading is likely to be financially viable. Although this chapter discusses detailed calculations, a typical analysis will produce 'ballpark' estimates. These estimates should enable you to locate an individual trade's position along a relative continuum of financial attractiveness from "high" to "low." After reading this chapter, considering the examples provided, and employing the methodologies discussed (or other appropriate approaches), the watershed participant should be able to screen out unlikely trading scenarios and make an informed decision as to whether further pursuit of water quality trading is warranted.

Approach

This chapter reviews the primary drivers of financial attractiveness and describes the three stages for conducting an analysis to assess those drivers in a specific situation. First, the Handbook suggests investigating key point sources for which the necessary data are relatively accessible. The investigation includes building a basic model assessing the sources' current and future costs for controlling the relevant pollutant(s). With this basic understanding of the financial considerations for a few key sources, the reader is encouraged to compile data for other sources in the watershed. Data collection strategies and data formatting are considered. Finally, this chapter describes factors such as trading ratios that influence the strength of financial attractiveness and how to incorporate them into an analysis.



Certain types of trades will present themselves as relatively straightforward, easy to execute, and financially beneficial to all parties. Other potential trades will be more difficult and may not result in cost savings. For example, two point sources of phosphorus, located a quarter-mile apart, and facing large differences in their control costs likely will uncover a compelling case for trading. On the other hand, two sources at opposite ends of a complex watershed, attempting to control temperature, and sharing only moderately different control costs are unlikely to obtain any advantages from trading. The ability to differentiate scenarios systematically will help watershed participants use trading wisely as a tool to improve water quality at lower cost. Throughout this chapter, the Happy River Basin example will be used to illustrate the analytical process.

The economic models, financial models, and analysis techniques provided in this chapter are, by design, very basic. They will help you screen your watershed for financial attractiveness at a very general level and provide you with the basic ability to gauge whether you have low, medium, or high financial opportunities for trading. Pilot projects have indicated that conducting more precise and in-depth analysis will typically involve a substantially increased level of effort and will quickly move outside the realm of readily available data. The tools provided in this chapter have been well tested, do not require sophisticated economic modeling skills to implement, and are sufficient for basic screening purposes. More precise analysis will typically require in-depth interaction with individual discharge sources and may encounter issues related to proprietary business information. As a result, this more in-depth work will often be best conducted by individual sources in the context of specific trade negotiation activities.

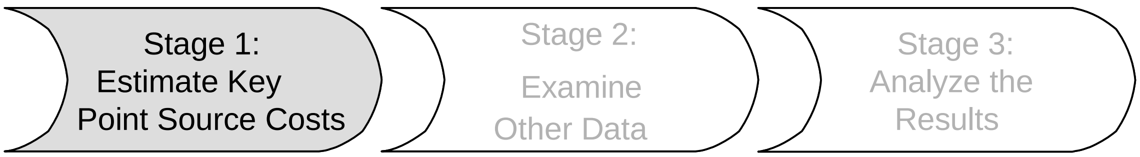
What Makes Water Quality Trading Financially Attractive?

The financial attractiveness of water quality trading is created by differences in the pollutant control costs faced by individual dischargers. These differences may make it possible to improve water quality at lower cost overall by allowing pollutant dischargers facing high control costs to pay dischargers with lower cost control options to “overcontrol” their discharges. “Overcontrol” as used here means reducing a pollutant discharge below the target load specified by the watershed’s market driver (typically a TMDL). The amount of pollutant control beyond obligations represents the stock of potential surplus reductions available for exchange with other parties. In water quality trading, pollutant overcontrol creates a “product” with buyers and sellers in a potentially competitive market that can encourage innovation and efficiency untapped by a more traditional approach.

To assess trading viability, a common measure is needed to assess the costs each discharger will face to comply with its requirements. Chapter One explained the need to identify a tradeable commodity. Moving on to calculate the cost of producing the commodity in the form of surplus pollutant reductions will show whether the relative cost efficiency of some dischargers’ control options can lead to economically efficient trades.

Some pilot projects have used "incremental cost of control" as the common measure. Incremental cost of control is calculated as the average cost of control *for the increment of reduction required for an individual source to achieve the Target Load*. For example, if a discharger needs a 5 lbs./day reduction to comply with its permit, but the only reasonably available technology costs $10 million and produces a 20 lbs./day reduction, traditional average cost would divide costs by 20 lbs./day, but incremental analysis divides the costs by 5 lbs./day. Importantly, in this example, the incremental cost analysis suggests a unit cost four times higher than average cost.

STAGE 1: Calculating Incremental Cost of Control for One or More Key Point Sources



The first step to assess financial attractiveness is to calculate the incremental cost of control for one or more key dischargers. The first sources analyzed should be point sources that are obligated to make significant pollutant reductions thus providing an impetus for trading activity. These could be sources that are likely to be large buyers or sellers of pollutant reduction credits, i.e., those that have a significant discharge and/or will need a substantial level of control to meet the wasteload allocation. The following data are needed to calculate incremental cost of control:

- The source's current load;
- The source's TMDL (or equivalent) target load;
- The source's projected load on its required compliance date if no controls are implemented;
- The source's projected future load (considering anticipated growth and other relevant factors);
- Annualized cost of the control option(s) including capital investment and annual operating and maintenance (O&M) costs; and
- Expected reductions achieved by the control option.

Calculating the incremental cost then involves the following tasks.

Task 1: Calculate Required Reductions

A facility's future discharge will be influenced by any changes in demand for the facility's primary services or products (e.g., municipal sewage treatment, industrial production, or agricultural production). For a publicly owned wastewater treatment plant, discharge will likely vary as local population increases and/or the number and activity level of industrial users changes. Industrial sources may discharge more as production rises. An increase (or decrease) in discharge and resulting reductions needed to maintain compliance will affect needed reductions, incremental cost of control and, potentially, the financial attractiveness of trading in the watershed.

The reductions needed to comply equal the discharger's target pollutant wasteload minus its current loads and any expected future loading increases. Both the projected load at the compliance date and the projected long-term future load should be calculated. Compliance dates and capital budgeting interact with projected changes in future demand to influence discharge control choices; therefore, multiple timeframes may require examination. Currently, NPDES permits implement TMDLs for point sources and typically give sources three to five years to meet their permit limits. This normally gives dischargers a window of opportunity to evaluate their options, select the best alternative, and implement it. In the Happy River Basin example, the NPDES permit holders have five years to comply.

Water pollutant control technology often represents a significant, fixed, long-term capital investment. If a discharge increases beyond the existing control technology's ability to maintain compliance during its useful life, new investments may be required in the future. Sources therefore need to examine the implications of their available options over an extended period.

In the example, the point sources project discharge volumes in five years for compliance requirements and in ten years for capital budgeting needs. Future discharge levels can be difficult to estimate. For the purposes of analysis, it may be best to create several scenarios with different levels of anticipated growth. Past pilot projects have used a system of "High," "Moderate," and "Low" growth trends. Current pollutant loadings may be estimated to increase at a constant rate over a specified period to estimate future loads and future required reductions.

➔ Hopeville's Required Pollutant Reductions

Projecting Hopeville's Required Reductions

The Hopeville POTW currently discharges, on average, 4.1 million gallons of wastewater per day. Routine sampling results show that the total phosphorus (TP) concentration in the effluent is 2.99 milligrams/liter. Converting gallons into liters and milligrams into pounds, the POTW's current TP load is 62 lbs./day[4]. POTW managers believe their system could face demand increases between 1 percent and 8 percent, on average, over 10 years. Hopeville believes that a reasonable assumption is that moderate population and industrial growth will increase its TP load 3 percent annually over the next five years to 72 lbs./day. The TMDL assigns Hopeville a wasteload allocation, or Target Load, of 50 lbs./day and this becomes an enforceable compliance requirement in its permit. Figure 3.1 summarizes needed reductions at today's current discharge, five years from now at the time permit compliance is required, and ten years in the future assuming 1 percent, 3 percent, and 8 percent annual growth.

As shown in the table, Hopeville needs to consider a wide range of potential pollutant reductions to meet its permit obligations under different growth scenarios. At current discharge levels, the POTW needs to reduce TP discharge by 12 lbs./day. Five years from now, when failing to comply has real economic consequences, Hopeville will need to have reduced its TP discharge by between 16 and 42 lbs./day, depending on demand for its services. Looking further into the future, Hopeville will need to generate between 19 and 84 lbs./day of TP reductions to remain in compliance. For the purposes of examining financial attractiveness, Hopeville chooses to focus on reductions needed in five years for compliance and assumes that it will experience moderate

[4] 1lb = 453592.37 milligrams and 1 gallon = 3.79 liters

growth. Therefore, the assumption is that Hopeville will be generating 72 lbs./day of TP and will have to reduce that discharge by 22 lbs./day in five years.

Figure 3.1, Hopeville POTW Load Projections

Hopeville POTW Load Projections				
Current Load (lbs./day)	Annual Growth	TP Load (lbs./day)	Target Load (lbs./day)	Reduction Needed (lbs./day)
Current Baseline				
62	0%	62	50	12
5 years (Compliance Date)				
62	1.0%	66	50	16
62	3.0%	72	50	22
62	8.0%	92	50	42
10 years (Capital Budgeting)				
62	1.0%	69	50	19
62	3.0%	83	50	33
62	8.0%	134	50	84

Task 2: Examine Control Technology Options

The next task is to examine available technologies' ability to control the pollutant discharge and the associated costs. Multiple technologies and mitigation approaches may be available to each source to address water quality impairments. While the cost and efficacy of control options vary, more control generally means greater cost. Moreover, current control technology often achieves reductions by removing pollutants in large increments. Some control technologies will, therefore, produce the needed reduction increment and a significant additional increment for little or no additional cost. As control needs increase past the technology's ability to control the pollutant, the facility may need to invest in more control, often by taking the next "technology step."

➔ Hopeville's Control Technology Options

Hopeville's wastewater treatment engineers have identified three technologies that could reduce phosphorus discharge from their POTW and offer a range of control.

- ➔ Step 1: Advanced Primary Treatment (APT) is capable of removing 16 lbs./day.
- ➔ Step 2: After an investment in APT, the next "step" is Biological Nutrient Removal (BNR) which would remove an additional 22 lbs./day.
- ➔ Step 3: Finally, additional aeration basins and secondary clarifiers would eliminate an additional 30 lbs./day for a total phosphorus removal of 68 lbs./day.

Task 3: Calculate Incremental Reductions Needed for Compliance

When a technology step (or combination of steps) fails to generate, at a minimum, the total reduction needed, a source may be forced to consider investment in an additional technology step, even though this would produce more reductions than are needed. To evaluate its options, Hopeville generated the following table for its 5-year projection.

Figure 3.2, Hopeville's POTW 5-Year Projection

Hopeville POTW 5-Year Projection

Low Growth Scenario

	Annual Growth	TP Load (lbs./day)	Target Load (lbs./day)	Total Reduction Needed (lbs./day)	Reduction Achieved (lbs./day)	Cumulative Reduction Achieved (lbs./day)	Incremental Reduction Needed (lbs./day)	Potential Surplus Reductions Available to Market (lbs./day)
	1.0%	66	50	16				
Step 1	APT				16	16	0	0
Step 2	BNR				22	38	0	22
Step 3	Clarifiers				30	68	0	50

Moderate Growth Scenario

	Annual Growth	TP Load (lbs./day)	Target Load (lbs./day)	Total Reduction Needed (lbs./day)	Reduction Achieved (lbs./day)	Cumulative Reduction Achieved (lbs./day)	Incremental Reduction Needed (lbs./day)	Potential Surplus Reductions Available to Market (lbs./day)
	3.0%	72	50	22				
Step 1	APT				16	16	6	0
Step 2	BNR				22	38	0	16
Step 3	Clarifiers				30	68	0	46

High Growth Scenario

	Annual Growth	TP Load (lbs./day)	Target Load (lbs./day)	Total Reduction Needed (lbs./day)	Reduction Achieved (lbs./day)	Cumulative Reduction Achieved (lbs./day)	Incremental Reduction Needed (lbs./day)	Potential Surplus Reductions Available to Market (lbs./day)
	8.0%	92	50	42				
Step 1	APT				16	16	26	0
Step 2	BNR				22	38	4	0
Step 3	Clarifiers				30	68	0	26

➔ Hopeville's Incremental Reductions Needed for Compliance

Under low growth assumptions, Hopeville faces a reduction need of 16 lbs./day. As the table demonstrates, APT generates 16 lbs./day of reductions, the exact amount of reductions identified by the TMDL. If the POTW implemented this control technology, compliance would be reached and there would be no incremental reductions needed. However, under moderate growth estimates, the TMDL would specify Hopeville to reduce its discharge by 22 lbs./day. The difference between the reductions achieved with APT (16 lbs./day) and the total reductions needed (22 lbs./day) would equal 6 lbs./day. These represent the incremental reductions needed for compliance. Similarly, under high growth assumptions, implementing APT and BNR would generate 38 lbs./day of reductions, while Hopeville would need to reduce its TP discharge by 42 lbs./day. Under these assumptions, the POTW would fall short of compliance and need 4 lbs./day of incremental reductions. If Hopeville implements the third technology step beyond APT and BNR, the facility would not require any incremental reductions, even under the high growth scenario, and would in fact have surplus reductions to sell.

Task 4: Calculating Annualized Control Costs

To estimate the anticipated annualized cost of each control option, you will need to total the annualized capital cost and the annual O&M cost.

- Annualized capital cost is the total cost (including associated finance charges) incurred for installing a control option divided by the control option's useful life.
- Annual O&M cost should include but not be limited to monitoring, inspection, permitting fees, waste disposal charges, repair, replacement parts, and administration.

The following worksheet describes the calculations[5]:

Calculation of Annualized Control Costs

Cost of Installing Control Option	_______________	(1)
Time Period of Financing (Expressed as years)	_______________	(n)
Interest Rate for Financing (Expressed as a decimal)	_______________	(i)
Annualization Factor*	_______________	(2)
Annualized Capital Cost [Calculate (1)x(2)]	_______________	(3)
Annual Cost of Operation & Maintenance**	_______________	(4)
Total Annual Cost of Control [(3)+(4)]	_______________	

* Appendix E contains the Annualization Factor for a range of interest rates and time periods.

** For recurring costs that occur less frequently than once a year, pro rate the cost over the relevant numbers of years (e.g., for pumps replaced once every three years, include one-third of the cost in each year).

The appropriate interest rate will depend on the facility's ability to access financing. Public treatment works may have access to grants and revolving funds designated for water quality infrastructure improvements. Currently, the EPA and state funded Clean Water State Revolving Fund issues loans at rates between 0 percent and market rates, with an average of approximately

[5] As previously mentioned, the models and tools in this chapter provide you with general screening capabilities. In certain cases, an investment made in control technologies may be phased in over several years. This potentially affects your annualized cost calculation. When analyzing a phased investment, the precision of your analysis will increase by appropriately modeling each phase of the project and summing the individual results.

2.5 percent. In some circumstances, certain private entities are also eligible for loans from these below market funds. Borrowers from the capital markets face interest rates of approximately 6 percent (at the time of publication). Nonpoint sources may also have potential to reduce the cost of control through cost-share programs from the Natural Resources Conservation Service, local soil conservation districts, or other local and federal agencies.

➔ Hopeville's Annualized Control Cost

Hopeville is analyzing its Step 1 control costs based on installing APT. The equipment costs $332,468 to install (1) and will be financed through a municipal bond backed by Hopeville's water and sewer fees over a 10-year period (n). Similar bonds issued by comparable municipalities pay 4.5 percent (i). The Annualization Factor for a 10 year financing period at 4.5 percent is .1264 (2) (see Appendix E for Capital Cost Annualization Factors); therefore the annualized Capital Cost equals ($332,468) multiplied by (0.1264) or $42,024 per year (3). The O&M costs for this option are estimated to total $14,008 (4) annually. Therefore it will cost the POTW $56,032 each year to control their discharge and maintain compliance by investing in APT.

Task 5: Calculate Incremental Control Cost

The final task is to evaluate the unit cost of pollutant control for each source. While traditional economic models often evaluate marginal or average cost, in the case of assessing trading viability, incremental cost represents a better approximation of the upper-bound of a source's willingness to pay others for pollutant reduction credits. As discussed later in the chapter, other measures may be useful when assessing the price a source may be willing to *accept* for credits it has to sell. As Figure 3.3 illustrates, using average costs undervalues the true cost of meeting the incremental reductions because it treats each additional pound of reduction as a discrete unit rather than treating the entire control option as the step function it is.

It should also be noted that each control step, once implemented, is a "sunk" cost. If a source had previously installed control technology, those funds are already committed and do not influence the next step decision for pollutant control. For example, if a source implements step 1 control technology and is now looking toward a step 2 option, the incremental cost of control considers only the cost of the second step of control technology; the previous step cost is "sunk" and is no longer part of the decision making analysis.

To calculate incremental control cost for each step of pollutant control, divide annualized costs by the incremental reductions needed for compliance. This should be done for each relevant time period (e.g., 5 years and 10 years) under each growth scenario. Hopeville analyzed its three options for the POTW and produced the following table for its five-year projection.

The above analysis would be repeated for the key point sources, i.e., those likely to be large credit buyers or sellers, in the watershed.

Figure 3.3, Hopeville's POTW 5-Year Projection Including Costs

	Low Growth Scenario									
	Annual Growth	TP Load (lbs./day)	Target Load (lbs./day)	Total Reduction Needed (lbs./day)	Reduction Achieved (lbs./day)	Cumulative Reduction Achieved (lbs./day)	Incremental Reduction Needed for Compliance (lbs./day)	Control Increment Capital/O&M Incurred ($ annualized)	Incremental Control Cost ($/lb./day)	Average Control Cost ($/lb./day)
	1.0%	66	50	16			16			
Step 1	APT				16	16	0	$56,032	$9.59	$9.59
Step 2	BNR				22	38	0	$219,022	N/A	$27.28
Step 3	Clarifiers				30	68	0	$339,450	N/A	$31.00

	Medium Growth Scenario									
	Annual Growth	TP Load (lbs./day)	Target Load (lbs./day)	Total Reduction Needed (lbs./day)	Reduction Achieved (lbs./day)	Cumulative Reduction Achieved (lbs./day)	Incremental Reduction Needed for Compliance (lbs./day)	Control Increment Capital/O&M Incurred ($ annualized)	Incremental Control Cost ($/lb./day)	Average Control Cost ($/lb./day)
	3.0%	72	50	22			22			
Step 1	APT				16	16	6	$56,032	N/A	$9.59
Step 2	BNR				22	38	0	$219,022	$100.01	$27.28
Step 3	Clarifiers				30	68	0	$339,450	N/A	$31.00

	High Growth Scenario									
	Annual Growth	TP Load (lbs./day)	Target Load (lbs./day)	Total Reduction Needed (lbs./day)	Reduction Achieved (lbs./day)	Cumulative Reduction Achieved (lbs./day)	Incremental Reduction Needed for Compliance (lbs./day)	Control Increment Capital/O&M Incurred ($ annualized)	Incremental Control Cost ($/lb./day)	Average Control Cost ($/lb./day)
	8.0%	92	50	42			42			
Step 1	APT				16	16	26	$56,032	N/A	$9.59
Step 2	BNR				22	38	4	$219,022	N/A	$27.28
Step 3	Clarifiers				30	68	0	$339,450	$232.50	$31.00

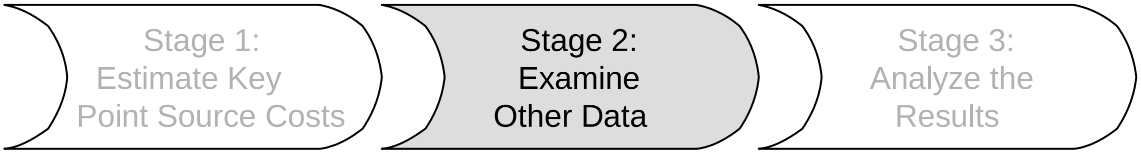
Note: Incremental control cost = annualized cost ($/yr) ÷ incremental reduction needed (lbs./day) ÷ 365 (days/yr).

➔ Hopeville's Incremental Control Cost

As noted earlier, Hopeville's "Step 1" control option generates the exact number of reductions needed for compliance under low growth assumptions. Therefore, the incremental control cost for Step 1 is equal to $56,032 (the annualized cost) divided by 16 lbs./day (the incremental reduction needed for compliance with no additional control) or $9.59/lb./day.[6] If the city experiences medium growth over the next five years, Step 1 will fall 6 lbs./day short and force Hopeville to implement both Step 1 and Step 2. The incremental control cost for Step 2 is equal to $219,022 divided by 6 lbs./day (the incremental reduction needed for compliance after using Step 1 control) or $100.01/lb./day. However, Step 1 and Step 2 together would not produce compliance under a high growth scenario. Consequently, in the high growth scenario, the incremental control cost would be $339,450 divided by 4 lbs./day (the incremental reduction needed for compliance after using Steps 1 and 2 controls) or $232.50/lb./day.

[6] Most trading projects have chosen to denominate their costs in dollars/pound/day. Accordingly, the table divides the annualized control cost by 16 lbs. and 365 days. $56,032/16 lbs./365=$9.59.

STAGE 2: Examine Other Data



As already discussed, the goal of water quality trading is to take advantage of differences in incremental control costs among sources in a watershed by allowing facilities facing higher costs to compensate those who can produce reductions at lower cost, thereby producing the same (or more) environmental benefit with less overall cost to society. To assess whether more cost-effective pollutant reductions can be achieved through trading it is not necessary to analyze costs for every source in the watershed. It is important to analyze costs for key point sources and, where nonpoint sources reductions are desirable, for a selected group of typical nonpoint sources. Analyzing incremental costs for selected sources in a watershed is an important preliminary segmentation of the market into high cost pollutant reducers (likely credit buyers) and low cost pollutant reducers (likely credit sellers). At this time, the main focus of analysis should be to characterize the size of the incremental control cost differences present in your watershed. The differences in incremental control costs may be mitigated by other financial and market factors that are discussed in Stage 3. At this time, you are concerned only with identifying the range of cost differences present based on different growth assumptions.

Compiling Information from Other Sources

The potential advantages of trading may motivate a variety of actors, both public and private, to investigate trading opportunities in the watershed. Analyzing trading potential therefore may involve compiling information from many sources, including farms, POTWs, and publicly traded corporations. These potential market participants may have different motivations for discussing water quality trading. In addition, incentives to share information with outsiders, like regulators or environmental groups, may vary. Engendering trust and being creative may help in acquiring needed data. (For example, Appendix F is a sample data sheet distributed to pollutant sources participating in a pilot project. This information was then compiled into spreadsheets used for a market assessment.) Trust building and stakeholder engagement is discussed further in Chapter V.

Public Point Sources

Ability to gather the needed control cost information for POTWs or other public point source dischargers is likely enhanced by public disclosure and information laws. Citizens are often entitled to obtain a wealth of information including planning documents and discharge data. Often, public facilities have required planning cycles for projecting future demands for service and preparing to cost-effectively manage community infrastructure needs. In addition, working directly with the POTW to obtain the pertinent information may help develop relationships beneficial to future trading efforts.

Private Point and Nonpoint Sources

Soliciting information from private sources is more challenging. Creating a water quality trading market is an unconventional approach to improving water quality that explicitly depends on the potential benefits of trading in a given watershed. In conventional markets, cooperation evolves during the exchange of goods and services when buyers indicate their willingness to pay and sellers exhibit their willingness to accept. Consequently, in a traditional market, information sharing is usually limited to negotiating a specific transaction. Analyzing the financial attractiveness of watershed scale trading requires sharing information prior to negotiating trades. The desired information includes potential reduction costs, which could give competitors clues about a facility's future strategic plans. Wide dissemination of this information could reduce competitive advantages currently enjoyed by the local facility. In addition, detailed information on cost, market supply, and market demand for pollutant reductions may allow other market participants to capture larger shares of trade benefits. Therefore, both the information required to develop the watershed trading financial analysis and the results of that analysis may be perceived as potentially leading to financial losses. Private entities may be understandably reluctant to provide information considered business sensitive, but the potential benefits of participating in the trading market may provide an incentive for information sharing.

Nonpoint Source Cost and Pollutant Reduction Information

In many cases, nonpoint sources have access to information resources pertinent to their likely costs. If they are unwilling or unable to share the information, nonpoint cost and pollutant reduction information will likely have to be pieced together from a variety of sources. Some trading pilot projects, like Tar-Pamlico in North Carolina, have completed cost studies and published them on the Internet. Other information sources include state agricultural agencies, the U.S. Department of Agriculture's Natural Resource Conservation Service, Agricultural Research Service, and cooperative extension programs.

Putting the Information Together

As more dischargers are included in an analysis, complexity increases. The key to organizing the information is to ensure an "apples to apples" comparison. As discussed in the previous chapter, annual and seasonal TMDL allocations are often implemented through NPDES permit limits with daily, weekly, or monthly compliance metrics. In the example, the pollutant is measured in pounds per day. Although translating between any two metrics is possible, you should verify that the analysis employs a common numerator and denominator for all sources. The format used below to analyze incremental cost of control in the example has been used in pilot trading programs. It is always wise, however, to tailor the format for the analysis according to the needs and skills of watershed participants.

➔ A Financial Snapshot of Sources in the Happy River Watershed

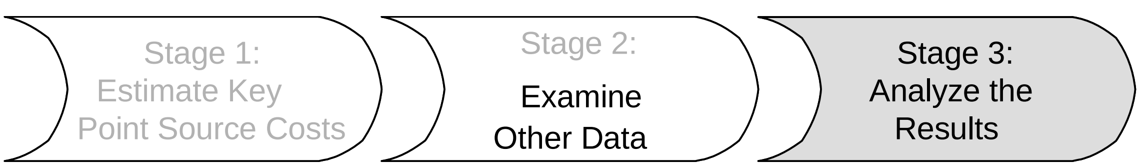
Combining the Needed Data

Hopeville and its fellow sources exchanged the needed information and produced the following spreadsheet, cataloging incremental control cost in five years under a *moderate growth scenario* for each source. Sources are listed from upriver to downriver and all possible technology steps for each source are listed.

Figure 3.4, Happy River Watershed Combined Analysis

Medium Growth 5 Year Projection											
Facility	Annual Growth	Phosphorus Load (lbs./day)	Target Load (lbs./day)	Reduction Needed (lbs./day)	Incremental Reduction Achieved (lbs./day)	Total Reduction Achieved (lbs./day)	Incremental Reduction Needed (lbs./day)	Control Increment Capital/O&M Incurred ($ annualized)	Incremental Control Cost ($/lb./day)	Average Control Cost ($/lb./day)	Potential Surplus Reductions (lbs./day)
Herb's Farm	3.0%	873	527	346							
Step 1					91	91	255	$49,823	N/A	$1.50	None
Step 2					623	714	0	$464,014	$4.99	$2.04	368
Pleasantville	3.0%	917	633	284							
Step 1					662	662	0	$2,071,893	$20.01	$8.57	378
Step 2					107	769	0	$5,222,364	N/A	$133.72	485
Acme Inc.	5.0%	698	410	288	506	506	0	$6,301,466	$60.01	$34.12	218
Production Company	5.0%	535	415	120							
Step 1					46	46	74	$249,499	N/A	$14.86	None
Step 2					485	531	0	$985,312	$36.44	$5.57	411
Widgets Inc.	5.0%	302	215	87	287	287	0	$1,552,455	$48.96	$14.82	200
Hopeville	3.0%	72	50	22							
Step 1					16	16	6	$56,032	N/A	$9.59	None
Step 2					22	38	0	$219,022	$100.01	$27.28	16
Step 3					30	68	0	$339,450	N/A	$31.00	46
AAA Corp.	7.0%	274	166	108	163	163	0	$589,966	$14.99	$9.92	55

STAGE 3: Analyze the Results



Task 1: Identify Potentially Viable Trades

The format used to compile incremental control cost information in Figure 3.4 allows watershed participants to analyze a one-to-one pollutant reduction purchasing relationship. The next step is to identify potentially viable trades. As demonstrated in the 5-Year Medium Growth Projection, the approximate incremental control costs ($/lb.), in descending order, are:

- Hopeville: $100
- Acme Inc.: $60
- Widgets Inc.: $49
- Production Company: $36
- Pleasantville: $20
- AAA Corp.: $15
- Herb's Farm: $5

Because trading allows facilities facing higher reduction costs to compensate those with lower reduction costs, sources theoretically would consider trading with any source below them on the list.

An important distinction should be made between evaluating potentially viable trades and estimating the price or economic benefits of trades. The analysis to this point has focused on the incremental control cost, which represents the maximum willingness-to-pay from the buyer's perspective. Using this measure is appropriate when evaluating a watershed for trading potential; it is not, however, the only perspective. Once you have identified potentially viable trades, you may be interested in other measures from the seller's perspective. Calculations such as average cost or marginal cost may provide a more realistic indication of the price a credit seller is willing to accept.

For example, a source might choose to use trading as a profit maximizing endeavor, pricing credits at the maximum that any watershed buyer would be willing to pay. On the other hand, another source might sell credits at a price that recovers just some of the cost of generating them. The range of possible prices could include anything in between these two extremes.

The implication of considering the seller's perspective is that the incentive to trade may be even greater than when only the buyer's incremental cost is considered. If a seller is willing to price credits below their incremental control cost, the lower price will be even more attractive to potential buyers than the analysis initially suggested. For example, if Production Company were willing to price their credits at $30/lb. to offset at least some of their control cost of $36.44/lb., Acme and Widgets have an even greater financial incentive to trade.

Task 2: Detailed Analysis

Although the Preliminary Analysis may identify potential trades, assessing financial attractiveness on this basis alone requires making several assumptions. (The previous chapter discussed how unlikely some of these assumptions may be.) For example, one would have to assume that:

- The effectiveness of the control technology selected is not variable;
- Reductions in all locations in the watershed are environmentally equivalent;

- Transaction costs are zero;
- Reductions are certain to occur; and
- The timing of all reductions will coincide with compliance mandates.

The financial attractiveness of a trade may decline as these and other complicating factors are included in the analysis. An organized analysis is useful to add the relevant additional considerations as an overlay to the preliminary financial analysis. These additional considerations (discounts, ratios, transaction costs, and risk) are best investigated in ascending order of complexity. As each consideration is added to the analysis, stakeholders can decide whether further effort to create a trading market is warranted. If the incremental cost differences become very small, thereby substantially reducing financial attractiveness, watershed participants may decide that trading is not viable. If a reasonable level of financial attractiveness remains, additional factors can be considered.

Incremental Control Cost Adjusted by Uncertainty Discount

Two types of pollutant reductions have been identified in pilot projects and the literature—measured reductions and calculated reductions. Certain control technologies result in easily measured water quality improvements; ongoing monitoring effectively quantifies the actual reductions achieved. In some cases, however, measuring a control option's impact on pollutant loading is either impractical or very costly. Reductions for these control options may be estimated based on models, scientific tools, or performance data. Loading reductions from Best Management Practices (BMPs) used by nonpoint sources are most likely to be calculated.

BMPs perform differently based on a variety of site specific factors that may not be accounted for in existing data or models, introducing the chance for variable and unpredictable results. In pilot projects, the relatively variable and unpredictable performance of nonpoint source BMPs has been handled by discounting the estimated reductions available for trade. The uncertainty discount is intended to ensure that errors in BMP performance estimates will not jeopardize the water quality equivalence of trades involving these pollutant control actions. The size of the discount will likely be driven by local conditions with input from stakeholders. To measure the uncertainty discount's effect on the financial attractiveness of individual trades, you will need to recalculate the source's incremental cost of control using the discounted reductions.

➔ Discounting Credits for Uncertainty

Herb's Farm and Pleasantville

Herb's Farm can use its Step 1 and 2 control options—sediment ponds and constructed wetlands that are maintained to treat phosphorus—to control discharges from its fields and trade the overcontrol to Pleasantville. Available data show that, on average, these treatment options could reduce phosphorus loadings from the farm by about 620 lbs./day. At an annualized cost of $464,014 the incremental control cost for Step 2 is approximately $5/lb./day[7].

[7] The cost per pound per day is based on the same incremental costs analysis performed for Hopeville. As per Figure 3.4, Herb's Farm Step 1 reduces discharge by 91 lbs./day. The farm would need an additional increment of 255 lbs./day to meet the TMDL allocation, thus enabling reductions beyond this level to qualify as credits. As such, to calculate the incremental control cost, the annualized cost for Step 2 ($464,014) must be divided by 255 lbs. by 365 days.

However, reductions by Herb's Farm are likely to vary based on its unique (and sometimes unknown) characteristics. It would be impractical to measure the actual phosphorus reduction achieved on a daily basis. An alternative is to apply an uncertainty discount factor to the projected reductions achieved. A 50 percent uncertainty discount would mean, in effect, that the farm must produce 2 pounds of pollutant reductions for every 1 pound it wishes to sell. Consequently, from Pleasantville's perspective, the total cost of achieving its needed increment of control through trading with Herb's Farm will increase because it will need to purchase twice the number of credits to achieve the needed pollutant reduction. The price per pound of reduction increases from $5 to $10. This erodes somewhat the financial attractiveness of a trade between Herb's Farm and Pleasantville but is still only half as costly for Pleasantville as installing controls onsite. Also keep in mind that Herb's Farm may be willing to sell credits for less than the incremental control cost (e.g., possibly at average cost or below), depending on the return on investment the owner hopes to achieve. At the same time, the market may support a significantly higher price depending on the buyer's willingness to pay.

Incremental Control Cost Adjusted by Water Quality Equivalence Ratios

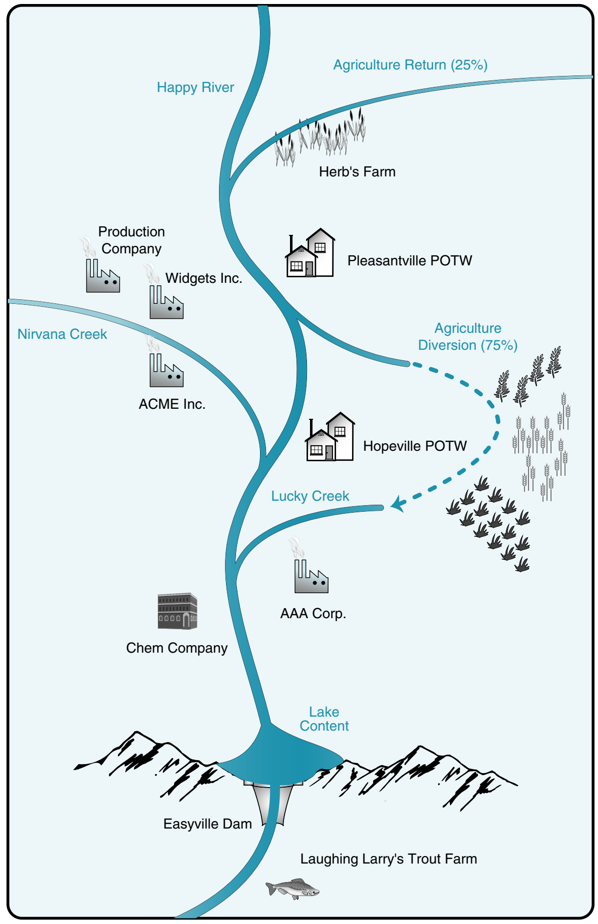
The water quality impact of a pollutant discharge varies depending on its location in the watershed. As discussed in the previous chapter on Pollutant Suitability, a discharge's impact depends on the pollutant's fate and transport as well as hydrologic conditions in the watershed. In general, when trading occurs over large areas, water quality equivalence ratios should be established to ensure that pollutant reductions traded in any part of the watershed will have an equivalent impact on water quality. Ratios can be distributed within a market to find the least cost pathway to achieving the reduction goal.

Pilot projects have used different water quality equivalence ratio methodologies ranging from the simple to highly complex. Some have used a simple fixed ratio (i.e., 2:1) for all trades. Others have created an index system based on a mass balance model that accounts for inputs, withdrawals, and groundwater infiltration. In these systems, a compliance point downstream is used to index the fate and transport of the pollutant from upstream sources. Dividing Source A's index by Source B's index determines the ratio of reductions Source A would have to buy from Source B.

Because these ratios can compare water quality equivalence only between two sources at a time, it is difficult to present a comprehensive analysis of their effects on the financial attractiveness of trading for the whole watershed in a single spreadsheet. Watersheds with a large number of sources can be extremely complex. Ten potential trading sources would involve 54 trade permutations, many of which are not likely to prove viable. The goal of your analysis should be to identify "Alpha Trades," those with potentially significant financial gains, and therefore strong financial attractiveness, even after water quality equivalence ratios are applied.

Potential Alpha Trades that may merit analysis in the Happy River Watershed are:

- Hopeville compensates Pleasantville to overcontrol;
- Hopeville compensates Herb's Farm to overcontrol;
- Acme Inc. compensates Production Company to overcontrol;
- Widgets Inc. compensates Production Company to overcontrol;
- Pleasantville compensates Herb's Farm to overcontrol; and
- Pleasantville compensates Production Company to overcontrol.



Water quality equivalence ratios can have a profound effect on financial attractiveness. As the ratio between buyer and seller increases, the amount of purchased reductions necessary to maintain compliance increases, driving the cost per unit of purchased reduction higher. Conversely, as the ratio between buyer and seller gets smaller, cost per unit of purchased reduction falls. As illustrated in the Alpha Trade analysis below, two potential trades that initially appeared robust have no or modest value after application of equivalences ratios. However, four other potential trades, remain viable. Based on this analysis there does appear to be trading potential in the Happy River Basin, and watershed participants could proceed to begin thinking about market design.

➔ Alpha Trade Analysis

Hopeville Compensates Pleasantville

Hopeville faces incremental control costs of $100/lb. Pleasantville's incremental control cost is $20/lb., while its average control cost is about $9/lb., creating a substantial control cost difference of between $80/lb. and $91/lb. Financial attractiveness appears high assuming the reductions have an equivalent effect on water quality. However, as a mass balance model indicates, the distance between the two sources and an intervening river diversion between create a water quality equivalence ratio of 5:1. Therefore, Hopeville must purchase 5 pounds of reductions from Pleasantville for every 1 pound of its own required reduction. This significantly erodes the cost differential between the parties and may, depending on Pleasantville's pricing strategy, completely erode the financial attractiveness of trading between these two parties.

Hopeville Compensates Herb's Farm

Herb's Farm has an incremental control cost of $5/lb., creating an incremental control cost difference between Hopeville and the farm of $95/lb. However, the river diversion creates a water quality equivalence ratio of 5:1 between the POTW and the farm. Therefore, Hopeville must purchase 5 pounds of reductions from Herb's Farm for every 1 pound of its own required reduction. In addition, remember that Herb's Farm has a 50 percent uncertainty discount. In this case, the unit cost to Hopeville of a one pound reduction purchased from the farm, depending on Herb's pricing strategy, could increase from $5 to $50 ($5 x 5 x 2). The difference between Hopeville's cost of controlling one pound of phosphorus or purchasing the water quality equivalent from the farm is $50/lb. ($100 - $50). This appears to remain a highly attractive potential trade.

Acme Inc., and Widgets Inc. Compensate Production Company

As explored earlier, largely due to the proximity of the three companies in the industrial cluster, their water quality equivalence ratio to one another is 1:1. In this situation, evaluating trading scenarios is simply a case of comparing the incremental cost of control for each of the facilities. As it turns out, Acme is a 40 year old facility, and control technology would be very costly to install. Acme faces a $60/lb. incremental control cost. The Widgets facility already has relatively advanced control technology; its next step of control will also be quite expensive, approximately $49/lb. Production Company, however, is a new facility with only basic control technology allowing it to improve at a significantly lower incremental control cost, $36/lb., and average cost of about $6/lb. Within the industrial cluster, the Production Company has the lowest cost of pollutant control and has the potential to overcontrol significantly and create tradeable reductions (411 lbs./day). The difference between Acme's unit control cost and Production Company's control cost is, at least, $24/lb. ($60 - $36). The difference between Widgets' unit control cost and Production Company's control cost is at least $13/lb. ($49 - $36). Both Acme and Widgets have a significant financial incentive to purchase reductions from Production Company, and Production Company may have an opportunity to sell credits at a price substantially above its cost of control.

Pleasantville Compensates Herb's Farm

Pleasantville's downstream proximity to Herb's Farm means every pound of phosphorus the farm can remove from the river achieves similar environmental benefits than if Pleasantville had made the pollutant reductions itself; they have a 1:1 equivalence ratio. However, as noted before, Herb's Farm has an uncertainty discount of 50 percent, meaning Pleasantville would have to purchase 2 pounds for every pound of reduction it needs. Therefore, the cost to Pleasantville per pound of equivalent reduction purchased (using Herb's incremental control cost) from the farm would be about $10/lb. ($5 x 2); half the cost of its own $20/lb. incremental cost of control.

Pleasantville Compensates Production Company

Pleasantville's incremental cost of control to achieve the necessary reduction is $20/lb., and Production Company's incremental cost of control for the necessary reduction is $36/lb. Initially it appears that Pleasantville would not have an incentive to compensate Production Company to overcontrol. However, water quality equivalence ratios in downstream trades can reverse the relationship between higher and lower incremental control cost sources. In the context of this example, assume Lake Content is the relevant monitoring point. To establish a trading ratio between Pleasantville and Production Company, both sources use their ratio to the compliance point (Lake Content). Production Company's ratio to Lake Content from the confluence of its tributary and the mainstem is 2:1; every 2 pounds of reduction at Production Company results in

1 pound reduction at Lake Content. The large diversion downstream of Pleasantville means only a portion of the discharge from its facilities remain in the mainstem of the river and arrive at Lake Content. Pleasantville has a ratio of 6:1; every 6 pounds of reduction at Pleasantville results in 1 pound reduction at Lake Content. The relationship between these two ratios (6:1 – to – 2:1) establishes a water quality equivalence ratio of 3:1 between these facilities. In this case, for every 3 pounds of targeted reductions, Pleasantville would need to buy 1 pound of reduction from Production Company (or 1/3 lb. for every 1 lb.). Using Production Company's $36/lb. incremental control cost, the cost to Pleasantville could be $12/lb. (1/3 x $36). Depending on Production Company's pricing strategy, Pleasantville may or may not be able to purchase reductions for less than its own $20/lb. control cost.

Transaction Costs

Transaction costs influence the financial attractiveness of a trade. Transaction costs represent all the resources needed to implement the trade, including information gathering, negotiation, execution, and monitoring. For a trade to be developed, at least one party must expend resources (usually time and effort) assessing the potential viability of the trade and communicating findings to the other party. To achieve the necessary "meeting of the minds," discussions with the other party and additional key stakeholders (i.e., regulatory agencies and local interest groups) must be undertaken. These negotiations may involve staff time, travel expenses, and legal fees. Costs are later incurred in monitoring compliance with trade agreements and maintaining communications with stakeholders.

Transaction costs should be considered in your financial attractiveness analysis. While traditional regulatory approaches to water quality have relatively predictable transaction costs, transaction costs for trading can be highly variable. Depending on such factors as the volume of trading, the program infrastructure used to facilitate trading, and the number and types of participants involved, transaction costs can be minimal or can be large enough to diminish the financial attractiveness of trading. Regulatory agencies will have significant influence on the relevant variables, and are therefore key controllers of transaction costs. Trading system designers should be attentive to the transaction costs they design into each trading arrangement. Failure to adequately control transaction costs can diminish or even eliminate the potential benefits of trading. Various market mechanisms can help manage transaction costs, such as watershed permits and nonpoint source banks. Chapter IV discusses market infrastructure in greater detail.

Several common tools can be used to estimate transaction costs. For example, Full Time Equivalents (FTEs) can be used to represent the salary and personnel overhead expenses of employees typically performing functions related to the trading market. In addition to assessing and negotiating a trade, employees will need to meet monitoring and reporting obligations related to the trade. All these transaction costs of trading, along with the annualized capital and O&M cost for each control technology step, increase incremental control cost. To the extent that you are able to include these in your annualized costs, the precision of your incremental control costs estimates will increase.

Market and Trade Risk

Risk is the final factor to consider in assessing the financial attractiveness of a trade. The first consideration is that efforts to create a trading system may or may not result in an approved trade. As already discussed, designing a water quality trading program can be complex and involve substantial costs. During initial design and negotiation, watershed participants are likely to reassess the chances of success continuously and will discount the value of a potential trade accordingly. For a trade to be viable, potential participants must believe that the financial benefits of the trade will be large enough to justify bearing the market risk. The timeliness and predictability of the decision processes prior to the first trade are therefore key leverage points to mitigate market risk and facilitate trading.

The other dimension of risk is trade risk. In a water quality trading market, one party must rely on another party(s) to fulfill its obligations. Agreed upon terms of a trade may or may not be performed by the parties. If agreed upon reductions are not achieved and NPDES permit requirements are thereby violated, the purchaser of those reductions may face legal enforcement and monetary penalties. In the context of water quality trading, trade risk represents the expected cost of non-compliance and the perceived probability that such non-compliance will occur. Currently no entity provides third-party insurance policies for water quality trading. As long as they must self-insure, watershed participants will value trade risk subjectively and mitigate for it by discounting the price paid for available reductions.

The subjective valuation of trade risk limits your ability to estimate the trade risk markdowns watershed participants are likely to demand when negotiating a trade. At this point in your analysis, it may prove beneficial to discuss trade risk and the associated discounts with other watershed participants. Risk markdowns may be considerable in light of the large noncompliance penalties authorized by the Clean Water Act and the uncertainties surrounding trade risk.

As you begin to examine trading risk and transaction costs, you may wish to review the likely incremental cost differences between parties after uncertainty discounts and location ratios are considered. If a substantial difference remains, it is likely that risk and transaction costs will erode only a portion of the remaining financial attractiveness of a trade. If uncertainty discounts and location ratios have already significantly eroded the difference in incremental control costs, the remaining financial attractiveness may well be entirely consumed by transaction costs, market risk, and the buyer’s trade risk markdown.

Implications of Transaction Costs, Risk, and Market Design

Transaction costs and risk can be mitigated to some extent through thoughtful market design. Chapter IV more fully describes the building blocks and key functions of a market and offers suggestions on how to tailor a market to its watershed’s unique characteristics. Many stakeholders may be involved, each with different needs. A highly constructive stakeholder will focus on designing a market that ensures accountability and equivalent (or better) water quality results while reducing market risk and lowering transaction costs. Transaction costs are largely associated with collecting and communicating information and obtaining agreements and regulatory approvals. To the extent that trading arrangements are transparent and straightforward to execute, costs and risks associated with communication and understanding can be reduced. Similarly, transparency and the free flow of information create stable expectations and outcomes for market participants. With fewer lurking “unknowns”, participants will feel less vulnerable in the marketplace and their required risk discount may shrink.

Other Important Factors

As you can see, the financial attractiveness of water quality trading may be highly influenced by the considerations already addressed. Other factors may arise in your watershed based on its unique characteristics. The following are just two examples of watershed-specific considerations.

Market Size

Because pollutant control technologies often produce reductions in large blocks, the water quality trading marketplace may be “lumpy.” Depending on how much reduction a potential buyer needs relative to what technology can deliver, this can limit or enhance financial attractiveness. If a discharger needs one pound per day of reductions to comply, but its only available onsite control technology is very expensive and will produce reductions well in excess of one pound per day, then that discharger’s willingness to pay another party for that one pound of reduction could be very strong. On the other hand, if the same discharger needs 200 lbs./day, they will only be willing to purchase reductions if the entire 200 pound reduction is reliably available. If that 200 pound reduction is available only from diffuse sources with small individual surplus reductions, the associated transaction costs and trade risks may be so significant that trading is not viable.

Missing the Market

The ratio of fixed (capital) to variable (e.g., operations and maintenance) costs associated with control options, combined with the timing of pollutant reduction demand and supply, will affect the financial attractiveness of a trade. If the discharger’s control option involves relatively high fixed costs, the incremental costs of control will differ dramatically before and after investment in that control option. Before investment, a potential reduction purchaser will calculate the incremental cost of control as the combination of the amortized fixed and the annual variable costs of control. Once the discharger invests in high fixed-cost controls, those fixed costs are “sunk,” and he will calculate the incremental cost of control based only on his annual variable costs. As a result, any trades that were financially attractive before the investment will have a greatly diminished incremental cost differential after the investment and may actually represent a negative financial return.

It is especially important to consider the fixed/variable cost profile in cases where supply will lag behind demand. In such situations, the potential purchaser of pollutant reductions will need to comply (i.e., meet demand) by creating its own reductions, at least initially. If this discharger needs a high fixed cost control strategy to create these reductions, the financial attractiveness of any potential future trade will be altered, probably diminished. In effect, the parties will have missed the market unless potential suppliers of pollutant reductions have low incremental control costs that can compete with the discharger’s lowered incremental control costs after its large fixed cost investment. In some cases, a discharger can use a high variable cost control strategy to create the reductions needed initially without incurring large fixed costs. In such cases, the discharger may still find it financially attractive to purchase reductions from another party in order to avoid continued implementation of its short-term, variable-cost control strategy (or in order to create additional margins for growth).

Alternative Scenarios

In light of the various factors influencing financial attractiveness and market participation, a watershed participant would be wise to assess the financial outcomes of trading under alternative assumptions. This is especially important relative to the two factors that are likely to exhibit variability due to quantification difficulties and/or subjectivity—transaction costs and perceived risk. Spreadsheet programs allow for easy scenario playing, including: removing individual participants from the market; changing water quality equivalence ratios; or projecting alternative TMDL allocation. Examining alternative scenarios may reveal, for example, that a large source unable to garner all reductions it needs from other watershed participants may decide to invest in controls and thereby eliminate almost all of the demand in the watershed, rendering trading unlikely due to insignificant remaining demand. You may discover other factors that could erode control cost differences beyond the level at which trading remains financially attractive.

On the other hand, if after accounting for credit discounts and initial consideration of transaction costs there remain multiple buyers and sellers with robust cost differences, you can be fairly confident that your watershed has met the threshold conditions for trading. The understanding gained from the analysis undertaken so far will inform your consideration of market infrastructure and how different program designs might work in your watershed.