Pollutant Suitability

Purpose

This chapter is intended to help you assess your watershed and associated pollutants for water quality trading potential. The first step is to review the pollutant characteristics and the watershed conditions. Certain pollutants and watershed conditions are more suitable for trading than others.

This chapter considers:

- What factors determine a pollutant's suitability for water quality trading in a particular watershed?
- Do the watershed conditions and pollutant characteristics warrant consideration of water quality trading in the watershed?

Pilot projects have demonstrated that nutrients, such as phosphorus and nitrogen, can be successfully traded. Less information is available about trading other pollutants, although pilot projects have explored sediment, ammonia, and selenium trading. The EPA Water Quality Trading Policy specifically supports nutrient (e.g., total phosphorus and total nitrogen) and sediment trading. However, the policy indicates that other pollutants, such as metals and pesticides, will require more scrutiny to ensure that trading can lead to meeting water quality standards. EPA will support trading of these pollutants only under limited conditions as part of a pilot project. For temperature, total dissolved gas, BOD/Ammonia, and bacteria, this Handbook cannot provide a clear "yes" or "no" answer, but this chapter should suggest whether to continue consideration of water quality trading using the following chapters.

Approach

This chapter discusses conditions needed for a pollutant to serve as a commodity that can be bought and sold in a trading system. Common commodities, like wheat, can be traded easily because buyers and sellers understand and can clearly compare the characteristics of the product. For example, with wheat, all market participants have a common understanding of the meaning of a bushel of hard, red winter wheat. For water quality trading opportunities to exist, dischargers in a watershed must establish a common understanding of the commodity that is being bought and sold, including the effects of trading on water quality.

The chapter then suggests a process for analyzing the suitability of trading a particular pollutant in a particular watershed. To enrich your understanding of the conditions that enable trading, the Handbook employs a hypothetical watershed to illustrate key points and highlight potential trading opportunities.

What is needed for a pollutant to serve as a "tradable commodity" that dischargers can buy and sell in a given watershed?

A condition for water quality trading is identification of a pollutant commodity that can be sufficiently controlled, measured, and traded by sources (possibly including both point and nonpoint sources) in the watershed or targeted market area. The four key *trading suitability factors* – Type/Form, Impact, Time, and Quantity – are related to inherent pollutant characteristics, watershed conditions, and the compliance regime.

- ***Type/Form:*** Potential trading partners must not trade "apples and oranges." Generally, they must identify a single pollutant, in a common form. For example, dischargers could trade Total Phosphorus, but might not be able to trade soluble for non-soluble forms of phosphorus. In some cases, different pollutant types (e.g., Total Phosphorus and Dissolved Oxygen) can be traded using a defined translation ratio based on the quantities of each that have an "equal" overall effect on water quality.
- ***Impact:*** There must be environmental equivalence between the discharge points of purchase and sale to ensure that the water quality impact will be at least equivalent to, if not in excess of, established water quality-based requirements. For example, participants must predict the water quality effects of a one pound phosphorus reduction as required by a TMDL at one point in a watershed compared to a reduction of one pound (or more or less) at another point downstream.
- ***Time*:** Participants must consider and work to align two time dimensions to support a trade. First, purchased reductions must be produced during the same time period that a buyer was required to produce them (e.g., during the permit compliance reporting period or during the same season when the permit limit was applicable). Second, TMDL compliance deadlines must reasonably align as sources consider their options for meeting future reduction obligations.
- ***Quantity:*** Overall supply and demand must be reasonably aligned. The total amount and increments of reductions available must reasonably align with the needs of potential purchasers.

For water quality trades to occur, potential trading partners must be able to align all four suitability factors.

The Six Step Suitability Analysis

This section will help you examine the four trading suitability factors. For each factor – Type, Impact, Time, and Quantity – this section provides additional background information and examples in the form of six steps. Each step involves a series of questions to evaluate whether potential trading partners will be able to establish a tradable commodity. To help answer the questions, the inherent characteristics of a number of common pollutants are provided. Appendices A, B, and C contain this information. Stakeholders should also consider TMDLs, implementation plans, NPDES permit language, and other local assessments and requirements to evaluate specific sources or conditions in your watershed.

STEP ONE: CREATE A WATERSHED DISCHARGE PROFILE

The purpose of this step is to characterize the pollutant(s) of concern that are discharged in the watershed or defined trading area. You will use this information in later steps to evaluate suitability and, in the next chapter, the financial attractiveness of trading. During this step, it will be important to understand the type/form, location, and quantity of pollutants being discharged from point and non-point sources.

One way to display this information is to use a simple chart, as in Figure 1.1. You will complete only certain columns during this step; in subsequent steps you will gather more information to fill in additional columns. In the example that follows, this same format is used to create a profile for the sources in a hypothetical watershed.

Figure 1.1 : Template for Creating a Watershed Discharge Profile

Name of Discharge Source, Diversion, Agricultural Drain, or Tributary	Discharge Location	Form of Pollutant		Timing		Quantity			
	River Mile	As Addressed by TMDL	As Discharged	Discharge (e.g., seasonal, cyclical, etc.)	Obligation (Regulatory)	Baseline Load* (lbs./day)	Current Load* (lbs./day)	Target Load* (lbs./day)	Total Reduction Needed* (lbs./day)
Source #1									
Source #2									
Diversion #1									
Return #1									
Source #3									

* The **Baseline Load** is the amount of discharge used to develop a TMDL. During TMDL development, a specific year or flow rate is typically chosen to characterize the discharge behavior of point and non-point sources. This information can be found in the TMDL. The **Current Load** is the amount of pollutant discharged as you analyze the watershed for trading viability. The **Target Load** is the amount of pollutant discharge allocated to each source in the TMDL. The **Total Reduction Needed** is the difference between the Current Load and the Target Load.

You can typically find information to complete the chart in the text of a TMDL, in the TMDL implementation plan, or from other sources in the local watershed. For example, information about quantities discharged by point sources is contained in TMDL analyses and in the relevant NPDES permits (permit numbers are often listed in the TMDL). The TMDL will typically describe quantities discharged during a selected baseline period (e.g., 1995), current discharges (or "loads"), and the TMDL's specified waste load allocation for each point source based on a calculation of what is required to meet desired instream concentrations and achieve water quality standards. Additional guidance is provided in the following chapter (Financial Attractiveness) about calculating quantities associated with projected future growth. For nonpoint sources, TMDLs generally do not provide data about each individual source, but estimate quantities from selected reaches, inflows, or tributaries. Additional information about cropping patterns and agricultural practices in each area will be needed to estimate current loads from individual sources.

This profile offers a coarse initial screen for water quality trading viability. For example, if there are no major point sources in the watershed that are required to reduce pollutant loads, or if only a small number of widely dispersed sources discharge small quantities of the pollutant of concern, trading may not be viable. On the other hand, a watershed that includes a point source with large reduction obligations and many other closely clustered sources of the same pollutant may present opportunities for water quality improvements and other environmental benefits at lower cost through trading.

The questions below will help create a profile of pollutants being discharged into the watershed. It is important to gather as much of this information as possible because you will need it in later steps to evaluate suitability more specifically with regard to pollutant type/form, impact, time, and quantity.

For each source of the selected pollutant in the watershed:

- What is the geographic location of the discharge (by river mile)?
- What form of the pollutant is discharged (and/or controlled) by the source?
- What quantity of the pollutant does the source discharge? If possible, this should include current loads and allocated loads from the TMDL, along with any seasonal or other cyclic load variability considerations.

Overview of Happy River Basin

To demonstrate how you will use the information gathered to assess trading opportunities, a hypothetical watershed, the Happy River Basin, is presented below.

A number of segments along the Happy River currently experience nuisance aquatic growth conditions. A TMDL for phosphorus has recently been completed for the main stem of the river, providing Waste Load Allocations for the permitted point sources and Load Allocations for the nonpoint sources and tributaries. The TMDL indicates that, to achieve water quality standards, the concentration of phosphorus in the water column must be at or below .07 milligrams per liter along the entire river with monitoring stations established for compliance purposes. Eight sources of phosphorus discharge in the basin.

- Herb's Farm, a family-owned farm growing a range of crops, is located on an irrigation district controlled return flow which enters the Happy River at RM (river mile) 570.
- Pleasantville POTW (publicly owned treatment works), a municipal wastewater treatment plant owned and operated by the City of Pleasantville, is located at RM 567.
- Acme Inc., a food processing facility, is located four miles up Nirvana Creek, a tributary to the Happy River. The creek currently meets water quality standards and is not subject to a TMDL; therefore, Acme has not received a Waste Load Allocation. However, the Happy River TMDL provides a Load Allocation requiring a reduction in the phosphorus loads entering Happy River from Nirvana Creek. The creek's confluence with the Happy River is at RM 547.
- Hopeville POTW, a municipal wastewater treatment plant, owned and operated by the City of Hopeville, is located at RM 546.
- AAA Corp., a sugar mill owned and operated by a multinational corporation, is located three miles up Lucky Creek, a tributary to Happy River. AAA Corp. is required to meet a Waste Load Allocation provided in the Lucky Creek TMDL, which was finalized two years ago. Lucky Creek enters the Happy River at RM 544 and has been given an allocation at its confluence with the main stem.

- Ortho Company is a chemical manufacturing plant and a major discharger of phosphorus located downstream of Hopeville at RM 541.
- Easyville Dam, owned by Peaceful Power Company, is located downstream, at the end of Lake Content, a fifty-mile long reservoir, which is the pool behind Easyville Dam. The dam does not produce phosphorus. However, the power company has been given a load allocation under the TMDL to improve depressed levels of dissolved oxygen (DO) in the reservoir. The Dam sits at RM 490.
- Laughing Larry's Trout Farm, a privately owned aquaculture facility, is located at River Mile 489, below the Easyville Dam.

Figure 1.2 : Schematic Map of Happy River Basin

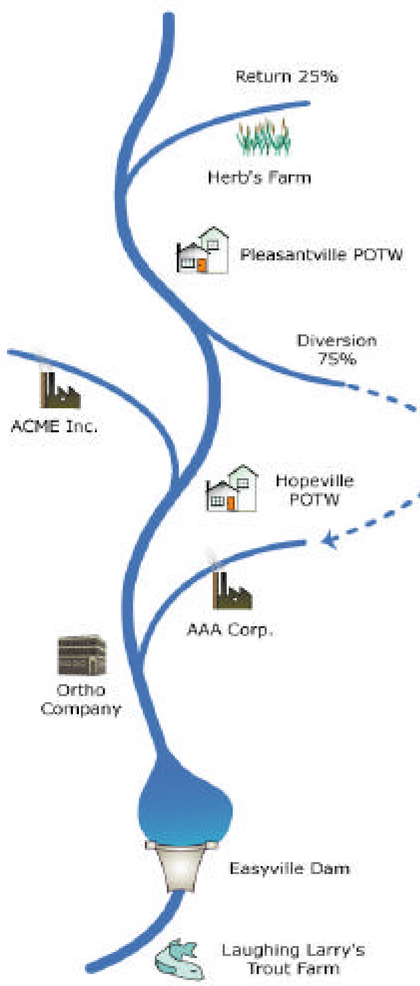

Figure 1.3 : Chart of Sources with Location, Pollutant Form, and Quantity Information

Name of Discharge Source, Diversion, Agricultural Drain, or Tributary	Discharge Location	Forn of Pollutant	Quantity			
	River Mile	As Addressed by TMDL	Baseline Load* (lbs./day)	Current Load* (lbs./day)	Target Load* (lbs./day)	Total Reduction Needed (lbs./day)
Drain A--Herb's Farm	570	Total Phosphorus	632	753	527	226
Pleasantville	567	Total Phosphorus	760	791	633	158
Acme Inc. (Nirvana Creek Confluence)	547	Total Phosphorus	492	547	410	137
Hopeville	546	Total Phosphorus	60	62	50	12
AAA Corp. (Lucky Creek Confluence)	544	Total Phosphorus	199	195	166	29
Ortho Company	541	Total Phosphorus	786	1645	655	990
Laughing Larry's Trout Farm	489	Total Phosphorus	185	250	154	96

*Note: Nirvana Creek and Lucky Creek have received allocations at their confluene with Happy River. The Baseline, Current, and Target Loads displayed are for the actual point of discharge to the tributary and are derived from the discharges' environmental impact at the confluence with Happy River.

STEP TWO: IDENTIFY TYPE/FORM OF POLLUTANT DISCHARGED BY SOURCES

The purpose of Step Two is to help evaluate whether sources are discharging the same *type and/or form* of pollutant. Type/Form is the first of the four factors that must be aligned among dischargers for trading to be viable. Sources must first determine that there is a common *type* of pollutant to be traded (e.g., phosphorus, sediments, or temperature). *Types* of pollutants may or may not be sufficiently correlated to allow trading. Even if sources are discharging the same type of pollutant, the form of pollutant as discharged may differ from source to source. Current practice requires that pollutant trading systems use an identified controllable pollutant common to all potential market participants. This establishes a "common currency" with which market participants can evaluate offers of behavior change from others.

A. Determine if sources are discharging the same form of pollutant as regulated by the TMDL.

Using the information developed in Step One, identify the form of pollutant addressed in the TMDL, and the form discharged by each identified source. In some cases, the form-suitability determination may be simple. If the TMDL has provided the majority of dischargers an allocation expressed as the same form of the pollutant (e.g., Total Phosphorus), then potential trading participants will have a solid match. For example, phosphorus loading is often regulated in TMDLs because excessive phosphorus concentrations encourage nuisance aquatic growth, reduce dissolved oxygen levels, and result in violations of water quality standards. In many cases, TMDLs provide load allocations for Total Phosphorus, rather than soluble or non-soluble forms because Total Phosphorus can be easily measured in monitoring samples.

Although Total Phosphorus is the pollutant form being measured, most sources discharge a combination of phosphorus forms (e.g., soluble or non-soluble). However, certain pollutants, including phosphorus, may pose difficulties even if the TMDL assigns allocation of a single pollutant form to all dischargers. (See Appendix A for more information.) For example, if individual dischargers have load characteristics that vary widely (e.g., one primarily discharges soluble phosphorus while another primarily discharges non-soluble sediment attached phosphorus) then a trade between the two may not be environmentally equivalent. As trading opportunities are considered in a watershed, it will be important to understand the actual forms of the pollutant being discharged by each source to assure that trades represent an equivalent impact on water quality.

The following questions are intended to help assess whether the pollutant can be treated as a “tradable commodity” based on commonality of the form of the pollutant being discharged.

- What is the form of pollutant addressed in the TMDL? For each pollutant, does the TMDL provide load allocations for more than one form?
- Do sources discharge the same form of the pollutant? If not, what form is discharged?
- What are the impacts of concern for this pollutant and do they vary by the different forms (if any) discharged?

In answering these questions, if you find that, 1) the TMDL provides load allocations for a single pollutant form; and 2) sources in a watershed discharge and measure that same form—you are in a strong position to continue the trading analysis. If this is the case, proceed to Step Three, to evaluate the potential for establishing environmental equivalence. If this is not the case, use the next set of questions in Step Two (B) to consider whether you can establish translation ratios between different pollutant types or forms.

B. Determine if there are opportunities to trade between different forms of the same pollutant, or between different types of pollutants.

This section considers circumstances in which different forms or types of a pollutant might be involved in a water quality trade. For example, if the TMDL provides load allocations for different forms (e.g., chemical compounds) of the same pollutant, you would need to assess the potential for establishing a *translation* between them. In some instances, such a translation can make it possible to trade more than one form of pollutant by defining the ratio at which the two forms may be exchanged with an “equal” effect on water quality. Without a reliable, scientifically defensible translation basis, it may be impossible to trade different forms of a pollutant.

In some cases, trading can even occur between two different types of pollutants if there is sufficient information to establish translation ratios that describe how they interrelate. For example, reductions in upstream nutrient levels can improve downstream dissolved oxygen levels or biochemical oxygen demand. The EPA Water Quality Trading Policy supports cross-pollutant trading for oxygen-related pollutants when translation ratios can be established.

The following questions should be answered if you are considering trading more than one form of the same pollutant, or if you are considering trading two different types of pollutants. (This will also help you identify situations where a TMDL provides load allocations for a single form, but sources actually discharge very different forms that have different impacts on water quality.) Establishing translation ratios requires adequate data and analysis about how pollutants behave under specific watershed conditions. If it appears that the data or analysis cannot be developed, water quality trading opportunities will be limited.

- If different forms are being discharged, is there sufficient information to establish a translation basis between those different forms of the pollutant?
- Is the pollutant measured/regulated directly or by using an indicator of its indirect effects on water quality? Has a basis for translating direct regulatory limits to indirect effects been established?
- Is there a typical causal relationship between this pollutant and others? Has a specific translation relationship been established between two pollutants within this watershed?

Type/Form: Exploring Potential Trading Opportunities Between Dischargers

The hypothetical TMDL provides Total Phosphorus load allocations for all dischargers located on the main stem of the Happy River. Lucky Creek, where AAA Corp. discharges, has a phosphorus TMDL in place and AAA is subject to a WLA. Because these dischargers have allocations for the same form of phosphorus, and their loads have reasonably similar form characteristics, they will be sufficiently matched to proceed with further consideration of trading.

The following examples of potential trades illustrate how pollutant form and type play a role in assessing the viability of trading in a watershed.

Pleasantville POTW and Hopeville POTW. The discharges from the two POTWs located at Pleasantville and Hopeville contain a similar combination of both soluble and non-soluble attached forms of phosphorus. Because the discharges will be measured using the same form of phosphorus (Total Phosphorus) and the actual forms discharged are also very similar, trading opportunities between these two sources can exist.

Herb's Farm and Pleasantville POTW. Herb's Farm is the only farm located on the irrigation district drain flowing into the Happy River at RM 570. Although the phosphorus entering the river through this agricultural drain is likely to be primarily the non-soluble sediment attached form, Total Phosphorus will be the form measured to monitor compliance with the TMDL load allocations. The discharge from the Pleasantville POTW, which contains a different combination of actual phosphorus forms than the Herb Farm drain, will also be measured and reported in units of Total Phosphorus. Although both dischargers will be measuring and reporting the same form of phosphorus, this trade might raise concerns because these sources are discharging different combinations of phosphorus forms. However, in practice, the trade is not likely to create localized impacts, and trading opportunities between these two sources can exist.

Easyville Dam and Hopeville POTW. Easyville Dam has a load allocation for dissolved oxygen (DO), not for Total Phosphorus (TP). Phosphorus loading in the Happy River above the dam contributes to nuisance aquatic growth in the reservoir, which is the major cause of violations of water quality standards related to DO. Hopeville POTW has a waste load allocation for Total Phosphorus. The operators of the dam have expressed interest in substituting upriver TP reductions for more direct DO enhancement efforts in the reservoir (e.g., direct oxygenation) to meet its allocation. A clear causal relationship does exist between phosphorus loading and DO levels, and the TMDL modeling provides a basis for developing a translation ratio to support TP to DO trading. If a reliable translation ratio can be established between the two types and the two sources, trading opportunities between these two sources can exist. In the absence of such a translation ratio, however, Easyville Dam would lack the basis for trading in the Happy Basin market.

Figure 1.4, Chart of Sources with Type of Pollutant in TMDL, and Type of Pollutant actually discharged.

Name of Discharge Source, Diversion, Agricultural Drain, or Tributary	Location	Form of Pollutant	
	River Mile	As Addressed by TMDL	As Discharged (% Soluble/ % Non-Soluble)
Herb's Farm	570	Total Phosphorus	30/70
Pleasantville	567	Total Phosphorus	90/10
Acme Inc. (Nirvana Creek Confluence)	547	Total Phosphorus	100/0
Hopeville	546	Total Phosphorus	90/10
AAA Corp. (Lucky Creek Confluence)	544	Total Phosphorus	100/0
Ortho Company	541	Total Phosphorus	100/0
Laughing Larry's Trout Farm	489	Total Phosphorus	50/50

STEP THREE: *DETERMINE THE POTENTIAL ENVIRONMENTAL EQUIVALENCE OF DIFFERENT DISCHARGE POINTS*

The purpose of Step Three is to evaluate the location of potentially tradable discharges and relevant receiving water conditions to determine whether the environmental impact is equivalent. Environmental impact is the second of the four factors that must be aligned for trading to be viable. Your Step One watershed discharge information will give you the location of the pollutant discharges. Participants must be able to establish that the trade would result in the same (or better) environmental improvement in the receiving water if pollutant loadings are reduced in the seller's discharge rather than in the buyer's.

Two related factors influence environmental equivalence. First, the fate and transport characteristics of a pollutant (e.g., how it behaves in a river system) must be considered. Second, the unique conditions of the watershed must be evaluated. The pollutant's concentration or presence and its effects on water quality may vary greatly as it moves from upstream to downstream. For example, a pound of phosphorus discharged into a river can "disappear" as it travels down a river through uptake by aquatic plants, settling out, and/or water diversion for agricultural or other uses. This can diminish the environmental value of a purchased pollutant reduction as it travels downstream. Purchasers therefore may be required to buy more total loading reduction from other sources than would have been required at their discharge point . Some trading systems use pollutant "equivalence ratios", or similar mechanisms, to establish the necessary environmental equivalence relationships. In these systems, each source or trade transaction is assigned a ratio to account for the effects of inputs, withdrawals, and diversions between the seller's and buyer's discharge points and all relevant compliance points. These ratios depend on pollutant parameter stability as well as the distance, river hydrology, and other relevant environmental conditions.

In general, the greater the geographic distance between discharge points, the greater the chance of high volume pollutant uptake and settlement, and/or complex hydrology in the receiving waters between those points. Therefore, sources in close geographic proximity are more likely to be able to establish a straightforward environmental equivalence relationship. In some cases, the influence of diversions and tributaries may be too great to establish reliable impact relationships.

How Ratios Are Used to Establish Environmental Equivalence

Most trading systems use equivalence ratios, or similar mechanisms, to adjust for the complex fate and transport characteristics of pollutants and variable watershed conditions. In these systems, each source or trade transaction is assigned a ratio to account for the effects of inputs, withdrawals, and other effects on the pollutant between the seller and buyer's discharge points, and any other monitoring points, to assure the equivalent environmental impact from pollutants present in the water column. Ratios allow trading partners to adjust the amount of reductions to assure trades create environmentally equivalent outcomes at the point(s) of environmental concern. Ratios are often based on each source's location along the river, tributary, or agricultural drain in relation to other market participants and/or designated instream compliance points. They can also be based on other site location factors that reflect the potential for further diversion and reuse of water below the point of discharge. Other site location factors for nonpoint sources include soil type and permeability, slope, vegetation, amount of rainfall, etc. Some demonstration programs use separate ratios to account for river location and other site location factors. Others use a composite ratio that accounts for all factors.

The example of phosphorus helps illustrate why equivalence ratios are needed. A pound of phosphorus discharged upstream may not arrive as a pound of phosphorus at a given point downstream. Some may be lost as the stream is diverted for agricultural use or for other water supply needs. Phosphorus can also drop out of the water column and be deposited as sediment, transmitted to groundwater through infiltration, or taken up by plants along the way.

The ratio reflects the best estimate of the effect of a reduction that will be realized at the buyer's discharge point, or other compliance points. For example, a 3:1 ratio indicates that for every three pounds of phosphorus released by a discharger, one pound will reach and have an environmental effect on water quality at the critical monitoring point. River location ratios are often calculated using modeling. Often, modeling (such as mass balance calculation) has already been used for TMDL development.

Appendices A, B, and C of this Handbook provide information about the inherent characteristics of selected pollutants that is relevant to how they may behave in receiving waters. You will also need to collect information about relevant conditions in your specific watershed, such as the locations and volumes of major inflows and outflows. If necessary data or reliable models are lacking, or pollutant fate and transport characteristics are very complex, uncertain, or unknown, conditions for trading may not be favorable.

Localized Impacts

Some potential trades that could result in a general water quality improvement in a broad area may also result in acute, localized impacts. Trades that create "hot spots" -- localized areas with high levels of pollution within a watershed – should be avoided. The following factors should be considered.

- *Characteristics of the Pollutant--*
  - *Each pollutant poses different risks to local water quality.*
- *Watershed conditions--*
  - *Areas that have no additional assimilative capacity for the relevant pollutant may show localized impacts if loads are increased.*
  - *Areas with low flows and/or a high capacity for retentiveness will be more likely to show localized impacts.*
  - *The presence of other pollutants will affect the potential for localized impacts.*
- *Type of trade--*
  - *Downstream trades (i.e., a source compensates a source downstream to overcontrol its discharge) have greater risks of localized impacts because if the buyer's discharge exceeds its TMDL allocation, loads in the stream segment between the sources may be too high.*
  - *Upstream trades (i.e., a source compensates a source upstream to overcontrol its discharge) present lower risks because overcontrol by the upstream discharger will result in improvements to water quality beyond those specified in the TMDL in the segment between the sources.*
- *Use of monitoring--*
  - *Monitoring programs designed to support trading should identify potential localized impacts and provide for control regime modifications to mitigate impacts.*

Answering the following questions will help you assess the potential environmental equivalence between discharges. Information to help answer these questions can be found in the Watershed Discharge Profile developed in Step One, in Appendices A, B, and C, and in relevant TMDLs.

- Where are the discharges of the relevant pollutant?
- Where are the major hydrologic inflows and outflows?
- What are the general fate and transport characteristics of the pollutant?
- How do river conditions, such as flow rate and temperature, affect the behavior and impact of the pollutants?
- Is there a potential for localized impacts? Under what conditions?
- What options need to be considered for establishing environmental impact equivalencies for different areas of the river?

Water quality trading is one of several tools available to implement TMDLs. Trading requires understanding the effect of pollution reductions by sources at different points in the watershed. Trades that result in localized impacts and fail to meet water quality standards are not acceptable. It is possible to use predictive models to estimate the environmental equivalence of different discharges, but water quality monitoring will be an essential element in any trading program to ensure that water quality goals are achieved.

Environmental Equivalence: Exploring Potential Trading Opportunities Between Dischargers

Information on the general fate and transport characteristics of phosphorus is provided in Appendix A. With that information in mind, you are ready to take a closer look at the specific conditions in the Happy River Basin watershed to assess the potential environmental equivalence and trading opportunities among dischargers.

The following examples of potential trades illustrate how environmental equivalence can play a role in assessing the viability of trading.

Herb's Farm and Pleasantville POTW

Herb's Farm is the only identifiable source located on an agricultural drain that empties into the Happy River at RM 570. The Pleasantville POTW discharges nearby, only three miles downstream. Because of swift flowing water, no other intervening diversions or returns, and little plant life between the two sources, the equivalence ratio between the two dischargers is close to 1:1. (Trades involving other sources will require calculation of separate ratios.) Because of the low equivalence ratio between Herb's Farm and Pleasantville POTW, opportunities for water quality trading between these two dischargers can exist.

Pleasantville POTW and Hopeville POTW

The Hopeville POTW is located over 21 miles from the Pleasantville POTW. Between Hopeville and Pleasantville is one major agricultural diversion, which diverts 75 percent of the flow of the river. Because of the diversion and resulting slower river flow, as well as plant uptake and other factors, trades between Hopeville and Pleasantville will have a 5:1 ratio.

There are two potential options for trading between the POTWs. One option is an "upstream trade," in which Pleasantville overcontrols phosphorus reductions beyond its waste load allocation to create reduction credits. In this case, Hopeville would purchase reduction credits from Pleasantville. However, because of the 5:1 ratio, Hopeville would need to purchase five pounds of reductions at Pleasantville to achieve an equivalent reduction of one pound of phosphorus at its plant. (This may or may not be cost effective for Hopeville.) Pleasantville would then reduce its phosphorus discharges beyond its waste load allocation and water quality in the 21 mile segment would be improved beyond that specified by the TMDL. This trade should also result in improved water quality in the river segment below Hopeville.

Another option is a "downstream trade," in which Hopeville reduces its phosphorus discharge beyond its TMDL allocations and Pleasantville purchases reduction credits from Hopeville. In this example, Pleasantville would not meet its TMDL waste load allocation and this will result in no phosphorus reduction in the 21 mile segment between the two dischargers. However, water quality downstream of Hopeville would improve as a result of its overcontrol. A downstream trade such as this would satisfy the TMDL only if the water quality impairment occurs in the river segment below Hopeville and not between Pleasantville and Hopeville. It is possible that, Pleasantville's TMDL waste load allocation was established to reduce its contributions to impairments below Hopeville. However, except in such unique circumstances, the elevated concentrations of phosphorous in the 21 mile segment between the sources is likely to cause unacceptable localized adverse impacts.

Laughing Larry's Trout Farm and Hopeville POTW
Laughing Larry's Trout Farm is located downstream of Lake Content, the reservoir behind Easyville Dam. A reliable location ratio has not been established for the trout farm that would allow it to trade with any dischargers located upstream. The complexity of the river ecosystem increases significantly in this area of the Basin as water flows through the reservoir. The slower moving water promotes aquatic plant growth and higher retentiveness of phosphorus in this area. The fate and transport characteristics of phosphorus and the complexity of the watershed conditions make it difficult to predict how phosphorus reductions above the dam will affect water quality at locations below the dam. This high level of uncertainty will likely prevent development of a ratio allowing Laughing Larry's to trade in the Happy River market area.

STEP FOUR: *DETERMINE THE POTENTIAL FOR ALIGNING THE TIMING OF LOAD REDUCTIONS AND REGULATORY TIMEFRAMES AMONG DISCHARGERS*

Timing is the third factor that must be in alignment for trading to be viable. In Step Two, you considered the variability among discharges in terms of the *forms* of a pollutant or *types* of pollutants. In Step Three, you considered the variability of geographic *locations* in the watershed. In this step, you will consider how discharges from different sources vary across *time* and the implications of this variability for the viability of trading. Three timing dimensions must be considered. Alignment of all three is needed to match trading partners.

Load variability: A discharger's load is likely to vary from time to time. You will need to identify only major load variations that occur over the course of the year, not minor fluctuations in discharges. For example, some POTWs reduce discharges to zero by substituting land application during summer months. Some agricultural nonpoint sources have significant reductions of nutrient loadings during the winter months. One important consideration is whether the load allocations in the TMDL are seasonal or annual. Potential trading partners must meet TMDL timing requirements and also link up with other sources with similar discharge timing. Because of the effects of temperature and sunlight, for example, winter nutrient loadings have very different environmental impacts from summer loadings.

Compliance determination variability: Because of the different considerations in establishing appropriate NPDES permit limits, as well as other factors such as the cost of monitoring, the temporal specifications for discharge monitoring and compliance determinations vary among dischargers (e.g., some have monthly limits, others have daily limits, and some have both). To be viable, a trade must be consistent with the time periods that are used to determine compliance with permit limitations or other regulatory requirements. For example, a point source with a permit that requires compliance with monthly average limitations will be able to trade only with a discharger who can demonstrate monthly reductions.

Compliance deadline variability: For a viable trade, dischargers' compliance deadlines must be reasonably aligned. For example, a potential purchaser may need to meet pollutant reduction requirements in 24 months. It may take twelve months to fund, install, and fully implement the pollution control technology needed to meet those requirements. Such a potential purchaser cannot wait 18 months while a potential reduction provider verifies its own obligations, selects its mitigation option, and calculates any surplus reductions available for purchase. In some cases, potential market participants may have different compliance deadlines because they are located in nearby tributaries with different TMDL implementation schedules.

Much of the information required to assess time dimension variability in Step Four will be found in the TMDL and NPDES permit language specific to each watershed and source. Appendices A, B, and C also include a discussion of the typical range of regulation for each pollutant.

Answering the following questions will help determine the potential alignment of schedules in terms of seasonal requirements, metrics for pollutant limits, and deadlines for compliance. If participants are unable to align all three dimensions of time, trading may not be viable. It is not necessary for all sources in the watershed to align their compliance schedules; however, a sufficient number must be aligned to support one or more beneficial trades.

- Permit and TMDL Compliance Periods-
    - Does the TMDL establish seasonal allocations or year-round reductions?
    - What units of time are used to define and monitor compliance with relevant permit limits?
    - What time period is used by non-permitted dischargers (e.g., nonpoint sources) to measure and, where applicable, report discharges? (Hourly, daily, weekly, annually?)
    - Do any sources have significant seasonal or other cyclical load variability?
- TMDL Compliance Deadlines-
    - Has a TMDL implementation schedule been established? If so, do compliance schedules among major dischargers reasonably match up?
    - Are there other compliance deadlines (e.g., permit requirements based on national effluent guidelines) that must be considered?

Timing: Exploring Trading Opportunities Between Dischargers

Three types of timing issues present challenges to potential trading partners in the Happy River Basin. The following examples illustrate issues relating to (1) seasonal load variability, (2) compliance determination variability, and (3) compliance deadline variability.

Herb's Farm and Pleasantville POTW (load variability)
Pleasantville POTW operates year-round, with some minor variation in the amount of phosphorus in its discharge. Herb's Farm contributes to phosphorus loading in the river only during the growing season. In the winter, when farmland is frozen over, the farm contributes very little phosphorus.

If the TMDL required year-round load reductions to meet Pleasantville's waste load allocations, Herb's Farm would not be able to produce reductions for the entirety of the relevant time period. However, the Happy River phosphorus TMDL is typical of other phosphorus TMDLs and

Hopeville POTW and Pleasantville POTW (compliance determination variability)
In this hypothetical, both POTWs are regulated by NPDES permits with limits expressed in similar temporal terms (e.g., monthly averages). These closely matched limits help support water quality trading opportunities between the POTWs.

AAA Corp. (compliance deadline variability)
AAA is located on Lucky Creek, a tributary to the Happy River. Lucky Creek has its own separate TMDL and implementation plan. AAA was given a waste load allocation under the Lucky Creek TMDL. The Lucky Creek and Happy River TMDL plans have different compliance deadlines, so there is a potential timing misalignment. If the TMDL for Lucky Creek had not yet been completed, AAA might not be able to participate in the trading market with Happy River dischargers. However, because the Lucky Creek TMDL has been completed, AAA currently has sufficient knowledge about its requirements. With this knowledge, they may be able to align the timing of their compliance efforts in order to participate.

STEP FIVE: DETERMINE IF THE SUPPLY OF AND DEMAND FOR POLLUTION REDUCTION CREDITS IS REASONABLY ALIGNED WITHIN THE WATERSHED

The watershed discharge information developed in Step One should include quantities of the relevant pollutant discharged by the sources in the watershed. In this Step, that information will be analyzed to determine whether supply and demand are reasonably aligned. For trading to be viable, the quantity of reductions that can be supplied must meet or exceed the quantity of reductions needed to ensure compliance.

Demand for reductions is driven by current and future loads (what dischargers are currently discharging or expect to discharge in the future), as compared to target loads (what the TMDL allows sources to discharge). For individual nonpoint sources, estimates of these quantities are not normally specified in the TMDL, and so will need to be calculated, using aggregated nonpoint discharge data from the TMDL along with other information, such as data developed by soil conservation districts. The TMDL will provide information about current and target loads from inflows and tributaries. Methodologies for calculating historical, current, and target loads for individual non-point sources along each inflow and tributary may differ from watershed to watershed and from state to state. These calculations may have a high degree of uncertainty, but can produce a valuable rough understanding of the supply and demand dynamics in the watershed.

Supply is dictated by a discharger's ability to "overcontrol," or reduce its discharges below the target load specified by the TMDL. The volume of reductions achieved beyond TMDL obligations represents the stock of potential surplus reductions available for exchange with other parties. The increments, or range, of reductions demanded and supplied will determine whether a match is possible. The quantity of reductions that may be supplied is determined by the efficacy of control techniques and management methods available to sources. These techniques and methods include altering industrial product production levels or land management practices, substituting inputs such as raw materials and agricultural chemicals, or investing in new technology.

In the next chapter, the financial feasibility of various control options are examined as a factor in projecting supply and demand. At this stage, answering the following questions will help develop an initial understanding of the supply and demand dynamics in the watershed. If it appears that the supply of reductions can reasonably meet the demand, then trading may be a viable tool to address water quality problems.

- For each relevant discharger, what are the quantities of current/future loads compared to target loads?
- For each discharger, what is the capacity to provide reductions beyond applicable required TMDL load allocations (i.e., do they have the technical capacity to generate overcontrol)?

Supply and Demand: Exploring Trading Opportunities Among Dischargers

It is often difficult to project the balance of supply and demand for reductions. In the Happy Basin hypothetical, you have a general idea of the total amount of reductions needed by all sources to meet TMDL load allocations. In the next chapter on Financial Attractiveness, the Handbook will examine how differing costs of control options may make some sources likely buyers and others likely sellers. But even at this stage, some early supply and demand patterns begin to emerge.

The following examples illustrate how supply and demand plays a role in assessing the viability of trading.

Acme Inc. and Hopeville POTW (Supply and Demand in Balance)
Hopeville has projected that it will need to reduce phosphorus discharges by 12 pounds per day to meet TMDL target allocations. (See Figure 1.5, Chart of Sources with total reductions needed by Happy River dischargers.) Hopeville may consider purchasing reduction credits from Acme Inc. rather than investing in control technology that is projected to produce considerably greater pollutant loadings reductions than it needs. To meet its load allocation, Acme also expects to install control technology with potential to overcontrol, thus generating potentially saleable reduction credits. Other dischargers in the Basin also have potential to generate a sufficient supply of reduction credits to meet Hopeville's demand.

Ortho Company (Demand outstrips Potential Supply)
Ortho Industries, located at River Mile 541, is a major discharger of phosphorus. To meet its TMDL waste load allocations, Ortho will need to reduce its discharges by about 990 lbs./day. Ortho is considering an on-site control option that will meet its allocation. It is also considering purchasing reductions from other dischargers in the Basin. For cost reasons, Ortho has decided to focus on a "one size fits all" control technology package. There is no available alternative that would allow for a blended strategy that includes the use of both a less effective, less costly technological treatment control option and purchased reductions from other dischargers. Ortho must choose trading or on-site control. As Ortho considers purchasing reductions from other dischargers, it will need to project whether the potential supply of reductions will meet its demand (i.e., enable it to comply fully with its waste load allocation). The calculated ratios needed to ensure environmental equivalence are likely to at least double the reduction needed, increasing Ortho's demand to approximately 2000 lbs./day. Using Figure 1.5, Chart of Sources, you can calculate that it will be almost impossible for the remaining dischargers in the Basin to create a sufficient supply of reduction credits to meet Ortho's demand. Even if all other sources reduced their phosphorus discharges to zero, the supply of reduction credits generated by such overcontrol would total only about 1900 lbs./day. Ortho can see that trading will not be an option for its compliance plan because the supply of reductions cannot meet its demand.

STEP SIX: REVIEW THE RESULTS OF STEPS ONE THROUGH FIVE TO COMPLETE THE POLLUTANT SUITABILITY DETERMINATION

Before moving on to the next chapter, review the outcome of the suitability analysis in the five steps above. Pollutant suitability requires a high potential that all four suitability factors will be in alignment for at least two market participants. If any one of the five Pollutant Identification steps (i.e., watershed discharge profile, type/form, location, timing, and supply/demand) show low potential for alignment, the pollutant is probably not suitable for water quality trading in this watershed. Unless the pollutant has a medium to high potential for all four factors, further analysis to assess water quality trading of this pollutant in your watershed is probably not warranted. However, the user may wish to consider whether other pollutants discharged by sources in the watershed may have potential trading.

Figure 1.5, Complete Discharge Profile with all pertinent information

	Location	Form of Pollutant		Timing		Quantity			
Name of Discharge Source, Diversion, Agricultural Drain, or Tributary	River Mile	As Addressed by TMDL	As Discharged (Soluble/Non-Soluble)	Discharge (e.g., seasonal, cyclical, etc.)	Obligation (Regulatory)	Baseline Load* (lbs./day)	Current Load* (lbs./day)	Target Load* (lbs./day)	Total Reduction Needed* (lbs./day)
Herb's Farm	570	Total Phosphorus	30/70	Seasonal	June-Sept.	632	753	527	226
Pleasantville	567	Total Phosphorus	90/10	Year-round	June-Sept.	760	791	633	158
Acme Inc. (Nirvana Creek Confluence)	547	Total Phosphorus	100/0	Year-round	June-Sept.	492	547	410	137
Hopeville	546	Total Phosphorus	90/10	Year-round	June-Sept.	60	62	50	12
AAA Corp. (Lucky Creek Confluence)	544	Total Phosphorus	100	Year-round	June-Sept.	199	195	166	29
Ortho Company	541	Total Phosphorus	100	Year-round	June-Sept.	786	1645	655	990
Laughing Larry's Trout Farm	489	Total Phosphorus	50/50	Seasonal	June-Sept.	185	250	154	96

Outcome of Six Step Suitability Analysis

Of the seven Happy Basin sources identified at the beginning of the Six Step Suitability analysis, five appear to reasonably meet the four suitability factors; while two appear to be unlikely trading participants because they cannot match a key trading suitability factor with other sources.

- Laughing Larry's is located downstream of the Easyville Dam. Its location involves complex factors that prevent definition of a reliable relationship with other dischargers to ensure environmentally equivalent water quality improvements. (Trading Suitability Factor: Environmental Equivalence)
- Ortho Company will require more pollution reductions than could possibly be generated from all the sources in the basin when likely trading ratios are factored in. Its demand far outstrips potential supply. (Trading Suitability Factor: Supply/Demand)

In the next chapter, the remaining five sources will be further examined to assess if trading will be financially attractive for dischargers in the Happy River Basin.