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WATER QUALITY TRADING ASSESSMENT HANDBOOK

Can Water Quality Trading Advance Your Watershed's Goals?

November 2004

II. 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, i.e., cost-effective trades can reduce overall pollutant loadings without creating locally high pollutant concentrations. Less information is available about trading other pollutants, although pilot projects have explored reducing sediment loadings, temperature, and selenium through trading. The 2003 EPA Water Quality Trading Policy specifically supports nutrient (e.g., total phosphorus and total nitrogen) and sediment trading. The policy indicates that other pollutants, such as metals, will require more scrutiny to ensure that trading can lead to meeting water quality standards. The trading of persistent bioaccumulative toxics is not encouraged and would be supported by EPA only under limited conditions as part of a pilot project. While this Handbook cannot provide a clear "yes" or "no" answer in terms of pollutant suitability for trading, this chapter should help you determine whether to continue consideration of trading based on pollutant and watershed characteristics.

Approach

This chapter discusses conditions needed for a pollutant to serve as a commodity that can be bought and sold in a trading framework established to meet water quality goals. 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 should establish a common understanding of the commodity that is to be bought and sold. Establishing and adhering to this definition is essential to the integrity and success of a trading program.

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 in a given watershed for a pollutant to serve as a "tradeable commodity" that dischargers can buy and sell?

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 should not trade "apples and oranges." Generally a single pollutant should be identified 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 equivalent overall effect on water quality.
- ***Impact:*** There should be an ability to establish water quality equivalence between the location where a pollutant reduction is made and the location where that reduction is purchased or used. This ensures that the water quality impact of trading will be equivalent to, or better than, the pollutant reductions that would have occurred without trading. In addition to ensuring that overall pollutant reduction impacts are equivalent, trades must not create locally high loadings of pollutants or "hotspots."
- ***Timing*****:** Participants should consider and work to align two time dimensions to support a trade. First, purchased reductions should 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, the schedule for achieving pollutant reduction targets should align among trading partners.
- ***Quantity:*** Overall supply and demand should be reasonably aligned. The total amount and increments of excess pollutant reductions ("credits") available should reasonably align with the needs of potential purchasers of credits.

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

The Six Step Pollutant Suitability Analysis

This section will help you examine the four trading suitability factors. The analysis assumes that a TMDL has been developed for the watershed and relevant pollutant. For each factor—Type, Impact, Timing, 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 tradeable commodity. To help answer the questions, the inherent characteristics of a number of common pollutants are provided. Appendices A, B, C, and D contain this information. Stakeholders should also consider TMDLs, TMDL implementation plans, watershed plans, NPDES permit language, and other local assessments and requirements to evaluate specific sources or conditions in your watershed.

STEP ONE: Create a Watershed Loadings Profile

The purpose of this step is to characterize the pollutant(s) to be reduced (e.g., as identified in a TMDL) 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 pollutant(s) to be reduced from point and nonpoint sources.

One way to display this information is to use a simple chart, as in Figure 2.1. You will complete only certain columns during this step; in subsequent steps you will gather more information to fill in additional columns. The example that follows uses this same format to create a profile for the sources in a hypothetical watershed.

Figure 2.1: Template for Creating a Watershed Loadings Profile

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

The Current Load is the amount of pollutant discharged at the time of the trading suitability analysis[3]. The Target Load is the amount of pollutant loadings allocated to each source in the TMDL. For point sources, the Target Load will be reflected as a wasteload allocation later translated into an NPDES permit limit. For nonpoint sources, the Target Load will be reflected as a load allocation that can later be translated (e.g., in a watershed plan) into a set of management practices to achieve the load allocation. The nonpoint Target Load is a non-regulatory allocation

[3] Most TMDLs use Current Load to determine needed reductions. However, some TMDLs use a Baseline Load, distinct from the current load and tied to a specific year to allow for pre-TMDL credits. In these cases, some pre-TMDL pollutant reductions may qualify as tradeable credits. In other circumstances, older pollutant reductions may not be creditable in the trading framework. Excluding "old" reductions may discourage some trading, but doing so may be critical to ensure an environmentally sound marketplace. While such practice may be appropriate in some cases, this Handbook does not address pre-TMDL credits.

that would have to be achieved and surpassed in order to create surplus reductions (credits). The Total Reduction Needed is the difference between the Current Load and the Target Load.

You may be able to find sufficient information to complete the chart in the text of a TMDL, in a TMDL implementation plan, watershed 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 current discharges (or "loads") and the specified wasteload 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 land uses or areas, inflows, or tributaries. Additional information about agricultural practices in each area will be needed to estimate current loads from individual sources. State agricultural agencies and extension agents will often have helpful information and access to tools for estimating loadings and potential reductions from management practices.

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 produce 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 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 the selected sources of the pollutant in the watershed:

- What is the geographic location of the discharge (e.g., 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 TMDL for phosphorus has recently been completed for the main stem of the Happy River, providing wasteload allocations for the permitted point sources and load allocations for the nonpoint sources and tributaries. The TMDL indicates that the primary area of concern is Lake Content where nuisance aquatic growth and dissolved oxygen (DO) sags result from nutrient enriched water slowing and warming. Nine sources of phosphorus contribute loads to the basin.

- ➔ **Herb's Farm**, a family-owned farm growing a range of crops, is located on an irrigation district controlled return flow. The farm is a nonpoint source agricultural entity that does not have federal Clean Water Act regulatory requirements. However, Herb's Farm is the only source discharging directly into the irrigation return flow, which is assigned a load allocation under the Happy River TMDL. While point sources will all measure their phosphorus discharge, Herb's Farm, as a nonpoint source, will have the option of either calculating the phosphorus run-off or measuring it where possible and economically feasible. This would enable Herb's Farm to voluntarily participate in a trading market that might emerge. The return flow 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, discharges at RM 567. The POTW is required to meet a more stringent NPDES permit limit based on a wasteload allocation in the TMDL.
- ➔ **Acme Inc.**, a food processing facility, is located four miles up Nirvana Creek, a tributary to the Happy River in an industrial corridor cluster. **Production Company**, a microchip manufacturing facility, is located on just the opposite side of Nirvana Creek from Acme. **Widgets Inc.**, a widget factory, is located next to Production Company and across from Acme. The creek currently meets water quality standards; therefore, these three dischargers have not received TMDL wasteload allocations. However, the Happy River TMDL provides a load allocation identifying a reduction in the phosphorus loads entering Happy River from Nirvana Creek. These sources are expected, as part of the TMDL implementation plan, to receive modifications to their NPDES permits to further limit phosphorus discharge. 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, discharges at RM 546. Hopeville is required to meet a more stringent NPDES permit limit based on a wasteload allocation in the TMDL.
- ➔ **AAA Corp.**, a sugar mill owned and operated by a multinational corporation, discharges at a location three miles up Lucky Creek, a tributary to Happy River. AAA Corp. is required to meet a more stringent NPDES permit limit based on a wasteload allocation in the Lucky Creek TMDL which was finalized two years ago. Lucky Creek enters the Happy River at RM 544 and has been given a load allocation at its confluence with the main stem under the Happy River TMDL.
- ➔ **Chem Company** is a chemical manufacturing plant and a major discharger of phosphorus with its discharge located downstream of Hopeville at RM 541. Chem has received a wasteload allocation under the Happy River TMDL.
- ➔ **Easyville Dam**, owned by Hydro 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, under the Happy River TMDL, has

received a dissolved oxygen (DO) load allocation. This load allocation reflects the modification of hydrological conditions by the dam, which contributes to DO related violations of water quality standards. The dam does not hold an NPDES permit. Its load allocation will be addressed in the context of a state-issued permit. The Dam sits at RM 535.

- ➔ **Laughing Larry's Trout Farm**, a privately owned aquaculture facility, is located at River Mile 530, below the Easyville Dam. Because the Happy River TMDL did not extend beyond Easyville Dam, Laughing Larry's has not received an allocation under the TMDL.

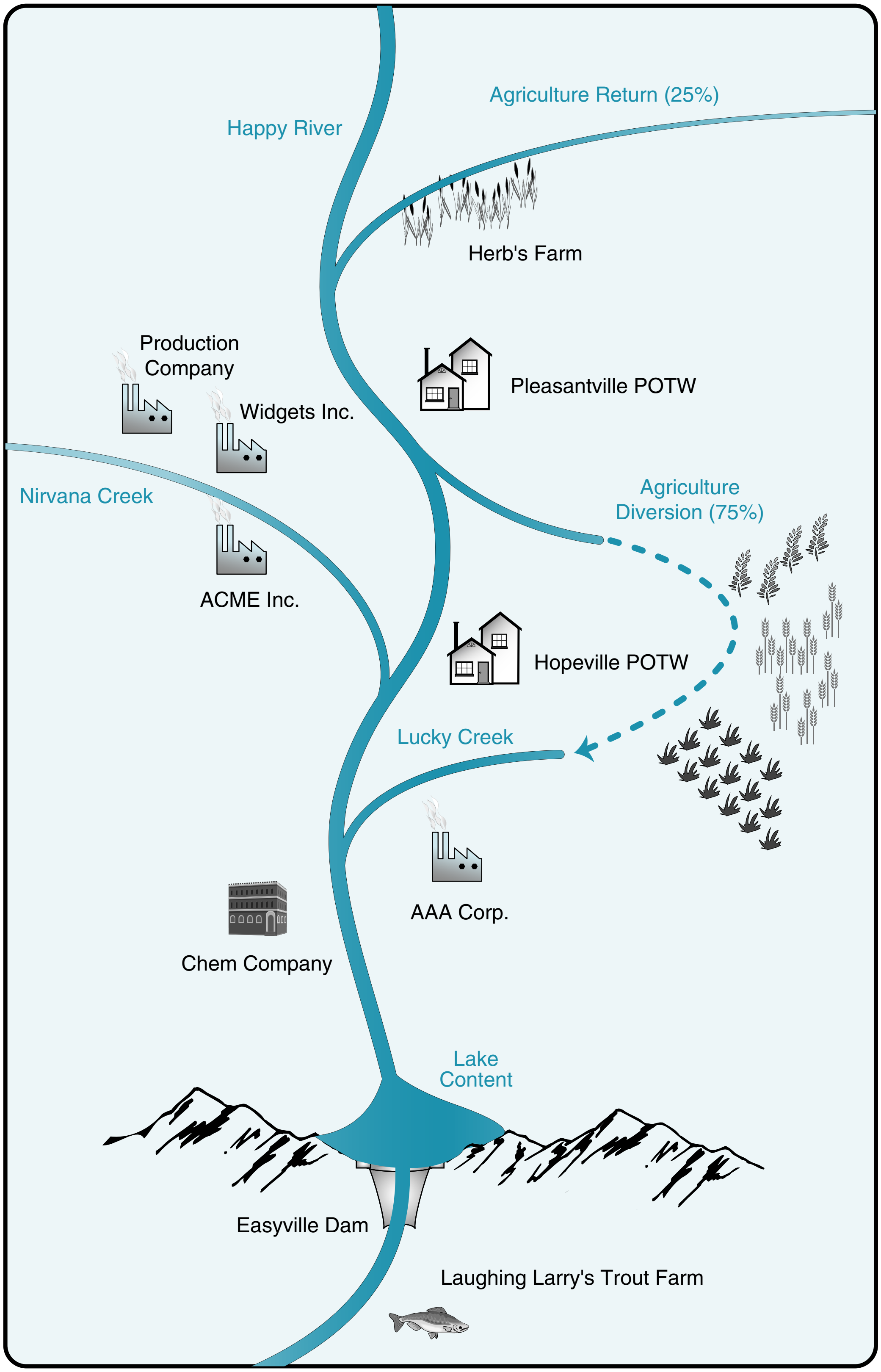
Note: Lake Content represents a typical set of physical characteristics that can lead to a pollutant sink and water quality concerns. Other physical features which have similar slow moving water conditions and/or open area exposed to warming may have similar water quality problems. While lakes, reservoirs, and large eddies are the primary areas of concern in freshwater, inland watersheds, bays, or estuaries can exhibit similar characteristics in coastal areas.

Figure 2.2: Watershed Loadings Profile with Location, Pollutant Form, and Quantity Information

	Location	Form of Pollutant	Quantity		
Name of Discharge Source, Diversion, Agricultural Drain, or Tributary	River Mile	As Allocated in the TMDL	Current Load* (lbs./day)	Target Load* (lbs./day)	Total Reduction Needed* (lbs./day)
Herb's Farm**	570	Total Phosphorus	753	527	226
Pleasantville POTW	567	Total Phosphorus	791	633	158
Acme Inc. (Nirvana Creek Confluence)	547	Total Phosphorus	547	410	137
Production Company (Nirvana Creek Confluence)	547	Total Phosphorus	419	415	4
Widgets Inc. (Nirvana Creek Confluence)	547	Total Phosphorus	237	215	22
Hopeville POTW	546	Total Phosphorus	62	50	12
AAA Corp. (Lucky Creek Confluence)	544	Total Phosphorus	195	166	29
Chem Company	541	Total Phosphorus	1645	493	1152
Laughing Larry's Trout Farm	530	N/A	N/A	N/A	N/A

*Note: Nirvana Creek and Lucky Creek have received allocations at their confluence with the Happy River. The Current and Target Loads displayed are for the actual point of discharge to the tributary and are derived from the discharges' water quality impact at the confluence with the Happy River.
**Note: Herb's Target Load is not a federal regulatory obligation, but a voluntary target derived from the TMDL load allocation through the TMDL Implementation Plan. As a nonpoint source, Herb's Current load could be either estimated or measured depending on physical conditions of the site and available data.

Figure 2.3: Schematic Map of Happy River Basin



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 water quality trading systems use an identified controllable pollutant common to all potential market participants. This establishes a "common currency" with which market participants can evaluate potential trades and enables evaluation of relative water quality impact of trades.

A. Determine if sources are discharging the same type/form of pollutant as identified by the TMDL.

Using the information developed in Step One, identify the type of pollutant addressed in the TMDL, and the various forms discharged by sources. In some cases a common type of pollutant will be present in more than one form. For example, phosphorus loading is often allocated in TMDLs because excessive phosphorus concentrations encourage nuisance aquatic growth and reduced dissolved oxygen levels. Often, TMDLs provide allocations for total phosphorus. Total phosphorus is comprised of both soluble and non-soluble forms and most sources discharge a combination of these forms. As trading opportunities are considered in a watershed, it will be important to understand the actual forms of the pollutant being discharged by sources to assure that trades represent an equivalent impact on water quality. 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 or may not have an equivalent impact on water quality depending on watershed conditions and where the pollutant loadings exert an impact. The following questions are intended to help assess whether a pollutant can be treated as a "tradeable commodity" based on commonality of the form of the pollutant being discharged.

- What is the type and form of pollutant addressed in the TMDL? Does the TMDL provide allocations for more than one form of the pollutant?
- 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 impacts vary based on the different forms (if any) discharged?
- If impacts vary based on form, would local watershed conditions be likely to exacerbate or mitigate the effects of different pollutant forms?

In answering these questions, if you find that 1) the TMDL provides allocations for a single pollutant form; and 2) sources in a watershed discharge and measure that same form, or 3) sources discharge different forms but watershed conditions mitigate the potential for differential impacts from the two forms (i.e., the impacts of concern do not vary significantly based on 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 water quality equivalence among pollutant reductions. If this is not the case, use the set of questions below 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 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 equivalent effect on water quality. Without a reliable, scientifically defensible translation basis, in certain cases 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 2003 EPA Water Quality Trading Policy supports cross-pollutant trading for oxygen-related pollutants when reliable translation ratios can be established.

The following questions should be answered if you are considering a translation ratio for more than one form of the same pollutant, or for two different types of pollutants. Establishing translation ratios requires adequate data and analysis, consistent with the TMDL, about how pollutants behave under specific watershed conditions. If it appears that the data or analysis cannot be developed, cross-pollutant trading opportunities will be foreclosed.

- 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 load limits to indirect effects been established?
- Is there an established causal relationship between this pollutant and others? Has a translation factor been established between the two pollutants that could apply in this watershed?

➔ Pollutant Type/Form: Exploring Potential Trading Opportunities

The hypothetical TMDL and associated implementation plan provides total phosphorus allocations for 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 for total phosphorus. Figure 2.4 lists the various forms of phosphorus as discharged by each of these facilities. 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 and Hopeville POTWs. The wastewater discharges from 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. 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 attainment of the TMDL allocations. The discharge from Pleasantville, 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. Under certain circumstances this type of trade might raise concerns (particularly for a localized impact) because these sources are discharging significantly different phosphorus forms. However, in this watershed and as indicated by the TMDL, the primary area of water quality concern is Lake Content. Over the mid-to-long term, both forms of phosphorus will play an equivalent role in nuisance aquatic growth conditions and attendant dissolved oxygen impacts in the lake. Because of local hydrological conditions in Happy River, specifically cold, swiftly flowing water, there is not a water quality concern at or near Pleasantville's discharge point. Therefore additional soluble discharge from Pleasantville will not affect Lake Content or the intervening river segment more than the non-soluble form. Thus, trading opportunities between these two sources can exist.

Hopeville POTW and Easyville Dam. 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 DO related water quality standards violations. Hopeville POTW has a wasteload 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 pollutant 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 River Basin market.

Figure 2.4, Chart of Sources with Pollutant Form As Discharged

Name of Discharge Source, Diversion, Agricultural Drain, or Tributary	Location	Form of Pollutant	
	River Mile	As Allocated in the TMDL	As Discharged (%soluble/ %non-soluble)
Herb's Farm	570	Total Phosphorus	30/70
Pleasantville POTW	567	Total Phosphorus	90/10
Acme Inc. (Nirvana Creek Confluence)	547	Total Phosphorus	100/0
Production Company (Nirvana Creek Confluence)	547	Total Phosphorus	100/0
Widgets Inc. (Nirvana Creek Confluence)	547	Total Phosphorus	100/0
Hopeville POTW	546	Total Phosphorus	90/10
AAA Corp. (Lucky Creek Confluence)	544	Total Phosphorus	100/0
Chem Company	541	Total Phosphorus	100/0
Laughing Larry's Trout Farm	530	N/A	N/A

STEP THREE: Assess Water Quality Equivalence of Pollutant Reductions at Different Discharge Points

The purpose of Step Three is to evaluate the location of potentially tradeable load reductions and relevant receiving water conditions to determine whether the water quality impact from traded load reductions is equivalent to reductions that would have been made in the absence of trading. Water quality impact is the second of the four factors that must be aligned for trading to be viable. Your Step One watershed loadings profile will give you the location of the pollutant loadings. Participants should 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 water quality equivalence. First, the fate and transport characteristics of a pollutant (e.g., how it behaves in a river system) should be considered. Second, the unique conditions of the watershed should 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, the effects of a pound of phosphorus discharged into a river can greatly diminish 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 own discharge point.

Most trading systems use pollutant "equivalence ratios" or similar mechanisms to establish water quality equivalence relationships. In these systems each source or trade transaction is assigned a ratio to account for the effects of distance, attenuation, withdrawals, and hydrology between the seller's and buyer's discharge points or other areas of interest such as a zone of low dissolved oxygen. The model used to develop the TMDL may be able to provide equivalence information. In all cases, the equivalence model and data used should be consistent and/or compatible with any model and assumptions used in developing the TMDL. Where possible, equivalence ratios should incorporate monitoring data to help characterize the relationship between sources.

In general, the greater the geographic distance between discharge points, the greater the chance of pollutant uptake and settlement, and complex intervening hydrology in the waters between those points. It will generally be more straightforward to establish water quality equivalence between sources in close geographic proximity. More distant sources will require more complex models to capture the dynamic relationships. In some cases, the influence of diversions and tributaries may be too great to establish reliable impact relationships.

How Ratios Are Used to Establish Water Quality Equivalence

Most trading systems use equivalence ratios or similar mechanisms to adjust for 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 uptake, diversions, and other factors on the pollutant between the seller and buyer's discharge points, or other points of environmental concern. Ratios are often based on a source's location along the river, tributary, or agricultural drain in relation to other market participants or a designated instream monitoring area. 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 diverted as water is withdrawn for agricultural use or 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 water quality effect of a reduction. For example, a 3:1 ratio indicates that for every three pounds of phosphorus reduced by a discharger, a one pound reduction will be achieved at the critical downstream monitoring point, e.g., area of low DO.

Appendices A, B, C, and D of this Handbook provide information about the inherent characteristics of selected pollutants that are 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, it may be difficult to establish reliable trading ratios.

Avoiding Localized Impacts or "Hotspots"

Some potential trades that could result in a general water quality improvement in a broad area may also result in acute or chronic localized impacts. Trades that create "hot spots"—localized areas with unacceptably high levels of pollutants—must be avoided. The following factors should be considered.

Characteristics of the Pollutant

- *Each pollutant poses different risks to local water quality; trading may have to be avoided for pollutants that exert acute effects.*

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 potential for localized impacts because if the buyer's discharge exceeds its TMDL allocation, loads in the stream segment between the sources may become unacceptably high.*
- *Upstream trades (i.e., a source compensates a source upstream to overcontrol its discharge) present lower potential for local impacts 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 Modeling and Assessment

- *Monitoring, modeling, and assessment approaches used to support trading should be able to identify the potential for localized impacts so that they can be avoided through program design.*

Various approaches exist to avoid unacceptable localized impacts. One is to use permit limitations to cap the number of credits used in an area susceptible to localized impacts. By limiting the amount of credits used, you can avoid transferring loadings to sensitive parts of the watershed. Other approaches include limiting the direction of trades, e.g., upstream versus downstream, and imposing discharger-specific limits for pollutant(s) that could cause localized concerns. Chapter IV contains more information on mechanisms being used by trading programs to avoid localized impacts.

Answering the following questions will help you assess the potential water quality equivalence between discharges. Information to help answer these questions can be found in the Watershed Loadings Profile developed in Step One, in Appendices A, B, C, and D 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 water quality 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 pollutant 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 water quality 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.

➔ Water Quality Equivalence: Exploring Potential Trading Opportunities Between Dischargers

Appendix A provides information on the general fate and transport characteristics of phosphorus. 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 water quality equivalence and trading opportunities among dischargers.

The following examples of potential trades illustrate how water quality equivalence can play a role in assessing the viability of trading. You may want to refer to Figure 2.3.

Herb's Farm and Pleasantville

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 1:1. (Trades involving other sources will require calculation of separate ratios.) Because of the low equivalence ratio between Herb's Farm and Pleasantville, opportunities for water quality trading among these two dischargers are likely.

Acme Inc., Production Company, and Widgets Inc.

The industrial cluster of Acme, Production Company, and Widgets has discharge outflows within a one mile distance of each other. Because of their close proximity, the equivalence ratio between the three dischargers is 1:1. (Trades involving other sources will require calculation of separate ratios.) Because of the low equivalence ratio within the industrial cluster, opportunities for water quality trading between these three dischargers are likely.

Pleasantville and Hopeville

The Hopeville POTW is located 21 miles from the Pleasantville POTW. Between Hopeville and Pleasantville is one major agricultural diversion, which diverts 75 percent of the river's flow. The diversion takes with it much of Pleasantville's phosphorous discharge resulting in a 5:1 ratio between Pleasantville and Hopeville. (This diverted load is assumed to not return to the Happy River.)

There are two potential options for trading between the wastewater dischargers. One option is an "upstream trade," in which Pleasantville undertakes phosphorus reductions beyond its wasteload allocation to create reduction credits. In this case, Hopeville could 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 Hopeville's discharge point. (This may or may not be cost effective for Hopeville.) Pleasantville would then reduce its phosphorus discharges beyond its wasteload allocation, and water quality in the 21 mile segment would be improved beyond that specified by the TMDL.

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 directly reduce its discharge and there would be no phosphorus reduction in the 21 mile segment between the two dischargers. A downstream trade such as this would satisfy the TMDL only if the water quality impairment addressed by the TMDL occurs in the river segment below Hopeville and not between Pleasantville and Hopeville. In this case, Pleasantville's TMDL wasteload allocation was established to reduce its contributions to impairments below Hopeville. Except in similar circumstances, a downstream trade in impaired waters could cause unacceptable localized impacts between dischargers.

Hopeville and Laughing Larry's Trout Farm

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. (This complexity also results in setting the lower boundary of the Happy River Basin TMDL at Lake Content.) 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 that would allow Laughing Larry's to trade in the Happy River market.

Note: The complex flow characteristics caused by the Easyville Dam could also be representative of bays or estuaries, where similar flow or hydrological conditions may exist. In general, pollutant sources that are difficult to hydrologically relate to other sources, or to the area of water quality concern, will not be able to trade to address that impairment.

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 should be considered; if all three can be aligned, trading may be viable.

Load variability: A discharger's load is likely to vary over time. You will need to identify only major load variations that occur over the course of the year, not minor fluctuations. Much load variability is seasonal. For example, some POTWs reduce discharges substantially 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 allocations in the TMDL are seasonal or annual. Potential trading partners need to meet TMDL timing considerations and 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. In addition, some areas, estuaries in particular, are more apt to have annual load limits than seasonal limits.

Compliance determination variability: Because of the different considerations in establishing appropriate NPDES permit limits, 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. 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 should 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 pollutant 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 should be found in the TMDL and NPDES permit language specific to each watershed and source. Appendices A, B, C, and D give an overview of timing considerations typical for each pollutant.

Answering the following questions will help determine the potential alignment of schedules in terms of load variability, metrics for pollutant limits, and deadlines for compliance or achieving NPS reductions. If participants are able to reasonably align all three dimensions of time, trading may be viable. It is not necessary for all point sources in the watershed to align compliance schedules; however, a sufficient number should be aligned to support one or more beneficial trades.

- Timing for Load Reductions (compliance determination variability)
  - 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 anticipated for non-permitted sources (e.g., nonpoint sources) to achieve and measure load reductions? (Seasonally, annually?)
  - Do any sources have significant seasonal or other cyclical load variability?
- Timing for Overall Implementation (compliance deadline variability)
  - 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., pending renewal of NPDES permit) that should be considered?

➔ Timing: Exploring Trading Opportunities Among Dischargers

Trading is most likely to occur when all three aspects of timing can be aligned among potential trading partners. The following examples illustrate issues relating to (1) aligned timing, (2) seasonal load variability, (3) compliance determination variability, and (4) compliance deadline variability.

Acme Inc., Production Company, and Widgets Inc. (aligned timing)
Acme, Production Company, and Widgets must participate in meeting the load allocation for Nirvana Creek. The Happy River Basin TMDL implementation plan requires Nirvana Creek to meet its load allocation by 2007, and the three companies expect to receive modifications to their NPDES permits to limit phosphorus discharge. Therefore, all three facilities are subject to the same compliance timing. In addition, all three are NPDES permit holders with similar, consistent loading throughout the year. The alignment of both their permit and their discharge timing strongly support trading opportunities.

Pleasantville and Herb's Farm (seasonal load variability)
Pleasantville's 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 primarily during the growing season. In the winter when farmland is frozen over, the farm contributes much lower loadings of phosphorus.

If the TMDL identified year-round load reductions to meet Pleasantville's wasteload allocation, Herb's Farm would be unlikely to produce sufficient reductions for the entire relevant time period. However, the Happy River phosphorus TMDL is typical of other phosphorus TMDLs and establishes only seasonal allocations which are applicable between April and September. Therefore, opportunities for trading between these two dischargers can exist.

Hopeville and Pleasantville (aligned compliance determination)
In this example, both Hopeville and Pleasantville 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 utilities.

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 wasteload allocation under the Lucky Creek TMDL. The Lucky Creek and Happy River TMDL implementation 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 motivated 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 to participate in trading.

STEP FIVE: Determine if the Supply of and Demand for Pollutant Reduction Credits Is Reasonably Aligned Within the Watershed

The watershed loadings profile developed in Step One should include quantities or estimates of the relevant pollutant discharged by representative 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 pollutant reductions that can be supplied must meet or exceed the quantity of reductions needed to ensure compliance.

Demand for pollutant 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 identified in the TMDL. For individual nonpoint sources, these quantities are not normally specified in the TMDL and so will need to be estimated using aggregated nonpoint discharge data from the TMDL along with other information, such as data developed by state agricultural agencies and soil conservation districts. The TMDL will provide information about current and target loads from inflows and tributaries. Methodologies for calculating current and target loads for individual nonpoint 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 source's ability to "overcontrol," or reduce its pollutant loadings below the target load specified by the TMDL (or other appropriate baseline for nonpoint sources). The surplus reductions achieved beyond TMDL expectations represent the stock of potential pollutant reduction credits 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 production levels or land management practices, substituting inputs such as raw materials and agricultural chemicals, or investing in new control technology.

In the next chapter, the financial feasibility of various control options is 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 pollutant reductions can reasonably meet the demand, then trading may be a viable tool to address water quality problems. Although the example does so, you do not need to estimate supply and demand for each discharger in the watershed in order to gauge whether overall supply and demand could reasonably align. You will need to estimate demand from likely credit buyers in the watershed (i.e., large point sources) and a sufficient number of potential credit sellers to determine whether supply and demand can meet.

- For each relevant discharger, what are the current/future loads compared to target loads?
- For each source, what is the capacity to provide reductions beyond the TMDL allocations (i.e., do they have the technical capacity to generate pollutant reduction credits)?

➔ Supply and Demand: Exploring Trading Opportunities Among Dischargers

It is often difficult to project the balance of supply and demand for pollutant reductions. In the Happy River Basin example you have a general idea of the total amount of reductions needed by all sources to meet TMDL 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.

Herb's Farm and Hopeville (supply and demand in balance)
Under current conditions, Hopeville has projected that it will need to reduce phosphorus discharges by 12 pounds per day to meet its Target Load. (See Figure 2.2, Watershed Loadings Profile, with total reductions needed by Happy River dischargers.) Hopeville may consider purchasing reduction credits from Herb's Farm rather than investing in control technology that is projected to produce considerably greater pollutant reductions than it needs. Herb's Farm expects to install management practices with potential to create reductions that would satisfy the load allocation and generate sufficient excess reductions to meet Hopeville's needs even after application of location ratios. Other dischargers in the Basin also have potential to generate a sufficient supply of reduction credits to meet Hopeville's demand.

Acme Inc., Production Company, and Widgets Inc. (supply likely to meet demand)
The TMDL implementation plan assigns load targets to each facility. Acme needs to reduce 137 lbs./day, Production Company projects 4 lbs./day reduction, and Widgets needs to reduce 22 lbs./day. All of the facilities are investigating control technologies that have the potential for overcontrol beyond their needed reduction. Acme projects it would be able to supply Production Company and Widgets with the necessary pollutant reduction credits. And Production Company projects that with its control technology, they would be able supply Widgets with the needed credits for 22 lbs./day reductions. Thus it appears that supply and demand can be aligned among these three companies.

Chem Company (demand outstrips supply)
Chem Industries, located at River Mile 541, is a major discharger of phosphorus. To meet its TMDL wasteload allocation, Chem will need to reduce its discharge by 1151 lbs./day. Chem is considering an on-site option that will meet its allocation, a one-size-fits-all control technology. It is also considering purchasing reductions from other dischargers in the Basin. Because of limited technology control options Chem cannot opt to use a less effective, less costly onsite control and purchase reductions from other dischargers. Chem must choose trading or on-site control. (Note: in practice, 'blended' control strategies comprised of onsite controls and purchasing credits will often be an option). As Chem considers purchasing reductions from other dischargers, it will need to project whether the potential supply of pollutant reduction credits will meet its demand, i.e., enable it to fully meet its permit limit based on the TMDL wasteload allocation. Using Figure 2.2, Watershed Loadings Profile, you can calculate that Chem needs five times more reduction than any other source; it will be almost impossible for the remaining dischargers in the Basin to

create a sufficient supply of reduction credits to meet Chem's demand. Chem can see that trading will not be an option for its compliance plan because the supply of reductions is unlikely to 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. For trading potential to be high, all four suitability factors will need to align for at least two market participants. Water quality trading will be possible if all four pollutant suitability factors show medium to high potential for alignment. If any one of the four pollutant suitability factors (i.e., type/form, location, timing, and quantity) show low potential for alignment, the pollutant is probably not suitable for water quality trading in this watershed. The user may wish to consider whether other pollutants discharged by sources in the watershed may have potential trading opportunities.

Figure 2.5, Complete Watershed Loadings Profile with all pertinent information

	Location	Form of Pollutant		Timing				
Name of Discharge Source, Diversion, Agricultural Drain, or Tributary	River Mile	As Allocated in the TMDL	As Discharged (%soluble/ %non-soluble)	Discharge (e.g., seasonal, cyclical, etc.)	Control Obligation (Regulatory)	Current Load* (lbs./day)	Target Load* (lbs./day)	Total Reduction Needed* (lbs./day)
Herb's Farm**	570	Total Phosphorus	90/10	Seasonal	June-Sept.	753	527	226
Pleasantville POTW	567	Total Phosphorus	30/70	Year-Round	June-Sept.	791	633	158
Acme Inc. (Nirvana Creek Confluence)	547	Total Phosphorus	100/0	Year-Round	June-Sept.	547	410	137
Production Company (Nirvana Creek Confluence)	547	Total Phosphorus	100/0	Year-Round	June-Sept.	419	415	4
Widgets Inc. (Nirvana Creek Confluence)	547	Total Phosphorus	100/0	Year-Round	June-Sept.	237	215	22
Hopeville POTW	546	Total Phosphorus	90/10	Year-Round	June-Sept.	62	50	12
AAA Corp. (Lucky Creek Confluence)	544	Total Phosphorus	100/0	Year-Round	June-Sept.	195	166	29
Chem Company	541	Total Phosphorus	100/0	Year-Round	June-Sept.	1645	493	1151
Laughing Larry's Trout Farm	530	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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

**Note: As a nonpoint source, Herb's Farm has the option of calculating or measuring (where possible) the Current Load.

➔ Outcome of Six Step Suitability Analysis

Of the nine Happy River Basin sources identified at the beginning of the Six Step Suitability analysis, seven appear to reasonably meet the 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 equivalent water quality improvements. (Trading Suitability Factor: Water quality equivalence)

Chem Company will require more pollutant reductions than would likely be generated from sources in the basin when probable trading ratios are taken into consideration. To meet Chem's demand for credits, including trading ratios, a majority of sources would have to reduce their loadings to zero. Thus, Chem's demand outstrips potential supply. (Trading Suitability Factor: Quantity)

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