December 2002

An Implementation Plan for Soluble Reactive Phosphorus in the North Bosque River Watershed

For Segments 1226 and 1255

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TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
TEXAS STATE SOIL AND WATER CONSERVATION BOARD

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Introduction

In keeping with the Texas commitment to restore and maintain water quality in impaired water bodies, the Texas Commission on Environmental Quality (TCEQ or Commission) and the Texas State Soil and Water Conservation Board (TSSWCB) recognized from the inception of the total maximum daily load (TMDL) program that implementation plans would need to be established for each TMDL developed.

The TMDL is a technical analysis that:

(1) determines the maximum loadings of pollutant a water body can receive and still both attain and maintain its water quality standards, and
(2) allocates this allowable loading to point and nonpoint source categories in the watershed.

Based upon the TMDL, an implementation plan is developed. The implementation plan is a strategic planning document for use by appropriate state agencies, which identifies regulatory and non-regulatory activities designed to achieve water quality standards consistent with the TMDL. It also functions to provide direction for other public and private entities involved in TMDL implementation in the affected watershed. Though the plan itself is not a rulemaking, it includes a description of potential regulatory and voluntary strategies to achieve the pollutant reductions identified in the TMDL. All necessary rulemaking will be conducted in accordance with the Administrative Procedure Act. It also includes a schedule by which the Commission and TSSWCB anticipate these strategies will be implemented.

This implementation plan contains the following:

(1) a description of strategies for control actions and management measures[1] to achieve the water quality target;
(2) legal authority under which the participating agencies may require implementation of such strategies;
(3) schedule for implementing activities to achieve TMDL objectives;

[1] Control actions refer to point source pollutant reduction strategies, generally Texas Pollutant Discharge Elimination System (TPDES) permits. Management measures refer to nonpoint source pollutant reduction strategies, generally voluntary best management practices.

(4) a follow-up surface water quality monitoring plan to determine the effectiveness of the control actions and management measures undertaken;
(5) a statement of why TCEQ and the TSSWCB have concluded that the implementation of voluntary management measures will achieve the load allocations for nonpoint sources; and
(6) identification of measurable outcomes TCEQ will review to determine the efficiency of the implementation plan and whether water quality standards are being achieved.

This implementation plan is designed to guide the achievement of reductions in concentrations of phosphorus in the North Bosque and Upper North Bosque River as defined in the adopted TMDLs. Implementation is conceptually divided into two phases: Phase I will be implemented immediately, while Phase II generically includes additional controls and measures that may be needed if water quality goals of the TMDL are not being achieved. Figures 1 through 8 of this document are identical to figures with the same numbers in the TMDL document.

This implementation plan was prepared by the Texas State Soil and Water Conservation Board and the TMDL Team in the Strategic Assessment Division of the Office of Environmental Policy, Analysis, and Assessment of the TCEQ.

Technical assistance in the form of published reports and consultations was provided by:

- the Texas Institute for Applied Environmental Research (TIAER); and
- numerous programs or organizational units within the TCEQ.

This implementation plan was approved by the TSSWCB on January 16, 2003, and by the TCEQ on December13, 2002. The combined TMDL and implementation plan provide local, regional, and state organizations a comprehensive strategy for restoring and maintaining water quality in an impaired water body. TCEQ has ultimate responsibility for ensuring that water quality standards are restored and maintained in impaired water bodies.

Watershed Characteristics

The Bosque River is located in north central Texas, northwest of the City of Waco, and is a tributary of the Brazos River. The Bosque River is impounded at Waco, near its confluence with the Brazos River, to form Waco Lake (Segment 1225), which supplies public drinking water for many people in the vicinity of Waco. The North Bosque River is the longest arm of the Bosque system, draining approximately 75% of the Waco Lake watershed, while the Middle and South Bosque Rivers and Hog Creek drain most of the remaining area (Figure 1).

Topographically and historically, the Bosque River watershed is representative of the heart of Texas. The upper watershed has medium-sized hills, carved into a limestone

plateau, with relatively shallow, rocky soils and areas of moderate to steep slope. The upper watershed has long been utilized for ranching, dairies, and other animal production agriculture. The lower watershed, drained by the Middle and South Bosque Rivers, has rolling blackland prairie with deep soils, and row crop production is the predominant form of agriculture. The distribution of these and other land uses within the watershed is depicted on Figure 2.

The North Bosque River is administratively divided into two designated water quality segments (see Figure 1):

- Segment 1226, North Bosque River – extends from a point 100 meters upstream of FM Road 185 in McLennan County to a point immediately upstream of the confluence of Indian Creek in Erath County
- Segment 1255, Upper North Bosque River – extends from a point immediately upstream of the confluence of Indian Creek in Erath County to the confluence of the North Fork and South Fork of the North Bosque River in Erath County

Designated uses for both segments of the North Bosque River are established in the Texas Surface Water Quality Standards (30 TAC Chapter 307). The current designated uses for the North Bosque River (Segment 1226) are contact recreation, high quality aquatic life use, and public water supply. The current designated uses for the Upper North Bosque River (Segment 1255) are contact recreation, and intermediate quality aquatic life use. The differences in designated uses reflects the headwater characteristics of the Upper North Bosque River segment, especially its intermittent flow.

Bacterial concentrations in the Upper North Bosque River (Segment 1255) and its tributaries are of concern, to the extent that some water bodies in Erath County are impaired for contact recreation use. The 2002 water quality inventory found that downstream waters, including the North Bosque River (Segment 1226) and Waco Lake (Segment 1225), are fully supporting the contact recreation and public water supply uses. Specific TMDLs or implementation plans regarding bacteria issues have not been developed yet, but data collection in the North Bosque watershed is assessing and will continue to assess bacterial levels and sources. However, management measures for control of phosphorus loading will also have some corollary effect on reducing bacteria loading, since the nonpoint source nutrient and bacteria loads largely originate from the same sites and materials and are transported via the same processes and pathways.

Water quality concerns in the North Bosque River watershed are largely associated with animal feeding operations, though discharges from other agricultural uses and urbanized areas also contribute. Individual animal feeding operations are categorized as either Concentrated Animal Feeding Operations (CAFOs) or Animal Feeding Operations (AFOs). CAFOs are larger facilities that must be authorized by registrations or individual permits, while AFOs are similar but smaller facilities that may operate under the conditions of Chapter 321 of the Texas Administrative Code Subchapter B without

registration or individual permit. In the North Bosque River watershed, AFOs and CAFOs are virtually all dairies, but other types of animal production may also be so designated. For dairies, AFOs are generally facilities with 200 head or fewer, while CAFOs are those facilities with more than 200 head.

Throughout this implementation plan, use of the term "animal feeding operation(s)" refers to all facilities for any type of animal, while use of the acronyms AFO or CAFO distinguish or refer to the type of authorization and size. In this implementation plan, use of the term "dairies" refers to all CAFOs and AFOs that produce milk.

Summary of TMDL Goals

The North Bosque River TMDLs address phosphorus loading in the watersheds of the North Bosque River (Segment 1226) and the Upper North Bosque River (Segment 1255). The North Bosque River segments were included on the 303(d) List of impaired waters due to indications that nutrients are adversely affecting the segments. Studies within the watersheds identified phosphorus as the limiting nutrient and identified soluble reactive phosphorus as the parameter best correlated to algal growth response. For purposes of the TMDLs, the parameters soluble reactive phosphorus and orthophosphate-phosphorus are considered to be essentially identical. Within this document, references to the North Bosque River and its watershed generally include both designated segments, unless a specific distinction is made.

The goal of the North Bosque River TMDLs is to achieve a significant reduction in soluble reactive phosphorus (SRP) annual-average concentrations, as measured in the river at five index sites. Reduced annual-average concentrations in the river will also be reflected as reduced total annual "net loading" at the monitored index sites. Measures taken to achieve the goal of reduced concentrations in the river will reduce "gross loading" from the individual sources. Net loading is calculated from and closely linked to instream concentration, while gross loading is more comparable to effluent concentrations. Instream concentration and net loading are direct indicators of ecosystem response and condition that tend to integrate both management efficiency and stream assimilative capacity, while gross loading and effluent concentration measure individual treatment system or management measure performance without providing direct insight to stream conditions. Hence, instream concentrations and net loading are the preferred metrics for monitoring the success of TMDL implementation.

Reduction of Phosphorus in the North Bosque River

The goal of the TMDLs is expressed as a "percent reduction" of instream phosphorus concentrations at five index sites along the North Bosque River, relative to the existing condition at the respective sites. The "existing condition" at each site was defined by water quality data collected circa 1995 - 1998 for analyses that supported TMDL development. The broad numeric statement of the goals of the North Bosque River TMDLs is to reduce annual-average SRP concentrations in the river by approximately 50% for the entire North Bosque River watershed as a long-term watershed average with

some local variation that reflects location within the watershed. More precise values for the individual index sites are shown in Table 1 (which corresponds to Tables 4 and 6 of the North Bosque TMDL document). Net load and annual concentration values in Table 1 correspond to averages indicated by horizontal lines on the model output depicted in Figures 4 through 8, which are reproduced from the TMDL document.

Table 1. Percent Reduction Goals at North Bosque River Index Sites

Predicted Average Net Total-Annual Soluble Phosphorus Loading					
Loading is expressed in units of kilograms per year, kg/yr	**Above Stephenville**	**Below Stephenville**	**Above Meridian**	**Clifton**	**Valley Mills**
Predicted average total-annual load from 'Existing' scenario	4,061	10,068	22,117	26,990	28,832
Predicted average total-annual load from 'TMDL-e' scenario	1,556	4,173	10,479	15,498	17,625
% reduction	61.7 %	58.6 %	52.6 %	42.6 %	38.9 %
Predicted Average Annual-Average Soluble Phosphorus Concentration					
	Above Stephenville	**Below Stephenville**	**Above Meridian**	**Clifton**	**Valley Mills**
From 'Existing' scenario (ppb)	203.3	1,143.2	117.0	52.2	41.3
From 'TMDL-e' scenario (ppb)	114.2	448.1	54.5	30.3	27.5
% reduction	43.8 %	60.8 %	53.4 %	41.9 %	33.4 %

As shown in Table 1, the percent decreases, for both instream concentration and net loading, are expected to be somewhat higher upstream, and somewhat lower downstream, due to the geographic distribution of sources and the hydrology of the watershed. For example, at the Valley Mills index site, annual-average concentration is expected to decrease by approximately 33%, while average total-annual net loading (i.e. as measured in the river) decreases by approximately 39%. At the index site Above Meridian, near the middle of the watershed, annual-average concentration is expected to decrease by approximately 50%, with a similar reduction in average total-annual phosphorus net loading. At the sites near Stephenville, reduction targets are near 60%.

The instream concentration and net load reduction goals are to be achieved by reducing the average total-annual gross loading (i.e. as measured near the source) through the strategies for management measures and control actions described. The TMDL included an estimate that achieving the annual-average concentration targets at each of the index

sites might require aggregate gross load reductions of approximately 50% overall from both point and nonpoint sources.

Reduction of Algal Growth

Soluble phosphorus reductions of the magnitude sought by this implementation plan will reduce the potential for problematic algae growth in the North Bosque River and downstream waters, and should reduce the actual occurrence of algal blooms. Model simulations predicted that the annual-average soluble phosphorus concentration in the lower North Bosque River will be low enough to limit algal growth during most of the years following implementation (see Figures 4 through 5). Algal growth potential will also be significantly reduced at the upstream stations, although to a lesser degree (Figures 6 through 8). However, algae and nutrient interactions are extremely dynamic and very much influenced by weather conditions and other environmental factors. Efforts to control nutrient loading can reduce or limit the occurrence of algal blooms, but cannot totally prevent them in water bodies that contain natural communities of aquatic organisms adapted to episodic flow regimes and nutrient loadings that interact with other seasonal limitations such as temperature or light intensity. The model analyses predicted, as shown in Figures 4-8, that load reductions anticipated from this plan will improve water quality conditions (i.e. reduce nutrient loads and concentrations), though in some years the annual-average soluble phosphorus concentrations will still exceed the preliminary algal growth limiting concentration goals discussed in the TMDL.

Nonpoint Sources

This implementation plan addresses all aspects of dairy or animal feeding operation facilities as components of nonpoint source loading, although the potential for discharge from retention facilities causes some parts of animal feeding operations to be defined as point sources from a legal or regulatory perspective. Retention facilities are often called "runoff control structures (RCS)," "ponds," or "lagoons." Runoff from waste application fields (WAFs) caused by rainfall is a nonpoint source discharge that is controlled by use of best management practices (BMPs). Runoff from WAFs caused by excessive irrigation with waste material is an unauthorized discharge subject to enforcement. Since currently available information is not sufficient to distinguish animal feeding operation nonpoint loading (authorized runoff from WAFs) from point loading (authorized discharges from retention structures), the load allocation for animal feeding operation nonpoint sources includes the waste load allocation for animal feeding operation point sources. Unauthorized discharges from retention structures or waste application fields are addressed using enforcement policies in place at the time of the investigation. There is no load allocation for unauthorized discharges.

Estimates of gross soluble phosphorus loading that occurred during the period from November 1995 through March 1998 were calculated, by land use category, from data collected in the North Bosque watershed (McFarland and Hauck, 1999). Figure 3 presents those estimates, as calculated at each of five index sites along the North Bosque River. The bar graphs and pie charts in Figure 3 indicate that the land use named "WAF"

contributed a large portion of the total loading. The data used to develop Figure 3 characterized small watersheds with mixed land uses, including all aspects of dairy operations. All loadings that emanated from any aspect of a dairy operation during the monitored period were addressed in the analyses as WAFs, although it is probable that some amount of loading actually originated from authorized or unauthorized "point source" discharges from retention structures.

When properly performed, land application remains one of the best and most appropriate methods for dealing with large amounts of animal wastes. In many cases, land application is a beneficial reuse of waste materials. This implementation plan seeks to identify strategies to assure that all land application in the North Bosque watershed is planned, managed, and performed in accordance with effective nutrient management practices. In general, particular attention will be paid to waste application fields (WAFs) used by dairy operations in the North Bosque River watershed to ensure that waste application occurs on suitable sites and is properly managed to minimize phosphorus transport into surface waters. Strategies for NPS load reduction management in this implementation plan will focus on dairies and the WAF land use, especially during the initial phase of implementation. At the same time, compliance and enforcement activities will focus on eliminating unauthorized discharges and loading from all parts of dairy operations.

Distinguishing the relative importance of various aspects of dairy operations with regard to phosphorus loading would require more detailed sampling and analyses. More precise data would also be needed to characterize the differences in phosphorus export expected from a properly managed active WAF, from an improperly managed active WAF, and from an inactive WAF still recovering from excessive applications in the past. Developing enough single-land use data, including edge-of-field data from WAFs, to fully characterize and predict loading from various aspects of dairy operations will take a significant amount of time. Several entities will continue efforts to gather and analyze data from such studies, and the TCEQ and the TSSWCB will utilize such data as it becomes available.

The gross existing loadings from various land uses depicted in Figure 3 did not serve as input to the watershed model from which instream concentration and net loading targets were derived, so there is no direct linkage between gross loading and net loading embodied in previous analyses. However, comparing the gross loading estimates from Figure 3 to model-predicted net loadings at the same sites (Figures 4 - 8), and assuming a simple linear relationship between gross and net loading, allows an estimate of apparent reduction in total nonpoint source gross loading that would correspond to a model-predicted reduction in net loading. Using the index site "Above Meridian" as the reference point for such estimates, gross nonpoint source load reductions needed to meet the TMDL goals may range from 20% to 56%, depending on the type of simple linear relationship assumed (ratio or difference). Presuming that dairy operations are the only type of nonpoint source reduced, loading from dairies and WAFs may need to be reduced by 33% to 90% to achieve overall nonpoint source load reductions of that magnitude.

These estimated percentages refer to reductions in the amount of phosphorus exported from land to the stream system; the estimates are not directly related to the amount of waste applied to WAFs in the watershed.

This implementation plan will initially focus on achieving comprehensive nutrient management of dairy wastes to minimize current and future loading of phosphorus from WAFs. Initial implementation will also include enhanced efforts to enforce current permit requirements (see *Enforcement Program*) and to assure that existing retention structures have been adequately designed, constructed, and managed (see *Permitting Programs, Agriculture*) in order to eliminate unauthorized discharges from animal feeding operations (see additional discussion under *Point Sources*). However, the residual effects of abused or abandoned WAFs, or effects of unauthorized discharges from retention or waste storage facilities, may impede progress towards the TMDL goal and may require additional measures or other operational limits. Water quality monitoring, refinement of model analyses, and periodic assessments of progress will allow adaptation of implementation strategies as needed to better address the effects of residual sources and unauthorized discharges.

Nutrient Utilization Plan (NUP)

The NPS strategies proposed in this implementation plan would bring as many acres as possible, of the land receiving manure and/or wastewater applications, into conformance with United State Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS) Practice Standard 590 (Nutrient Management). Some permitted operations may already have developed a Nutrient Utilization Plan (NUP) as a requirement of their permit and the TCEQ Chapter 321 Subchapter B Concentrated Animal Feeding Operation (CAFO) Rules. It should be noted that a NUP is not a Comprehensive Nutrient Management Plan (CNMP), which is discussed later in this implementation plan as a mechanism for achieving proper nutrient management. A NUP is a subset, or a grouping of the measurable and enforceable practices, of a CNMP. A CNMP is a dynamic instrument that both prescribes future activities and documents past performance. It also records daily management of the facility while taking issues such as feed management, manure and wastewater handling and storage, nutrient management, land treatment practices, and other manure and wastewater utilization options into consideration. In most cases, an operator's NUP can be used to reduce the effort needed to compile an effective CNMP.

The TSSWCB has recently begun a project, partly aimed at addressing private and unpermitted land application sites, which provides cost-share funding for landowners who agree to manage their land in accordance with a certified water quality management plan (WQMP) which would include the elements of the NUP. Water quality management plans include suites of best management practices (BMPs) on a producer's entire agricultural operation that can minimize environmental degradation as a result of existing conditions, as well as prevent future problems from occurring.

Point Sources

New strategies for control actions for load reduction from point sources will be directed primarily towards the municipal wastewater treatment plants (WWTPs). Well proven and readily available wastewater treatment technology for phosphorus control is typically able to meet a permit limit of 1 mg/L (1,000 µg/L) total phosphorus. Due to the significant difference in the size of individual WWTPs in the watershed, the desired load reduction may be accomplished without immediately requiring all of the municipalities to redesign their WWTPs for phosphorus treatment. The precise nature of individual permit limits will be determined during the permitting process and may include various types of permit limits that regulate flow, loading, and/or concentrations to achieve the TMDL goal of reducing point source phosphorus loading.

Discharges of process water or runoff from some areas of animal feeding operations are considered to be point source discharges by regulatory definition, although such discharges are commonly spoken of or modeled as nonpoint sources. The Chapter 321 Subchapter B regulations include design, construction, operation, and management requirements for waste storage and/or retention structures. Discharges from retention structures are authorized only when such structures have been correctly built, maintained, and operated, but are overwhelmed by extreme precipitation events; discharges under other conditions are not authorized and are subject to enforcement actions. The combination of design criteria, management practices, and legal strictures embodied in the Subchapter B regulations should assure that authorized point source discharges from animal feeding operations will support water quality standards. Since currently available information is not sufficient to distinguish animal feeding operation nonpoint loading (rainfall runoff from WAFs) from point loading (authorized discharges from retention structures), the load allocation for animal feeding operation nonpoint sources includes the waste load allocation for animal feeding operation point sources. Initial implementation efforts for animal feeding operation point sources will focus on enforcement of existing regulations and elimination of unauthorized discharges. The TCEQ intends to clarify, by rule change or otherwise, the difference between “chronic” and “catastrophic” conditions that may cause discharges from animal feeding operations. TCEQ will also evaluate the impact of eliminating the authorization to discharge under “chronic” rainfall conditions.

Control Actions and Management Strategies

During the initial phase of implementation, the general approach is to reduce the combined gross phosphorus loading from animal feeding operations and wastewater treatment plants (WWTPs) to achieve the goals described above. There are multiple ways the reductions in gross loading might be accomplished. Implementation of the North Bosque River TMDLs will use the concept of adaptive management, meaning that the plan may be modified as time progresses. Plan elements may be expanded beyond their original scopes, or new elements may be developed, if water quality goals of the TMDLs are not being achieved within a reasonable time. On the other hand, plan elements may be

delayed or reduced in scope if water quality goals are achieved through greater BMP efficiency than anticipated or by management measures extraneous to the TMDL implementation plan. For instance, a U.S. Army Corps of Engineers watershed restoration project now in planning stages may lead some landowners to set aside riparian buffer zones, or to establish wetland areas, for the purpose of reducing nonpoint source loading of various substances including phosphorus.

CNMPs

A key element of action plans in priority watersheds impacted by agricultural or silvicultural sources will be the voluntary development, certification by the TSSWCB, and implementation of comprehensive nutrient management plans (CNMPs) that manage pollution from CAFOs, and water quality management plans (WQMPs) that abate nonpoint source pollution on private lands. Implementation of these voluntary plans is crucial in achieving and documenting the attainment of water quality goals relating to agricultural and silvicultural NPS pollution.

There are several added benefits to developing and implementing a CNMP. The joint Environmental Protection Agency (EPA) - USDA *Unified National Strategy for Animal Feeding Operations*, published March 9, 1999, set a national performance expectation that all animal feeding operations, including permitted CAFOs, would obtain a CNMP. This expectation is evident in the most recent proposed changes to EPA's regulations regarding CAFOs. Also, the Farm Security and Rural Investment Act of 2002:

- removes the prohibition against Environmental Quality Incentives Program (EQIP) cost share for waste storage facilities for large, confined animal feeding operations,
- requires livestock producers who receive cost share for animal waste systems to have CNMPs,
- authorizes the Secretary of Agriculture to make incentive payments to producers to implement land management practices and CNMPs, and
- targets 60 percent of EQIP funding to livestock water quality concerns.

The concept of the CNMP has been an integral part of the TSSWCB's WQMP Program since its inception when the facility is an AFO. However, because of the non-point source designation of the program's definition, it has not been made available to CAFOs. Because of the national implications regarding CAFOs and the need for such a program for water quality impaired areas such as the North Bosque River watershed, the TSSWCB has worked with the USDA-NRCS, the Texas Institute for Applied Environmental Research (TIAER), Texas Cooperative Extension (TCE), TCEQ, and the Texas Association of Dairymen (TAD), to develop a CNMP program for Texas. Program development is underway.

WQMPs

Water quality management plans are site-specific plans, authorized under state law, that are designed to control NPS pollution from agricultural and silvicultural activities. Funds supporting development of WQMPs come from legislative appropriations. WQMPs are traditional conservation plans that meet the resource management system criteria in the United States Department of Agriculture - Natural Resources Conservation Service (USDA-NRCS) Field Office Technical Guide and contain measures to address all potential sources of NPS pollution. WQMPs are developed through soil and water conservation districts (SWCDs) with assistance from the USDA-NRCS and the TSSWCB staff and are certified by the TSSWCB. This approach to NPS abatement and management is unique because it uses a voluntary approach while affording the landowner a mechanism for compliance with state water quality standards for a given stream segment.

Nutrient management planning in accordance with the USDA-NRCS Practice Standard for nutrient management (Code 590) is currently being observed on many dairy operations and on the private agricultural property of other landowners. However, many acres of private land are being supplemented with dairy manure and/or wastewater that may be applied without proper nutrient management practices. A concerted effort will be made by TSSWCB to enhance the application of management measures on existing dairy operations and to install proper nutrient management measures on all other such lands.

TSSWCB Role

The Texas State Soil and Water Conservation Board (TSSWCB) will assist dairy operators, and other agricultural producers, in the voluntary development and implementation of water quality management plans (WQMPs) for AFOs, and Comprehensive Nutrient Management Plans (CNMPs) for CAFOs in the North Bosque watershed that utilize animal wastes. The TSSWCB WQMPs for individual operations will address all land uses that comprise the total operation, which may include dairies, cropland, pastureland, or rangeland, as well as WAFs, and will address commercial fertilizer use as well as manure. CNMPs are not required to cover a producer's total operation, or "whole-farm," but they are required to cover the entire conservation system, or the production area and waste management activities. Nutrient management plans (NMPs), developed according to USDA-NRCS Practice Standard 590, are mandatory subsections of all WQMPs and CNMPs. In the case of a CAFO, the NMP must be a Nutrient Utilization Plan (NUP) as defined by the current Chapter 321, Subchapter B, CAFO Rules.

Efforts to reduce phosphorus loading from agricultural sources throughout the entire watershed will be most effectively managed and measured if smaller microwatersheds are targeted individually for BMP implementation and water quality monitoring. Monitoring microwatersheds will enable more precise identification of areas with waste management problems or inadequacies and better support efforts to improve management. State agencies should provide programs that will allow for agricultural microwatershed

management councils of producers to discuss the need for accurate and comprehensive nutrient management planning, CNMP/WQMP development and implementation processes, meaningful water quality monitoring, cost-share availability, and self-policing or peer pressure as a mechanism to assure implementation.

Implementation Phases

The adaptive management concept is reflected in the phases of implementation described below. Phase I elements will be implemented immediately. Elements that may be needed if Phase I is not enough to achieve water quality goals are generically described as Phase II, although there could actually be several secondary phases.

Phase I

The first phase implementation plan is based on feasible measures that were simulated in model analyses performed for the TMDL. Simply stated, those measures were:

- Phosphorus application rates in WAFs.
- Reduced phosphorus diet for dairy cows, to reduce the phosphorus content of dairy wastes.
- Removing approximately half of the dairy-generated manure from the North Bosque River watershed for use or disposal outside the watershed.
- Effluent limits on phosphorus for municipal wastewater treatment plants.

Those basic elements will be implemented through the following strategies. Each is discussed in more detail below.

- Comprehensive nutrient management planning for all identifiable agricultural sources of phosphorus loading in the North Bosque watershed.
- Microwatershed-based approach to water quality monitoring and agricultural producer assistance.
- Facilitating establishment of commercial composting facilities in the North Bosque region and a sustainable market for compost products.
- Permit limits for phosphorus at municipal wastewater treatment plants.
- Adapting rules, permit reviews, and enforcement activities, including proposing changes to the current CAFO regulations.
- Water quality monitoring, refinement of the TMDL model and analyses, and assessment of progress towards water quality goals.

For most dairies, participation in efforts to remove manure from the watershed and efforts to reduce the phosphorus content of feed will be voluntary activities. Using those voluntary management measures may benefit the dairy operations by reducing their costs and efforts needed to develop comprehensive nutrient management plans. The success of

Phase I measures will be determined based on water quality results. Therefore, TCEQ and the TSSWCB have concluded that implementation of the voluntary management measures will assist achievement of water quality goals and that other elements of comprehensive nutrient management plans, which will be regulatory requirements for most dairies or CAFOs of other types, can support the goals if voluntary measures are not adopted by a sufficient number of dairy operations.

Comprehensive Nutrient Management Planning for All Identifiable Agricultural Sources of Phosphorus Loading in the North Bosque Watershed

The basic goal of this strategy is that waste management by dairies, and other facilities that manage large amounts of animal wastes, effectively minimizes phosphorus loading to the stream system. This goal would be furthered by use of comprehensive nutrient management plans (CNMPs) designed so that animal waste applications to sites within the North Bosque River watershed do not exceed the application rates required by the NRCS Practice Standard for Nutrient Management (Code 590). Utilization of the manure removal or reduced phosphorus feed management practices support and are components of the CNMP. The CNMPs could also incorporate any appropriate innovative methods dairy operators may choose to utilize, such as free-stalls, capture-and-treat systems, or others.

Comprehensive nutrient management planning includes feed management. Feed management activities are voluntary measures, as defined by the NRCS Field Office Technical Guide, but are highly recommended as a component of CNMPs developed within the North Bosque watershed. Feed management activities can reduce the amount of phosphorus in dairy wastes, to the extent possible, without adversely affecting milk production or herd health. Education and outreach efforts by the TSSWCB and other entities will encourage dairy operators to learn the practices and benefits associated with reducing feed phosphorus levels appropriately and to implement those practices. Specific information and recommendations should be obtained from Land Grant Universities, industry, the Agricultural Research Service, or professional societies such as the Federation of Animal Science Societies (FASS) or American Registry of Professional Animal Scientists (ARPAS), or other technically qualified entities.

Microwatershed-Based Approach to Water Quality Monitoring and Agricultural Producer Assistance

This strategy is based on an ongoing TSSWCB project entitled *Technical and Financial Assistance to Dairy Producers and Landowners of the North Bosque River Watershed Within the Cross-Timbers and Upper Leon Soil and Water Conservation Districts* (TSSWCB Projects # 01-13 and # 01-14). The project will establish an overall Technical Advisory council and numerous microwatershed landowner councils and will coordinate meetings of the councils. Monitoring will be conducted to characterize WAF performance in the microwatersheds, based on tributary sampling. Technical assistance

will be provided to landowners for development of CNMPs and implementation of the management practices in the individual plans.

This microwatershed approach provides finer geographic resolution for managing implementation activities. Data from microwatersheds will help define sources of pollutants, help characterize the effects of implemented management measures, and help the TSSWCB coordinate assistance for property owners. This approach will help each individual microwatershed group assess and correct deficiencies in waste application fields, retention structures, or other aspects of dairy management and may identify other types of land use that could improve management practices.

Removal of 50% of CAFO Manure from the Watershed for Disposal

The basic goal of this strategy is to remove from the North Bosque River watershed approximately 50% of the manure produced by dairies, and other facilities that manage large amounts of animal wastes, within the watershed. Operators of dairies and other facilities will be encouraged to participate in a program to create several composting facilities and a sustainable market for composted manure as a way to achieve this goal. Permit rules applicable to the North Bosque River watershed require new or expanding dairies to either remove manure from the watershed or employ other management options to prevent pollutant export. Composting may be the most cost-effective way for those dairies to satisfy such a permit condition. More information regarding the composting program is in *Watershed Restoration Action Strategy for the North Bosque River Watershed (HUC 12060204)* and §319 grant documents for the "State of Texas Composted Manure Incentive Program."

Municipal WWTP Effluent Limits

The basic goals of this strategy are to reduce overall phosphorus loading from existing WWTP discharges and to minimize future loading from new or expanded municipal discharges.

Discharges from WWTPs are not evenly distributed along the North Bosque River, since the municipalities vary substantially in size. Most of the WWTP loading occurs in the upper portion of the watershed, above Meridian. Model simulations performed to support TMDL development assumed that most of the load reduction would occur in the upper watershed. Making the initial reductions in WWTP loading in the upper watershed is necessary to achieve water quality goals at the below Stephenville index site. Since the City of Stephenville is by far the largest WWTP discharge, and is the discharge furthest upstream along the river, it is a focus for Phase I reductions from point sources.

Table 4 summarizes the initial allocation of total phosphorus (TP) among the existing WWTPs and allowance for future growth proposed by the TCEQ for Phase I. Total phosphorus is used for this waste load allocation to remain consistent with normal practice in WWTP permitting and design and because it is a more inclusive measure of phosphorus loading. The TCEQ will draft Phase I permits to incorporate requirements

that permittees monitor and report phosphorus loading, and will require planning and permitting to begin Phase II for individual permittees as each reaches or exceeds the load limits allocated for Phase I. In Phase II, permit limits may be either "load-based"– requiring that effluent flow and/or concentration be controlled so that the permitted loading rate for total phosphorus not be exceeded – or "concentration-based"– requiring an average effluent concentration (1 mg/L TP) for any flow discharged. Later phases may involve a transition from load-based to concentration-based permit limits for individual WWTPs.

The model simulations upon which Phase I is based included an explicit allowance for future growth of 0.6 million gallons per day (MGD) of hypothetical wastewater discharge with a soluble reactive phosphorus concentration equivalent to 1 mg/L TP, or 829.5 kilograms per year (kg/yr) of TP load. Table 4 allocates part of the allowance for growth (AFG) among all the cities except Stephenville and leaves the residual part as AFG. This distribution allows for the new Cranfills Gap facility and is appropriate in Phase I because Stephenville's load limitation, which is necessary to attain water quality goals at the below Stephenville index site, is expected to provide sufficient improvement to meet goals at downstream index sites. Changes at downstream WWTPs may not be needed to attain water quality goals. Existing permit limits will remain in effect until amendments are approved through the TCEQ permitting process. More information is available in the section *Municipal Permits*.

Adapting Rules, Permit Reviews, and Enforcement Activities to Watershed Issues

The basic goal of this strategy is to assure that regulatory activities adequately support efforts to achieve water quality targets. This type of effort is implicit in the concept of adaptive management. Much of the effort this strategy requires will happen within TCEQ, but it will affect many regulated entities within the North Bosque watershed. Some adaptations will occur during Phase I, and others may occur during Phase II. Model refinement efforts during Phase I will increase spatial resolution of analyses, integrate the latest knowledge concerning phosphorus dynamics, and support review and adaptation of the implementation plan.

TCEQ will initiate an analysis of the correlation between the occurrence of "chronic" rainfall events and overflows from lagoons and waste storage ponds. Results will be used to determine what revisions to the CAFO regulations are warranted.

Rule changes stipulated by the 77th Legislature that affect animal feeding operations in the North Bosque River watershed were developed during 2001 and are in effect for Phase I. Those rule changes require that new or expanding CAFOs in the watershed have certified nutrient utilization plans for any waste application fields with high soil phosphorus concentrations, and may limit the amount of manure a dairy operation is allowed to use or dispose within the watershed. Permits for new or expanded CAFOs

would include those rule changes. In conformance with existing rules, Phase I TCEQ permit review procedures will also seek to assure that:

- all authorized CAFOs have comprehensive nutrient management plans.
- all CAFO retention structures and facilities are designed, constructed, and managed to minimize the occurrence of discharges – which may require more than the published generic minimum design criteria and may require retrofit of some structures.
- all municipal wastewater treatment plant permits contain specific requirements and limitations regarding the phosphorus content of their discharges.

More information is available in the section *Permitting Programs*.

Compliance and enforcement activities in the North Bosque watershed during Phase I include inspections and other investigations based on issues of regional concern. Cities and CAFOs will be inspected with the goals of this implementation plan in mind. Formal enforcement actions result if CAFOs:

- increase herd size without proper authorization.
- fail to maintain adequate storage capacity or freeboard in retention structures or waste storage ponds, or fail to notify TCEQ of discharges.
- apply waste or wastewater to a WAF that has been documented to have exceeded 200 parts per million phosphorus in Zone 1 of the soil horizon.

More information is available in the section *Enforcement Program*.

The current CAFO regulations expire in July 2004. In the Spring of 2003, TCEQ will initiate the rulemaking process to revise appropriate sections of the current CAFO regulations, which may include but is not limited to:

- requiring all AFOs and CAFOs to use comprehensive nutrient management plans.
- specifying additional requirements for tailwater controls at waste application sites or additional management requirements to prevent runoff caused by excessive irrigation with wastewater.
- requiring AFOs and CAFOs to recertify retention structures if discharges have occurred due to “chronic” rainfall events.
- clarifying distinctions between “chronic” and “catastrophic” rainfall events, and/or eliminating the “chronic” rainfall event exemption.
- specifying more stringent design factors and/or management practices for retention structures.

More information is available in the section *Legal Authority*.

Water Quality Monitoring

The North Bosque River watershed will continue to be extensively monitored by various entities concerned with water quality issues. All data collected will be used to the extent possible to support assessment of TMDL implementation and to develop any adaptive strategies that may be needed as Phase II. All data collection and laboratory analyses will be performed consistent with Quality Assurance Project Plans (QAPPs). More information about monitoring activities is available in the sections of this plan titled *Water Quality Monitoring Plan* and *Measures of Success*.

Routine monitoring will occur at both historical and new sites on the river and its tributaries, to provide the primary basis for assessments of watershed conditions. Routine monitoring is performed by TCEQ and several other qualified entities and will be scheduled annually through the TCEQ coordinated monitoring process. Data from routine monitoring activities are stored in the TCEQ database.

Special project monitoring will support several individual projects. The Compost Program and Microwatershed Council Program will plan and perform monitoring activities intended to characterize the effects of existing management practices, and of new management practices, so that the effectiveness of various implementation elements can be determined. The Model Refinement Project will collect data needed to support model improvements, utilizing data from routine monitoring and other special projects to the extent possible. Data from special projects may be used for periodic assessments of general water quality if the data represent ambient conditions suitable for such assessments.

Schedule for Phase I

Table 2 summarizes the schedule for implementing major elements of this plan. More information is available in subsequent sections that address specific elements.

Relative Contributions of Phase I Management Strategies for Nonpoint Sources

Predicting how much the three strategies for nonpoint WAF and animal waste management will each contribute towards achieving the water quality goals is very difficult, since the measures are at least partially voluntary and their effects overlap to some extent. Furthermore, the locations and export loading rates of former or current WAFs with existing elevated soil concentrations of phosphorus are not clear, and the residual effects of those areas are not easily predicted. The potential effects of unplanned discharges due to mismanagement or extreme weather conditions are also unpredictable with existing models or information. Phase I management measures will need to overcome those unpredictable effects in order to be successful, or Phase II measures will be needed.

Table 2. Schedule for Phase I		
Activity	**Activity Description**	**Schedule for Implementing Phase I Activities**
Agriculture permits (TCEQ)	• Phosphorus-based waste management plans for new or expanding dairies are required before permits will be issued. • Existing facilities currently operating under phosphorus-based NUPs or TSSWCB water quality management plans will continue to do so. • Existing facilities currently operating under nitrogen-based waste management plans will be encouraged or required to develop phosphorus-based plans within 3 years, as appropriate under pertinent rules and regulations. • Chapter 321 Subchapter B rules will be modified during the 2004 reauthorization if needed to support this goal. • The goal of the TCEQ and the TSSWCB is that all dairies in the North Bosque River watershed will be practicing phosphorus-based waste management by the end of calendar year 2006.	Permit and operational changes begin 2002, complete by 2006 Initiate Ch 321 Sub Ch B rule reauthorization - Spring 2003 Implemented HB 2912 requirements for new and expanding dairies - Fall 2002
Municipal permits (TCEQ)	• Upon approval of the implementation plan, TCEQ will initiate minor amendment actions for permittees which do not currently have phosphorus limits consistent with the Phase 1 plan in order to make the permits consistent with the Phase I municipal wasteload allocation. The City of Clifton permit currently has a phosphorus limit which is consistent with (i.e. less than) the allocation; a major amendment action is necessary to change the Clifton permit to the load limit and conditions for Phase I. The Phase I Clifton permit amendment action will begin when the City of Clifton initiates a major amendment application. The initial load allocations for each city are shown in Table 4. The permits will be drafted to state that when the self-monitoring data indicates that the discharge has reached 100% of the loading rate specified in Table 4, based on the daily average for three consecutive months, the permittee shall within 90 days submit a plan to achieve compliance with the load limit on a continuous basis OR to achieve a concentration limit of 1 mg/l based on the permittee's requested design capacity flow.	Permit and operational changes beginning in 2003, continuing as needed for individual transitions to Phase II

Table 2. Schedule for Phase I, continued

Activity	Activity Description	Schedule for Implementing Phase I Activities
Composting program (TCEQ, TSSWCB)	• The composting program began operation when Federal grant funds became available on September 27, 2000, and will continue until at least August 31, 2003 when the current grant period ends. • Commercial composting facilities will be authorized as no-discharge operations by general permit. Alternatively, commercial composting may apply for authorization under an individual wastewater permit. These will be issued as TCEQ no-discharge permits in the watershed.	Program began 2001; continues indefinitely (grant funded through at least August 2003)
Comprehensive Nutrient Management Planning (TSSWCB)	• Program for development and implementation of Comprehensive Nutrient Management Plans (CNMPs) for all identifiable agricultural sources of phosphorous loading in the watershed including but not limited to feed management, waste applications site management, manure removal, and other management methods such as capture-and-treat systems.	Program begins 2002, continues indefinitely
Microwatershed Councils (TSSWCB)	• Conducting micro-watershed producer council meetings on at least a semiannual basis to present information on upcoming educational opportunities, discuss findings of monitoring studies, and discuss development and implementation of certified WQMPs/CNMPs for agricultural operations. • Deliverables include: delineation of the watersheds, compilation of the location and type of existing BMP's, list of updated or newly developed WQMPs and BMPs implemented, cumulative soil sampling results, and documentation of WQMPs receiving annual review.	Program begins 2002, continues indefinitely
Educational Outreach (TCEQ, TSSWCB, TCEQ)	• Animal waste management courses are required of CAFO operators within 12 months of authorization and subsequently every 2 years. Training and technical assistance is available and encouraged for other agricultural operators in development and implementation of WQMPs/CNMPs, feed management, waste management issues and practices, and for compost facility operators.	Began 1998, continues indefinitely

Table 2. Schedule for Phase I, continued

Activity	Activity Description	Schedule for Implementing Phase I Activities
Water Quality Monitoring (TCEQ, TSSWCB, and others)	• Implementation monitoring – weekly in-stream monitoring of soluble reactive phosphorous or PO4-P concentrations and flow measurements at 5 index sites in the watershed to begin 2002 or 2003. • Compost program monitoring – field monitoring to measure water quality improvements attributable to the removal and composting of manure will begin in 2002. • Micro-watershed councils monitoring – in-stream small tributary monitoring to characterize the performance of management of waste application fields and other wastewater management practices as part of TSSWCB micro-watershed councils project to begin in 2002. • Model refinement monitoring – data to support model refinement may be extracted from other monitoring activities as described above. Model refinement investigative work will begin in the fall of 2002. Additional data needs will be assessed throughout the model refinement development.	Some ongoing, special projects and expanded routine monitoring network by 2006 Model refinement will be completed by 2006. Coordinated monitoring plans are developed annually in the spring. Next development: Spring 2003

The following discussion illustrates how the Phase I measures may potentially interact, using estimates of their predicted effects at the index site called "Above Meridian," which is the middle site on Figure 3. These values represent estimates at one specific index site and would be different if calculated at other points along the river.

Using the index site "Above Meridian" as the reference point for such estimates, gross nonpoint source load reductions needed to meet the TMDL goals may range from 20% to 56%, depending on the type of simple linear relationship assumed. Presuming that dairy operations are the only type of nonpoint source reduced, simple estimations suggest that loadings from dairies and WAFs may need to be reduced by 33% to 90% to achieve overall nonpoint source load reductions of that magnitude. The following illustrative discussion will assume that dairy-related gross loading needs to be reduced by 60%, which is arbitrarily selected from within the estimated range.

The management goal of removing 50% of CAFO manure from the watershed will primarily rely on the composting program. If the goal is attained, WAF gross loading will be reduced by approximately 50% compared to what may otherwise have occurred. It is possible that even more could be removed. However, if nobody participates, the manure removal management strategy may achieve nothing, i.e. 0% is the minimum possible contribution. For illustrative discussion, assume this strategy removes enough manure

from the watershed so that phosphorus export from WAFs is reduced by 30%. That leaves 60 - 30 = 30% to be further reduced.

The reduced-phosphorus feed management strategy was proposed by dairy representatives during TMDL development. Information provided at that time suggests that careful feed mixing could reduce the phosphorus content of cow manure by as much as 28%. The potential contribution of this strategy is estimated as ranging from 0% (if nobody does it) to about 25% (if almost everybody does it). However, it will further contribute to phosphorus loading reduction only in the manure that is not hauled out of the watershed. For illustrative discussion, assume this strategy is applied by enough dairy operations to reduce the watershed average manure phosphorus content by 15%. Applying that percentage to the residual 70% remaining in the watershed (after haul-out of 30%), there is a further reduction in gross loading of phosphorus (not manure) of 0.15(70%) = 10.5%. Now a total of 30% + 10.5% = 40.5% has been reduced, leaving 60 - 40.5 = 19.5% further reduction needed.

Other aspects of comprehensive nutrient management, like application rates in WAFs, would account for the balance of the 60% reduction, which is 19.5% in this illustrative example. If the results of the other strategies are better than presumed for this example, the land application rate measure may not need to accomplish as great a reduction. Conversely, if voluntary participation in the other two strategies is small and they contribute little toward the reduction goal, or if unpredictable loading is large, the comprehensive nutrient management strategy will have to accomplish a greater reduction. Potentially, the comprehensive nutrient management strategy may need to contribute anywhere from as little as 1% to as much as 60% towards the 60% reduction presumed for this discussion. Of course, if the number of dairy cattle increases while dairy-related loading is being reduced, land application rates and CNMPs in general would also need to play a large role in preventing loading increases.

Phase II

If water quality goals are not being attained by Phase I management strategies within a reasonable amount of time, additional strategies will be needed. Water quality monitoring will be used to determine if the water quality goals are being attained or approached. For more information, see the sections “Water Quality Monitoring Plan” and “Water Quality Measures of Success.” Information derived from monitoring BMP effectiveness may be used to determine which sources need additional control, or to refine model analyses that predict the extent and effect of additional measures.

Additional strategies, if needed, may occur in several subsequent phases, depending on the effects of previously implemented strategies, but are described here as a single secondary phase for convenience. Types of future-phase management measures that may be considered are listed below, but other management measures or control actions could develop to augment or replace these. Details of Phase II elements will not be fully developed until the need for them is clear.

- Imposition of special requirements within the watershed for manure disposal, retention structures, tailwater controls, or other aspects of CAFO and AFO management.
- Requirement of storm water control plans to reduce phosphorus loading from cities, industries, or other regulated sites.
- Additional voluntary or regulatory strategies measures to reduce phosphorus loading from other land uses.
- Imposition of 1 mg/L total phosphorus permit limits for all wastewater treatment plants.

Programs To Implement Control Actions and Management Measures

Legal Authority

The TCEQ, because of its central role in establishing state water quality standards and determining compliance with those standards, has particular responsibilities to fulfill in the state's overall water quality management program. The TSSWCB supports the process by providing input to the technical analyses, participating in steering committees, and by implementing NPS management programs and projects as necessary to address the agricultural and silvicultural contributions to impaired water bodies in the state.

TSSWCB

The TSSWCB is responsible for developing and implementing provisions of TMDLs and watershed action plans related to agricultural and silvicultural nonpoint sources (Texas Agriculture Code 201.026 (a)), in conjunction with TCEQ management of the general TMDL process. The TSSWCB is the lead agency for abatement of pollution from agricultural or silvicultural activities, and shares responsibility with TCEQ for representing the state before the federal Environmental Protection Agency or other federal agencies in matters relating to agricultural or silvicultural nonpoint source pollution (Texas Agriculture Code 201.026 (b)). Another responsibility of the TSSWCB is to certify that water quality management plans for agricultural or silvicultural operations comply with state water quality standards (Texas Agriculture Code 201.026 (c)).

TCEQ

The TCEQ's general authority to protect water quality in the State of Texas is specified in the Texas Water Code. General powers and duties are provided by the provisions of Title 2, Subtitle A, Chapter 5, Subchapter D. The TCEQ derives its specific authority to conduct enforcement actions from TWC, Title 2, Subtitle A, Chapter 7. Specifically, TWC § 7.002 authorizes the Commission to initiate an action to enforce provisions of the water code and to institute legal proceedings to compel compliance with the TWC and with rules, orders, permits or other decisions of the Commission. Responsibilities and

authorizations pertaining specifically to water quality protection are contained within Title 2, Subtitle D, Chapter 26.

The TCEQ received delegation of the NPDES program from EPA on September 14, 1998, and is authorized to implement the Texas Pollutant Discharge Elimination System (TPDES), the regulatory program to control discharges of pollutants to surface waters. The TPDES program covers all permitting, surveillance and inspection, public assistance, and enforcement regulatory processes associated with waste discharges into surface water in the state, with the exception of discharges associated with oil, gas, and geothermal exploration and development. The TPDES program includes discharges of waste from industry and municipal treatment works, and discharges of storm water associated with industrial activities, construction sites, and municipal separate storm sewer systems (MS4s).

Texas statutory provisions require the Commission to establish the level of quality to be maintained in, and to control the quality of, water in the state (TWC Section 26.011). Texas fulfills its obligations under Section 303(d) of the Clean Water Act to list impaired segments and create TMDLs through functions assigned by the Legislature to TCEQ. The Section 303(d) list is prepared by TCEQ as part of its monitoring, planning and assessment duties (TWC §26.0135). Watershed monitoring and assessments involving agricultural or silvicultural nonpoint source pollution must be coordinated through the TSSWCB with local soil and water conservation districts (TWC §26.0135).

TMDLs are part of the state water quality management plans that TCEQ is charged by statute to prepare (TWC §26.036). As the state environmental regulatory body, the Commission has primary responsibility for implementation of water quality management functions within the State (TWC §26.0136 and §26.127). The Executive Director of the TCEQ must prepare and develop, and the Commission must approve, a comprehensive plan for control of water quality in the state (TWC § 26.012). Texas Surface Water Quality Standards are contained in Title 30, Chapter 307 of the Texas Administrative Code (30 TAC Chapter 307). TCEQ procedures for implementing these standards are described in the most recent version of the document titled *Implementation of the Texas Commission on Environmental Quality Standards*. The list of impaired segments and resulting TMDLs are tools for water quality planning.

The Texas Land Application Permit (TLAP) program is administered under Chapter 309 of the Texas Administrative Code (30 TAC Chapter 309). The TLAP program regulates municipal and industrial discharges made adjacent to waters of the state. “Discharge adjacent to waters” essentially means disposal of wastes by irrigation on land rather than by direct discharge to a water body. Cities or composting operations within the North Bosque River watershed that operate or propose “no discharge” permits are regulated by the TLAP program. A proposed general permit for composting facilities would be authorized under TLAP regulations.

Permits or registrations for CAFO waste management or discharge are authorized under Chapter 321 of the Texas Administrative Code (30 TAC Chapter 321) Subchapter B. CAFO irrigation facilities (i.e. waste application fields) have operational and regulatory requirements similar to those of the TLAP, but are regulated under different rules. In addition to regulating waste application fields, permits for dairies or other CAFOs regulate additional aspects of the operation, including discharges from retention structures necessitated by conditions such as extreme precipitation events.

The North Bosque River watershed is a "major sole source impairment zone" as defined in House Bill (HB) 2912, Article 12, relating to Regulation of Certain Animal Feeding Operations and Senate Bill (SB) 2, Article 8, relating to Concentrated Animal Feeding Operations, which were passed by the 77th Texas Legislature in 2001. Animal feeding operations in the North Bosque River watershed, including dairies, are subject to the requirements of that legislation as contained in 30 TAC Chapter 321.

The Chapter 321 Subchapter B CAFO regulations expire on July 27, 2004 unless readopted. The regulations will be reviewed and revised as appropriate for reauthorization. The regulations may be modified to better support implementation of this plan for the North Bosque River watershed during the next or any other reauthorization cycle. In the Spring of 2003, TCEQ will initiate the rulemaking process to revise appropriate sections of the current CAFO regulations, which may include but is not limited to:

- requiring all animal feeding operations to use comprehensive nutrient management plans that minimize phosphorus loading, regardless of herd size, date or type of authorization, type of animal, etc.
- specifying additional requirements for runoff and tailwater controls at waste application sites, or additional management requirements to prevent runoff caused by excessive irrigation with wastewater.
- requiring animal feeding operations to recertify retention structures if discharges have occurred due to "chronic" rainfall events.
- clarifying distinctions between "chronic" and "catastrophic" rainfall events, and/or eliminating the "chronic" rainfall event exemption.
- increasing storage capacity and/or freeboard requirements for waste storage and retention structures.
- changing minimum design criteria for retention structures (e.g. specifying that ponds must contain an event larger than the current 25-year 24-hour storm event or requiring more rigorous analyses of the potential for overflows to occur).

Permitting Programs

Strategies of this implementation plan that are implemented through regulatory requirements will be administered through existing TCEQ wastewater permitting programs in the Office of Permitting, Remediation, and Registration, Water Quality Division.

Agriculture

Animal feeding operations, including dairies, may be authorized in several ways:

- CAFO Individual Permits; customized requirements specific to the CAFO.
- CAFO Registration; general requirements under Chapter 321 Subchapter B rules.
- Animal Feeding Operation (AFO); general requirements under Chapter 321 Subchapter B rules, but without written authorization.

Individual permits or registrations under Chapter 321 Subchapter B rules are required for dairies with more than 200 head, and those facilities are categorized as CAFOs. Dairies with less than 200 head may operate without registration, but must comply with Chapter 321 Subchapter B rules and are categorized as Animal Feeding Operations (AFOs). The term "animal feeding operations" is also sometimes used in a generic, comprehensive sense that includes all CAFOs and AFOs for any type of animal.

Comprehensive nutrient management planning is recommended for all animal feeding operations of any type or size that manage animal wastes in the North Bosque River watershed, regardless of the individual facilities' sizes, locations, or form of authorization (i.e. registration, individual permit, etc.). CAFOs operating under Subchapter B written authorization are required to develop and implement pollution prevention plans (PPP) which include all controls and management practices necessary to control waste transport off the CAFO. The PPP embodies many of the same principles as the CNMP. A CNMP encompasses aspects of a nutrient management plan (NMP), but will additionally cover the entire conservation system (at a minimum the CAFO production area and waste management activities) by providing the operator with a dynamic operations manual for addressing the agronomic and environmental facets of the animal feeding operation. Nutrient management planning, which is an element of both the PPP and CNMP, requires that application of animal wastes to land within the North Bosque River watershed should not exceed application rates and schedules appropriate for the nutrient-related (including phosphorus) characteristics of the application site soils. NMPs have traditionally been developed as part of a conservation plan for producers and landowners to address nutrient specifications for cropping systems.

CNMPs and NMPs are all primary planning tools utilized to define and document appropriate waste management practices for the facility and/or specific waste application field. Additionally, Subchapter B regulations require Nutrient Utilization Plans (NUP) when soil phosphorus concentrations exceed the regulatory threshold. NUPs utilize a Phosphorus Index Analysis (PI) which evaluates site-specific risk factors and management practices that are in place to minimize the release of phosphorus to surface water. Facility-specific Phosphorus Index Analyses become part of a scheme of nutrient management to restrict manure application to phosphorus rates. Some factors evaluated in the nutrient management planning process include the amount and types of wastes generated, the slope and surface drainage characteristics of WAFs, soil permeability, the

extent of buffer strips and tailwater controls around WAFs, and the seasonal timing and abundance of precipitation, as well as many other factors pertinent to nutrient management. Annual soil sampling is required on each WAF to monitor soil phosphorus concentrations for comparison to the critical concentrations (determined by the PI for each WAF) that will trigger changes in waste application rate. The ultimate purpose of NUPs is to establish and guide management practices that allow a facility to maximize the beneficial reuse of animal waste as nutrients for improving agronomic production while minimizing export of nutrients to water bodies. It is recommended that dairy producers seek assistance from one of the agencies mentioned below to develop and implement the nutrient control measures itemized within this implementation plan.

Dairy facilities and other CAFOs may already have NMPs, pollution prevention plans and/or NUPs developed to support previous permit applications. Some facilities are operating under certified water quality management plans approved by the TSSWCB, which include the essential elements of an CNMP. New or expanding dairy CAFOs in the North Bosque River watershed are required to manage waste in the following ways:

- remove certain wastes from the watershed,
- haul wastes to authorized composting operations,
- apply wastes according to the pollution prevention plan requirements of Subchapter B,
- apply wastes in accordance with the terms of an NUP approved by a certified nutrient management specialist.

The TCEQ agriculture permit program will review and process new, renewal and amended registrations and individual permit applications for CAFO facilities within the North Bosque River watershed to assure that the requirements of current rules and regulations are met. Reviews of individual permit applications and registrations will consider the adequacy of the CAFO facilities, including close scrutiny of the retention structures and history of discharges. A record of frequent discharges due to precipitation events or poor management/operation may be grounds for requiring recertification of retention structures to assure the required storage capacity is met, in order to minimize the occurrence of precipitation-driven discharges. A poor history of compliance with permit requirements at a CAFO may cause the TCEQ to revise permit conditions or deny reauthorization.

As each CAFO application is reviewed for authorization under Subchapter B, the permitting program will determine whether comprehensive nutrient management planning is embodied in the facility's pollution prevention plan.

- New or expanding dairy CAFOs will be required to demonstrate through the application process that they will operate under the nutrient management practices as stipulated in Chapter 321 rules pertinent to a major sole source impairment zone.

- Existing dairy CAFOs that continue to operate without expansion, under either registration or individual permit authorization, will be required to update and implement any elements missing from the pollution prevention plan, or NUP, relating to appropriate nutrient management practices required under Subchapter B regulations. When appropriate, this category of existing CAFOs may be required to develop some form of phosphorus-based waste management plan.
- Voluntary modifications of existing CAFO facilities that are necessary to correct deficiencies of existing retention structures, or other aspects of CAFO management, without any change in authorized herd size or dairy site plan, will not require amendment of permits or authorizations. Voluntary changes that will improve operation or maintenance of retention structures, or other aspects of CAFO management, without changes in herd size or expansion of the site plan, may be processed as minor amendments under some circumstances if authorization is required. Permittees should discuss such plans with TCEQ agriculture permitting staff before beginning work, to determine if authorization is needed and to coordinate the work with the regulatory system.
- Dairy AFOs will be encouraged to develop and follow TSSWCB certified water quality management plans. All dairies that have fewer than 200 dairy cattle (including dry cattle) in confinement can legally be in this category. Any existing dairy that plans to expand its authorized herd to more than 200 head will be required to develop appropriate PPPs under Chapter 321 rules.

In some cases, permit conditions may suffice to achieve adequate nutrient controls without requiring NUPs or CNMPs for the waste application fields. For instance, a facility that is required by permit to remove 100% of its wastes from the watershed for disposal or reuse may not need a formal NUP or CNMP for the WAFs.

Any plan for nutrient management within the North Bosque River watershed will need to encourage efforts to remove excess wastes from the watershed for beneficial reuse or disposal. The more waste a facility can remove from the North Bosque watershed, the greater the likelihood the overall concentration level of phosphorus in the soils will be reduced within the watershed. Therefore, participation in the composting program is encouraged to voluntarily support this waste removal effort and for CAFOs it may be required as a component of some pollution prevention plans.

The TSSWCB can provide assistance to any agricultural producer, including dairy operators, for developing and implementing CNMPs. Operators of large dairies (CAFOs), small dairies (AFOs), or other types of agricultural property that use manure to supplement soils, are eligible for TSSWCB assistance. Besides help with development of plans, TSSWCB can also certify that the plans meet NRCS and TCEQ requirements, and may provide cost share assistance for construction/implementation of plan elements.

Further information and guidance regarding TCEQ's Subchapter B rules and regulations pertinent to animal feeding operation, Pollution Prevention Plans, or Nutrient Utilization

Plans is available from the TCEQ. Information about Certified Water Quality Management Plans, Nutrient Management Plans and Comprehensive Nutrient Management Plans is available from the Texas State Soil and Water Conservation Board, or from the U.S. Department of Agriculture Natural Resource Conservation Service. Assistance in developing those types of plans is available to agricultural producers from the TSSWCB and other agriculture-support entities.

Schedule
Approval of this implementation plan does not automatically change permit limits. Existing permit limits and conditions remain in effect until the established permitting process results in formal approval of amendments. The TCEQ may initiate revisions and amendments to individual permits when appropriate. The general permit may be revised, and may require re-registration of facilities to assure compliance with the revisions.

Phosphorus-based waste management plans for new or expanding dairies are required before permits will be issued. Existing facilities currently operating under phosphorus-based NUPs or TSSWCB water quality management plans will continue to do so. Existing facilities currently operating under nitrogen-based waste management plans will be encouraged or required to develop plans within 3 years, as appropriate under pertinent rules and regulations. Chapter 321 Subchapter B rules may be modified if needed to support this goal. The goal of the TCEQ and the TSSWCB is that all dairies in the North Bosque River watershed will be practicing phosphorus-based waste management by the end of calendar year 2006.

Assurance
The existing TCEQ permitting program and structure will assure that permits are reviewed and/or modified to address comprehensive nutrient management planning. The existing TCEQ compliance and enforcement program will assure that the permit requirements are implemented and met. The TSSWCB will perform annual status reviews to ensure the implementation of WQMPs and CNMPs. If the TSSWCB finds that a WQMP or a CNMP has not been properly implemented or maintained, the plan will be decertified. If a permitted facility is using a certified CNMP to fulfill a permit requirement for an NUP, the TSSWCB will notify the TCEQ if it becomes decertified, making the operation subject to an enforcement action by the TCEQ for being in violation of the permit.

Municipal Permits
This plan addresses only the phosphorus limitations for permits in the North Bosque River watershed. All other effluent limits for other constituents or aspects of WWTP discharge will continue to be determined by existing permitting processes.

This implementation plan anticipates that permit limits for municipal or industrial wastewater treatment facilities will be for total phosphorus (TP), for several reasons. Total phosphorus has usually been the parameter used to design WWTPs and establish permit

limits, so using that parameter here maintains consistency with normal permitting and design practices. Total phosphorus is also a more conservative and complete measure of effluent loading rate, since TP measurements include the PO4-P or SRP component also, but PO4-P or SRP effluent measurements omit some amount of sorbed or solid phase phosphorus.

There are some technological limitations to be considered when planning to control phosphorus loading from wastewater treatment facilities. Phosphorus removal may be achieved by chemical/physical processes, biological processes, or a combination thereof. A variety of patented process designs are commercially available. Widely used chemical/physical treatment processes can dependably meet permit limits of 1 mg/L total phosphorus (Metcalf & Eddy, 1979). Many municipal WWTPs built to meet permit limits for phosphorus are designed to achieve an average effluent concentration of 1 mg/L total phosphorus. A few facilities around the nation have done better, consistently achieving effluent concentrations as low as 0.1 mg/L total phosphorus, but that requires considerable expertise and commitment in facility operation as well as design engineering. Extreme treatment levels, to meet effluent limits significantly lower than 1 mg/L total phosphorus, are less likely to be feasible for small facilities such as those in the North Bosque River watershed.

There are currently seven municipalities with wastewater discharge permits in the North Bosque River watershed. Six existing facilities (Stephenville, Hico, Iredell, Meridian, Clifton, Valley Mills) discharge directly to the North Bosque or Upper North Bosque River, and were monitored from November 1995 through March 1998 to determine the amount of nutrient loading emanating from each. The loading rates monitored during 1995 - 1998, as shown in Table 3, were extracted from the report *Existing Nutrient Sources and Contributions to the Bosque River Watershed* (McFarland and Hauck, 1999). Permit numbers that identify the specific TPDES permits have been included for each facility. Cranfills Gap is included in Table 3 to provide continuity with subsequent tables and discussion.

The Clifton WWTP permit was amended during November 1999 to authorize expansion of the facility. The amended permit includes an annual average loading limit of 6.2 pounds per day of total phosphorus, which was the best estimate of existing loading from the Clifton WWTP then available. That limit was established to prevent an increase in phosphorus loading prior to completion of the TMDL analyses and implementation plan. The Clifton permit is the only one in the watershed that currently contains a phosphorus limit. Any changes to phosphorus limits in the Clifton permit will be consistent with the approved TMDL and this implementation plan.

The seventh facility (Cranfills Gap) received a new permit during April 2001. The Cranfills Gap WWTP will discharge to the headwaters of Meridian Creek, more than 20 stream miles from the North Bosque River. The permit authorizes a small facility adequate to serve approximately 400 people, with an expected service population of less

than 200 in the foreseeable future. The new WWTP will allow the residents of Cranfills Gap to convert from septic tanks to a modern collection and treatment system, which is expected to provide improvement or protection for local streams. The distance from Cranfills Gap to the North Bosque River is sufficient that most of the nutrient loading should be assimilated before reaching the river.

Table 3 also shows the 1995 - 1998 flows and loading rates converted to measurement units used in the TMDLs. Specifically, the flow units of 'million cubic feet per year' are converted to 'million gallons per day' (MGD), and the loading units of 'pounds per year' are converted to 'kilograms per year'. Table 3 also provides the average effluent concentrations for each existing facility, as calculated from the average flow and loading values. For the purposes of the North Bosque River TMDL and this implementation plan, orthophosphate-phosphorus is considered to be equivalent to soluble reactive phosphorus. The values shown in Table 3 define the 'existing conditions' for ensuing discussion.

Table 3. Existing Condition WWTP Phosphorus Loading to the North Bosque River, 1995-1998

Permittee (Permit No.)	Units reported in McFarland and Hauck, 1999			Converted to TMDL Units			Average Effluent Concentrations	
	Flow [million cubic feet per year]	PO4-P [lbs/yr]	Total P [lbs/yr]	Flow [MGD]	PO4-P [kg/yr]	Total P [kg/yr]	PO4-P [mg/L]	Total P [mg/L]
Stephenville (10290-001)	86.36	11,523	14,381	1.769	5,228.2	6,525.0	2.14	2.67
Hico (10188-001)	3.93	658	751	0.080	298.5	340.7	2.68	3.06
Iredell (11565-001)	1.22	182	209	0.025	82.6	94.8	2.38	2.74
Meridian (10113-002)	9.25	1,468	1,763	0.190	666.1	799.9	2.54	3.05
Clifton (10043-001)	14.94	1,621	2,191	0.306	735.5	994.1	1.74	2.35
Valley Mills (10307-001)	4.57	710	793	0.094	322.1	359.8	2.49	2.78
Cranfills Gap (14169-001)	-----	-----	-----	-----	-----	-----	----	----
Column Totals:	120.3	16,162	20,088	2.463	7,333.0	9,114.3		

Phase I

Table 4 summarizes the initial waste load allocation of total phosphorus for municipal sources during Phase I. This initial allocation approximately corresponds to model simulations performed for the TMDL, but is stated in total phosphorus instead of orthophosphate-phosphorus. The modeling included 0.600 MGD of allowance for future growth (AFG) at 1 mg/L total phosphorus, which equates to 829.5 kg/yr of total phosphorus. In this allocation, the total phosphorus loading associated with part of the AFG is distributed among Cranfills Gap, Hico, Iredell, Meridian, Clifton, and Valley Mills. The AFG shown in Table 4 is less than was modeled to reflect that redistribution.

Upon approval of this implementation plan, TCEQ staff will initiate minor amendment actions for permittees which do not currently have phosphorus limits consistent with the Phase I plan in order to make the permits consistent with the Phase I municipal wasteload allocation. The City of Clifton permit currently has a phosphorus limit which is

Table 4. Initial Waste Load Allocation, Full Permitted Discharge

Permittee (Permit No.)	Permitted Flow [MGD]	Initial Allocation Load [kg/yr Total P]	Initial Allocation Load [lb/d Total P]
Stephenville (10290-001)	3.000	4,200	25.4
Hico (10188-001)	0.200	525	3.2
Iredell (11565-001)	0.050	280	1.7
Meridian (10113-002)	0.450	980	5.9
Clifton (10043-001)	0.650	1,160	7.0
Valley Mills (10307-001)	0.360	500	3.0
Cranfills Gap (14169-001)	0.040	65	0.4
Allowance For Growth	0.225	290	1.8
Column Totals:	4.975	8,000	48.4

At average PO4-P/TP ratio of 0.82 (CDM data), total allocation = 39.7 lb/d PO4-P.
If average PO4-P/TP ratio is 0.90, total allocation = 43.6 lb/d PO4-P.

consistent with (i.e. less than) the allocation; a major amendment action is necessary to change the Clifton permit to the load limit and conditions for Phase I. The Phase I Clifton permit amendment action will begin when the City of Clifton initiates a major amendment application. The TCEQ will draft permits to state that when the self-monitoring data indicate that the discharge from a WWTP has reached 100% of the

loading rate specified in Table 4, based on the daily average for three consecutive months, the permittee shall within 90 days submit a plan to:

- achieve compliance with the load limit on a continuous basis,

OR

- achieve an effluent concentration limit of 1 mg/L total phosphorus based on the permittee's requested design capacity flow.

Phase II

Phase II begins for each of the existing municipal permittees when their permits are amended after Phase I load allocations are reached. In Phase II, the load or concentration limits become regulatory limits stated in the effluent limits table of the permit. Permits may be drafted to include a compliance period of up to three years to achieve compliance with the load or concentration limitation. Those facilities that choose to meet load limits during Phase II must control discharge volume and quality so as to remain below the load limit. Those facilities that choose to meet a 1 mg/L effluent concentration limit will be allowed discharge volume limits appropriate for their population needs and WWTP design capacity. However, the TCEQ retains the authority to modify the requirements of Phase II if additional information or future conditions indicate that to be necessary.

Schedule

Approval of this implementation plan does not automatically change permit limits. Existing permit limits and conditions remain in effect until the established permitting process results in formal approval of amendments. The TCEQ may initiate revisions and amendments to permits if appropriate.

Upon approval of this implementation plan, TCEQ staff will initiate minor amendment actions for permittees which do not currently have phosphorus limits consistent with the Phase I plan in order to make the permits consistent with the Phase I municipal wasteload allocation. The City of Clifton permit currently has a phosphorus limit which is consistent with (i.e. less than) the allocation; a major amendment action is necessary to change the Clifton permit to the load limit and conditions described above for Phase I. The Phase I Clifton permit amendment action will begin when the City of Clifton initiates a major amendment application.

Permit amendments to incorporate Phase II conditions will occur as the discharges of individual permittees reach the Phase I allocations. A permittee may choose to enter Phase II immediately, or at any time prior to reaching the Phase I allocation, but once into Phase II may not return to Phase I. Due to its unique situation, the City of Stephenville may find it advantageous to address Phase II immediately.

Assurance

The existing TCEQ permitting program and structure will assure that permits are reviewed and/or modified to incorporate appropriate phosphorus limits. The existing

TCEQ compliance and enforcement program will assure that the permit requirements are implemented and met.

The Texas Water Development Board (TWDB) has several programs that provide grants or low cost loans to municipalities for water and wastewater infrastructure needs. Eligible permittees in the North Bosque River watershed may elect to apply for financial assistance for wastewater treatment upgrades from the TWDB.

Industrial Permits

There are currently no industrial wastewater discharge permits for facilities in the North Bosque River watershed, nor is there any indication that applications for such discharges are pending. However, there is an existing industrial no-discharge permit for a facility located in the Paluxy River (Segment 1229) watershed, north of Stephenville. That permit authorizes use of two irrigation sites, one of which is located on the Upper North Bosque River (Segment 1255) side of the watershed divide. No-discharge permits authorize disposal adjacent to waters in the state (i.e. to application fields), but not to the waters themselves.

Commercial composting facilities in the North Bosque River watershed will require industrial wastewater permit authorizations. The current expectation is that most of the commercial composting facilities will be authorized as no-discharge operations by general permit registrations through the Texas Land Application Permits process. Individual permit applications for commercial composting facilities in the watershed under the Texas Land Application Permits program would also be processed as no-discharge permits.

If applications for industrial wastewater discharge are received, permit limits and conditions appropriate for the type of discharge and its precise location will be developed, and will address phosphorus discharge to assure the permits are consistent with the goals of the TMDLs. For general planning purposes, entities that propose to discharge treated industrial wastewater in the North Bosque River watershed should anticipate receiving effluent limits equivalent to 1 mg/L, or less, of total phosphorus.

Storm Water Permits

The TCEQ was authorized by EPA, on September 14, 1998, to administer the NPDES storm water program through the issuance of TPDES permits. EPA has agreed, under the terms of a memorandum of agreement between the two agencies, to continue to administer NPDES storm water permits that were effective on this date until they either expire or are replaced by a comparable TPDES permit. TCEQ will reissue these permits as TPDES permits upon their expiration. The NPDES program includes the regulation of storm water discharges from industrial activities, construction activities, and municipal separate storm sewer systems (MS4s).

The storm water permit program is implemented nationwide in two phases (which are not the same as the two phases of this implementation plan). Phase One permits regulate discharges of storm water associated with industrial activities, storm water discharges from construction activities that disturb 5 or more acres, and discharges from large and medium size MS4s (cities with a population equal to or greater than 100,000 people). The TPDES Phase One general storm water permit for industrial activity was issued in August, 2001. Phase One medium and large municipal separate storm sewer system (MS4) individual permits are being issued as their NPDES individual permits expire.

Phase Two permits will regulate discharges from construction sites that disturb at least one acre and discharges from small MS4s (urbanized areas and certain designated cities). Phase Two general permits for small MS4s and construction activities are scheduled for issue in December 2002. The Phase Two general permit for construction activities is for both small construction activities between 1 and 5 acres and Phase One activities disturbing 5 acres or more. In the North Bosque River watershed, only construction sites will be immediately affected by Phase Two storm water permit requirements. However, the TCEQ has until December 2002 to complete designation of small MS4s not in urbanized areas that will be required to obtain coverage.

On August 20, 2001, TCEQ reissued the NPDES permit number TXR050000, regulating storm water discharges associated with industrial activities, as TPDES permit number TXR050000. This general permit provides that storm water discharges to impaired water bodies may be authorized if they are consistent with the approved TMDL and the implementation plan. Covered facilities must incorporate the limitations, conditions and requirements applicable to their discharges, including monitoring frequency and reporting required by TCEQ rules, into their storm water pollution prevention plan in order to be eligible for permit coverage.

Phase I of this implementation plan proposes no changes to existing or pending storm water permit conditions or limits within the North Bosque watershed. However, if monitoring or other information eventually initiates Phase II implementation, the implementation plan may require storm water permits for entities that affect the North Bosque River watershed to be revised to reduce phosphorus loading. Revisions to the plan may also affect individual TPDES permits authorizing storm water discharges, MS4 permits, or storm water permits that authorize discharges from construction activities.

Composting Program

The composting program provides the primary means for seeking to remove approximately 50% of CAFO manure from the North Bosque River watershed. Participation in the compost program will be voluntary, but may provide the most efficient way for some facilities to meet individual regulatory requirements. Agriculture permits for some facilities therefore may require participation in the compost program or individual arrangements to accomplish the same result.

The desired goal of the composting program is the relocation of excess manure in order to reduce nutrient loading from conventional land application practices. The primary concept is to create a sustainable market for manure-derived compost, so that private commercial composting facilities can be established and remain economically viable in the long term. The composting facilities will provide an alternative way for dairies to dispose of manure, thereby reducing the amount of manure to be land applied within the North Bosque River watershed. More information regarding the composting program is available on the TCEQ Web site (see *Other Sources of Information*).

In response to the program's popularity and successes to date, Texas will be providing additional funding to the program during the project's remaining two years. Additional efforts are underway to identify and secure even more funds to assist with the export of surplus manure generated by dairies located in the Bosque watershed. Efforts are also underway to ensure that markets are in place to drive the continued export of manure from the Bosque and Leon River watersheds after the end of the project. The TCEQ works with the TSSWCB to promote awareness of composted manure as a soil amendment, and to stimulate markets among government agencies. The Texas Department of Transportation (TxDOT) is expected to be the largest governmental purchaser of compost over the next few years, and has already identified projects that may use in excess of 149,000 cubic yards.

The TSSWCB's portion of the project, the Dairy Manure Export Support (DMES) project, addresses removing the manure. The DMES project provides incentives to support the transport of surplus manure from dairy farms in portions of the North Bosque River watershed to compost facilities. When manure is transferred to composting facilities in the watersheds, it must be properly treated and contained, and must not exacerbate existing water quality problems. During the early stages of the project, the TCEQ NPS Program developed guidance, site criteria, and reporting forms for participating compost operators. TCEQ staff provided technical assistance on compost production techniques to interested compost operators. Compost users may also receive TSSWCB assistance, under long standing agricultural assistance programs, to develop and implement nutrient management plans that include compost.

In addition to technical assistance, the TCEQ has also established quality assurance requirements for such compost. During 2001, TCEQ staff performed site visits at each compost facility to ensure the product meets TxDOT and other appropriate specifications. The TCEQ also checks for proper maintenance of storm water controls, such as lagoons and berms, and adherence to other necessary procedures.

The TCEQ and the Brazos River Authority (BRA) are developing a water quality monitoring strategy for the North Bosque and Leon watersheds to measure water quality improvements attributable to the removal and composting of manure. During 2001, the TCEQ met with the BRA and other monitoring partners to begin design of a monitoring plan. Field monitoring will get underway during 2002. In addition, the TSSWCB has

contracted with the Texas Institute for Applied Environmental Research (TIAER) to perform microwatershed monitoring that will help identify specific tributaries and subwatersheds that may need additional, more intensive, BMP implementation, and will aid in measuring water quality improvements that result from the composting program.

Schedule

The composting program began operation when Federal grant funds became available on September 27, 2000, and will continue until at least August 31, 2003 when the current grant period ends. Payouts to appropriate participants began approximately in January 2001.

Assurance

Grant funding under §319 of the Clean Water Act will assure several years of subsidy to develop markets and allow commercial composting facilities to establish viable operations. The waste management option provided to dairies is a benefit that will encourage voluntary participation. New or expanding dairies in the North Bosque River watershed will be required to remove all excess manure from the watershed, as stipulated in 30 TAC Chapter 321. The composting program plan includes monitoring participation and the amount of manure from the North Bosque River watershed that enters the program, and the amount that leaves the watershed.

Voluntary Best Management Practices and Educational Programs

As the water quality management agency of the state, the TCEQ seeks to provide information to all interested persons or entities on how to best protect and manage water quality. The educational program described in this document is an outreach effort by the TCEQ and other agencies to assist those entities participating in TMDL implementation and to encourage protection of the state's water quality.

Reducing the phosphorus content of animal feed in order to reduce the phosphorus content of manure is a voluntary element of the implementation plan. Implementation of this measure can benefit the individual dairy or other type of agriculture operation, by both reducing the cost of feed and reducing the land area needed for phosphorus-based application of manure. The Chapter 321, Subchapter B rules require that CAFO operators within the Dairy Outreach Program Area (DOPA) must complete an eight-hour course on animal waste management within 12 months of authorization, and complete an additional eight hours of training in animal waste management in each subsequent 24-month period. Continuing education periodically provided for agricultural producers in the North Bosque River area by the Texas Cooperative Extension (TCE) and the TSSWCB primarily address waste management issues and practices. Since phosphorus has been identified as a concern in the area, the continuing education classes have largely focused on management practices specific for phosphorus. The class curricula are designed to cover any topics that the dairy operators need, and will sometimes include the methods and benefits of reducing phosphorus levels in animal feed.

The same continuing education program(s) may also assist implementation by educating dairy operators or others regarding other aspects of phosphorus-based waste management, such as proper management of waste application fields, development of nutrient management plans, and so forth. The TCEQ will continue to support and assist the educational outreach efforts of the other agencies, in keeping with the programs and protocols current at any time.

In addition, the composting program includes a training and technical assistance program for compost facility operators, TxDOT staff and contractors, and staff of other state agencies. The TCEQ Small Business and Environmental Assistance Division is training and assisting compost operators in best management practices for their sites, and is providing workshops and other assistance to state agency staff and contractors in the use of compost products for nonpoint source pollution control and soil improvement.

Microwatershed Councils

In addition to the existing educational endeavors carried out by the TSSWCB, a special voluntary project funded by §319 of the Clean Water Act calls for agricultural producer councils to be grouped by microwatersheds for the purposes of information dissemination, discussion of WQMP/CNMP development and implementation issues and cost-share opportunities, proliferation of peer-involvement, and overcoming producer denial. Additional facets of this project include the TSSWCB working cooperatively with the Cross-Timbers Soil and Water Conservation District (SWCD), headquartered in Stephenville, and the Upper Leon SWCD, headquartered in Comanche, to provide technical and financial assistance to dairy producers and third-party landowners toward the development and implementation of certified WQMPs and CNMPs for the purposes of reducing NPS nutrient losses from agricultural operations that land-apply animal waste.

In this project the SWCDs can arrange for the technical assistance necessary to develop WQMPs and CNMPs through direct interaction with the dairy operators in the North Bosque watershed. The SWCD technicians will work closely with the TSSWCB Regional Office in Dublin. Technical assistance is best provided or arranged by local SWCDs because it allows for more local support to landowners in the implementation of BMPs. The district technicians will work with landowners to develop WQMPs (for nonpoint source AFOs and third-party landowners) and CNMPs (for point source CAFOs), consistent with the recent changes to the Subchapter B CAFO Rules and the most current standards in the USDA-NRCS Field Office Technical Guide. The TSSWCB and the NRCS are also arranging training and certification courses for third-party developers of CNMPs in the North Bosque River watershed.

TIAER will monitor the North Bosque River watershed to determine the reduction in NPS pollution resulting from the implementation of these WQMPs and CNMPs and provide data to inform microwatershed producer councils of their contribution to NPS pollution. The producer councils will include landowners and agricultural producers from

within each microwatershed, and the monitoring will be set up at targeted areas within each microwatershed. The monitoring effort will make use of numerous automated sampling systems in TIAER's possession that will be made available to this project, as well as supplemental financial support for data obtained through QAPPs approved by EPA or the State of Texas. A monitoring demonstration will also be carried out so that each microwatershed producer council will be able to see local evidence of NPS nutrient losses from WAFs.

Schedule

Educational outreach regarding phosphorus management at dairy facilities has occurred since at least 1998, and will continue indefinitely. Activities associated with the composting program began in late 2000. The TSSWCB §319 project described above began in January 2002 and is anticipated to begin providing direct technical assistance to producers by mid-2002.

Assurance

Educational outreach to agricultural producers is a well established role of both the Texas Cooperative Extension and the TSSWCB. Both agencies have programs in place. For dairy operators, the reduced cost for feed and reduced area needed for land application are benefits expected to motivate voluntary participation in this implementation element. Training opportunities and assistance for compost facility operators through the composting program are supported by grant funds for the life of the program.

Compliance and Enforcement Program

The compliance and enforcement program is administered by the TCEQ Office of Compliance & Enforcement which includes the Enforcement Division, Compliance Support Division, the Monitoring Operations Division and the Field Operations Division. The Field Operations Division (FOD) consists of 16 regional offices and two special project offices located throughout the state, and a central office located in Austin. Major regional office responsibilities include conducting investigations for compliance determination at the permitted and registered air, water, and waste facilities located across the state, investigating complaints at permitted and nonpermitted facilities/operations based on citizen requests for assistance, and developing many of the agency's enforcement actions for most types of air, water, and waste violations identified during investigations.

All violations of any permit or any documented unauthorized discharges of waste identified during investigations or compliance determination are evaluated using the Enforcement Initiation Criteria (EIC) adopted by the TCEQ. The EIC document establishes the procedures for determining the severity of enforcement actions.

Regional offices located in Waco (Region 9), Dallas/Fort Worth (Region 4), and the Stephenville special project office, all share various responsibilities for investigations of activities which may impact environmental conditions in the North Bosque River

watershed. These offices conduct routine investigations of permitted wastewater dischargers and special investigations of any unpermitted or otherwise unauthorized discharges into the North Bosque River and its tributaries. The Stephenville special projects office annually investigates all Concentrated Animal Feeding Operations (CAFOs) that have TPDES permits in the Dairy Outreach Program Areas (DOPAs) .

When potential excessive application of nutrients in the North Bosque River watershed was identified as a concern, the Stephenville special project office initiated a survey of application fields at selected CAFO facilities in the area. The survey was conducted from May 2000 through August 2000. These studies found many facilities with phosphorus concentrations in waste application field soils exceeding 200 parts per million (ppm). Several enforcement actions were generated based on the sample results. Owners of the facilities were sent a certified letter notifying them that additional investigations will be conducted, and that applying waste or wastewater to a field that is documented to be over 200 ppm phosphorus, unless applied according to an approved Nutrient Utilization Plan, will result in the TCEQ initiating enforcement action against that facility.

Other CAFO or AFO activities that result in formal enforcement actions include:

- Increasing herd size without notifying the TCEQ;
- Increasing herd size without a required permit;
- Failure to maintain adequate storage capacity or freeboard in retention structures or waste storage ponds;
- Causing or allowing discharges of wastes due to improper management or operation of waste disposal activities or retention structures;
- Failure to notify the TCEQ of any discharge from retention structures during chronic or catastrophic rainfall events.

In addition, enforcement within the North Bosque River watershed has been adjusted so that any violations related to the CAFO activities listed above, or other types of unauthorized discharges by CAFOs, have been assigned a higher level of significance.

Investigations of wastewater dischargers which are considered “major” by the EPA are routinely conducted by the Field Operations Division in alternate years. “Minor” facilities are investigated based on criteria set by the TCEQ and EPA. Additionally, the FOD is able to conduct discretionary investigations based on issues of regional concern. In this case of a TMDL, all dischargers into impaired water bodies will be considered for discretionary investigations during March of each year as the FOD begins to develop work plans for the following fiscal year.

Water Quality Monitoring Plan

Specific details of surface water quality monitoring activities will become part of the annual coordinated monitoring plan and schedules, and will be reviewed as each annual plan is developed. This document provides a more general description of the long term goals and intent of environmental monitoring activities that are specifically required for implementation of the North Bosque River TMDLs.

House Bill 2699 of the 77th Legislature, passed in 2001, mandated some specific monitoring and reporting activities by the TCEQ within the North Bosque River watershed. The bill directs the TCEQ to activate water quality monitoring sites in the North Bosque watershed, to collect samples from those sites on a quarterly basis, and report the results of the monitoring on a quarterly basis. The bill further specifies a list of parameters to be analyzed and reported, including orthophosphate-phosphorus (PO4-P). The TCEQ is directed to provide the quarterly reports to the Governor, the Lieutenant Governor, the Speaker of the House of Representatives, each member of the House Committee on Appropriations, each member of the Senate Committee on Finance, each member of the House Committee on Natural Resources, and each member of the Senate Committee on Natural Resources. The legislation states that the TCEQ is allowed to prescribe additional water quality control practices for animal feeding operations by rule or general permit or to include additional provisions in an individual or general permit as necessary to protect water resources in the North Bosque River watershed.

The TCEQ will develop and implement a long-term monitoring program to evaluate water quality improvements and attainment of the water quality targets for the North Bosque River watershed. The monitoring program will use existing TCEQ processes and programs, as described below, to provide continuity with historical monitoring and provide more specific data in the future. Short term projects by other entities may also provide usable data periodically throughout implementation, and will be utilized to the extent possible. The monitoring effort will:

- provide data useful in refining the initial modeling efforts and verifying model assumptions;
- include both wet weather and low flow conditions to better characterize the contributions of point and nonpoint sources, and;
- expand monitoring to provide information for identifying tributaries and subwatersheds with significant load contributions, especially in the Upper North Bosque River (Segment 1255).

Environmental monitoring and data management activities of the TCEQ are primarily managed by the Office of Compliance & Enforcement, Monitoring Operations Division. Other program areas within TCEQ and external entities often coordinate with Monitoring Operations to provide data. The data collection and management activities of the Monitoring Operations Division include many types of data, but the ensuing discussion

addresses only those activities that are directly pertinent to implementation of the North Bosque River TMDLs.

Coordination of water quality monitoring is an annual activity that involves the TCEQ Regional Offices, the Clean Rivers Program (CRP) of the TCEQ, and the CRP regional planning agency partners. The goal of coordinated monitoring is to assure that water quality monitoring performed by TCEQ, the CRP Regional Partner, and any other qualified monitoring organizations operating within the basin, is complementary and efficient. The individual monitoring entities are thus able to adjust schedules to provide more complete and representative temporal coverage, and may adjust the types of data collected to achieve more compatible or more comprehensive aggregate data sets. Completed plans for each year specify the sites that will be monitored, the parameters that will be measured at each site, and the schedule for each parameter and site.

During calendar year 2002, TCEQ will begin incorporating new implementation monitoring and subwatershed monitoring into the coordinated monitoring plan for State fiscal year 2003, using information from this document to guide station locations, parameters sampled, and sampling schedules. Due to the size of the watershed and the logistics of monitoring station establishment, several years may be needed to fully develop the monitoring network. TCEQ intends that a complete water quality monitoring system able to support the requirements of legislative directives and the TMDLs will be in place and operating in the North Bosque River watershed by the end of calendar year 2006.

Compost Program Monitoring

The TCEQ and the Brazos River Authority (BRA) are developing a water quality monitoring strategy for the North Bosque and Leon watersheds to measure water quality improvements attributable to the removal and composting of manure. During 2001, the TCEQ met with the BRA and other monitoring partners to begin design of a monitoring plan. Field monitoring will begin during 2002.

Monitoring sites and schedules developed for the Compost Program will be included in the coordinated monitoring plans each year. Sites and activities associated with Compost Program monitoring may also be part of the tributary and/or mainstem monitoring activities discussed below. Appropriate data collected for Compost Program monitoring (i.e. representative of ambient stream conditions) will also be used for general assessments of water quality.

Implementation Monitoring

Additional water quality monitoring for determining success of the TMDLs for the North Bosque River will begin with Phase I of implementation, and will continue throughout any subsequent phases. These additional monitoring activities will be included in the coordinated monitoring plans.

Instream concentrations of phosphorus will be monitored in the North Bosque River at Valley Mills, Clifton, above Meridian, below Stephenville, and above Stephenville. Monitoring stations will approximately correspond to model output points, so that comparisons between model predictions and monitored data are possible. More precise locations will be defined as the monitoring activities are initiated, and new stations will be established as needed.

The primary parameter for evaluating success will be the instream concentration of soluble reactive phosphorus (SRP) or orthophosphate-phosphorus (PO4-P), which are considered equivalent for the purposes of the North Bosque River TMDLs and implementation plan. Flow measurements will be included as needed to allow computation of net loading rates based on concentration data. Flow data may come from existing or new permanent flow measurement stations maintained by the US Geological Survey or other entities, or may come from measurements performed manually as water quality data are collected. Load calculations during high flow events can depend on USGS gage data extrapolations as manual measurements under those conditions may be hazardous. Measurements will be at least weekly, and will include both baseflow and storm runoff conditions. Monitoring will be performed by one or more of TCEQ, TSSWCB, Brazos River Authority (BRA), TIAER, or other qualified monitoring organizations identified through the annual coordinated monitoring plans.

Assessment of the monitored data will consider annual average concentrations for SRP or PO4-P. Assessments will be performed annually by TCEQ. Comparisons of index site data to the cumulative frequency curves, as described below under *Measures of Success*, will begin when five years of data are available for the respective index sites.

Subwatersheds upstream from mainstem stations that do not show progress will be presumed sources of excessive loading. Tributary monitoring may refocus on specific subwatersheds that mainstem data or available information indicates are the most likely to be sources of excessive loading.

Tributary Monitoring

Instream concentrations of phosphorus will be monitored in tributaries of the North Bosque River segments to identify subwatersheds that are disproportionate sources of loading. Parameters other than phosphorus will also be monitored, reported, and assessed. Subwatershed monitoring data will be used to characterize management practice performance and loading during the recent past, and may support model refinement or serve as the basis for imposing additional subwatershed-specific controls (e.g. review of facility compliance, development of NUPs, etc.).

Detailed tributary monitoring plans may selectively focus on subwatersheds that contain significant numbers of dairies or WAFs or other sources that are deemed likely sources of significant loading. Tributary sites will be monitored for both baseflow and storm runoff conditions, with flow measurements adequate to estimate loading with reasonable

accuracy. Tributary stream and/or subwatershed monitoring may at times be performed by one or more of TCEQ, Brazos River Authority (BRA), TIAER, or other qualified entities participating in coordinated monitoring activities. During Phase I, a large amount of monitoring will occur at the microwatershed level as part of the TSSWCB §319 project previously described in this document under the section heading *Microwatershed Councils*.

If specific tributary subwatersheds are identified as contributing disproportionately large nutrient or pollutant loads, or as having other indications of existing or potential disproportionate pollutant effects (e.g. degraded biological communities, low dissolved oxygen, significant growth in dairy operations, etc.), outreach or regulatory programs will verify compliance with existing management requirements. If noncompliant, enforcement mechanisms will be employed. If compliant, analyses to refine subwatershed components of the overall TMDL will be indicated, which may include adjustments to regulatory practices or load allocations.

Model Refinement Monitoring

The TCEQ is committed to refining the model analyses upon which the North Bosque River TMDLs are based. Additional data of various types may be needed to support that effort. The general intent is that model refinement will utilize all data or information that are pertinent and serve to improve the models. As the aspects of modeling to be refined are precisely defined, data requirements and availability to support model refinement will also become clear and appropriate plans made.

Data to support model refinement may be extracted from the other monitoring activities described above, or from other sources (e.g. special studies of soil dynamics or CAFO management), or may require additional data that support specific needs of the models. If the model refinement effort requires new monitoring sites or data types, those will be incorporated into the coordinated monitoring plans each year as needed. Data gathered for model refinement that is also pertinent for assessments of ambient water quality conditions will be used for such assessments.

Schedule

Coordinated monitoring plans are prepared each year to address and direct activities during the ensuing fiscal year. New monitoring specifically intended to measure success of the North Bosque River TMDL implementation plan will be incorporated into the watershed monitoring schedule as soon as possible following adoption of the implementation plan. The goal of the TCEQ is to have the environmental monitoring activities described above fully operational by the end of calendar year 2006.

Assurance

Existing programs and processes within the TCEQ will assure that surface water quality monitoring activities are scheduled and performed each year. To the extent that funds are available, the TCEQ budget will assure some amount of monitoring is possible during

each year. The coordinated monitoring process will assure that the efforts of other appropriate monitoring entities will support TMDL implementation, while seeking efficient synergy among monitoring efforts.

Measures of Success

Water quality will be the primary, and ultimate, measure by which success of the North Bosque River TMDLs is evaluated. Programmatic measures of success will enumerate activities and steps taken by TCEQ program areas towards implementing the control actions and management measures that are expected to eventually result in water quality results. The TCEQ anticipates developing an internal tracking system to document programmatic implementation. If environmental data eventually indicate that there has not been sufficient change in water quality to be deemed successful, then programmatic measures may indicate whether implementation efforts have been incomplete or erratic, and thus provide some insight regarding appropriate Phase II efforts. Programmatic measures may also serve to document TCEQ efforts in annual reports to the State Legislature.

Programmatic Measures

Permit actions within the North Bosque River watershed will be counted and assessed. All types of water-related permit actions will be enumerated, including municipal and industrial wastewater, storm water, and agricultural operation permits. Annual assessments will report the number of new permits issued and the number of existing permits amended or renewed, by category of permit. The assessments will also report the percentage of permits within each category that have been revised or issued with conditions that implement the TMDLs. The goal will be to have 100% of permits revised to incorporate TMDL requirements by calendar year 2006.

Enforcement activities within the North Bosque River watershed will be counted and assessed. Annual assessments will report the number of inspections performed each year, categorized by permit type and including unpermitted activities. Annual reports will count the number of CAFOs within the North Bosque River watershed that were sent soil monitoring report forms, and the number of those CAFOs that did not submit the appropriate number of completed soil monitoring forms. The number of permit violations or unauthorized discharges will also be reported, categorized by type (e.g. municipal, industrial, agricultural, storm water). The total amount of fines levied for violations will be included, whether paid directly to the state or used for Supplemental Environmental Projects (SEP), categorized by type. Reports of enforcement activity will provide insight regarding the extent of unauthorized or poorly-managed discharges, and the amount of regulatory effort to address those situations; however, these numbers would not be used to define success of the TMDL.

The compost program will track and annually report the amount of dairy manure produced within the North Bosque River watershed that is exported as a result of the compost program. That information will be used in conjunction with annual estimates of total dairy manure produced within the North Bosque River watershed to calculate the percent removed. Annual removal rates equal to or greater than 50% will be considered indicative of success.

The extent of water quality monitoring activities will be reported as a programmatic measure, while the results from monitoring will support the water quality measures of success. Annual assessments will report the number of water quality monitoring sites active during the preceding year, and the number of events monitored (i.e. samples collected and analyzed) or records collected (i.e. constituent values for database – each sampling event will generate multiple records). The annual report will also specify how many of the five index sites have become active and are collecting data for use as described below.

Water Quality Measures of Success

Average annual soluble phosphorus concentrations at each of the five TMDL index sites along the North Bosque River will be assessed using a method based on comparison of stream monitoring results to two sets of curves that represent each of the five index sites. One set of curves is based on results from watershed modeling performed for TMDL development, and the other set is based on regression analyses of historical nutrient concentration and flow data representing the years 1996 through 2000. The five index sites are named Valley Mills, Clifton, Above Meridian, Below Stephenville, and Above Stephenville. The site names identify approximate locations, as indicated on large-scale maps and figures in the TMDL report and this document. Precise locations for monitoring stations at the index sites will be determined as the monitoring network is developed.

A set of probability distribution curves was constructed from TMDL model predictions. Each index site will utilize a different probability distribution curve, as illustrated in Figures 9 through 13. The probability curves in Figures 9 through 13 are identical to the "TMDL-e" curves shown in Figures 4 through 8. At least five years worth of data will be required to reasonably determine if the annual average river quality is consistent with the probability curve goals. After that, each year will add another point to the monitored result, making assessment more robust. Subsequent evaluations of progress against the model-predicted probability distribution curves will occur annually, and will utilize all data collected since implementation monitoring began.

A set of regression equations was derived from analyses of historical data from sites in the vicinity of the aforementioned five index sites. The regression equations are first-order linear "curves" that plot as straight lines on charts. The equations presented here were derived by the Texas Institute for Applied Environmental Research, but it is possible that the equations could change to some extent if additional data or analyses

indicate that to be appropriate at some time in the future. The equations or curves relate annual average concentrations of soluble reactive phosphorus (y-axis values) to the base-10 logarithms of annual average streamflows (x-axis values), and are presented in Table 5 and Figures 14 through 18. Comparison of monitored annual average data to these regression curves will provide indications of whether the recent annual average phosphorus concentrations (and annual loads) were relatively lower than observed during 1996-2000 for similar annual flow conditions.

Table 5. Historical Data Regression Equations for North Bosque River Index Sites

In equations, "x" = $\log_{10}$ of annual average flow in cubic feet per second
"y" = annual average concentration (mg/L) of soluble reactive phosphorus

Index Site	Equation	R^2 value	Data Years
Above Stephenville	y = 0.0347 x + 0.2388	0.3519	1997-2000
Below Stephenville	y = -1.0176 x + 2.7889	0.6207	1994-2000
Above Meridian	y = 0.0396 x - 0.0419	0.7164	1996-2000
Clifton	y = 0.0236 x - 0.0249	0.94	1996-2000
Valley Mills	y = 0.0209 x - 0.0228	0.846	1996-2000

Evaluation of Stream Water Quality Goal Attainment

- Evaluation will be based on concentration measurements of soluble reactive phosphorus or orthophosphate-phosphorus. Monitoring plans and QAPPs will establish exactly which parameter is analyzed and reported by laboratories, and how various forms of phosphorus measurement may be combined if necessary. Methods used must provide minimum detection levels and minimum analytical reporting levels low enough to clearly show whether TMDL goals are met—specifically, the minimum analytical levels should be less than 10 µg/L or 0.010 mg/L. Monitoring plans will also address whether flow measurements are possible or needed at each site, and whether load calculations can or will be made. For most consistent comparability to model predictions of time-weighted concentration, sampling should occur at a regular time interval. To provide adequate resolution, the time interval between sampling events should not exceed two weeks (i.e. $26 samples per year); ideally, the time interval between sampling events should be one week or less (i.e. $52 samples per year).
- All suitable individual (grab) concentration measurements collected during a year will be averaged to determine the annual average SRP or PO4-P concentration for each site. A data base records the annual average concentration for each site and each year of monitoring.
- If continuous-record monitoring stations with sufficiently low analytical reporting limits are established at any of the index sites, annual averages at those sites may be calculated directly from the data records of those stations.

Comparison of monitored data to model-predicted probability curves

- Annual average values are plotted on probability charts like those in Figs 9 - 13, using separate charts for each index site. The annual average values are plotted in rank order from left to right on the charts, at intervals of 1/(n+1) where "n" is the number of annual average data points available for that particular index site.

  For instance, if there are 7 annual average data points available (n = 7), the plotting interval is 1/(7+1) = 1/8 = 0.125. The highest annual average value is then plotted over a probability of 0.125 (on scale from 0 to 1), the second highest over a probability of 2(0.125)= 0.250, the third highest over a probability value of 3(0.125)=0.375, etc. The lowest of the seven data points thus ends up plotted over a probability value of 7(0.125) = 0.875.

  Each new annual data point added to the curves will change the shape to some extent, by changing the intervals at which all the values are plotted (shifts points right or left on chart) as well as adding another concentration value.
- The curves thus defined by the plotted annual average values are then compared to the model-predicted probability curves for respective index sites, as shown on Figs 9 - 13.
  - If the monitored data curve at a site is entirely below the model-predicted curve for that site, the water quality goals are being attained.
  - If the monitored data curve at a site is entirely above the model-predicted curve for that site, the water quality goals are definitely not being attained, and additional implementation phases will be needed as soon as possible.
  - If the monitored data curve at a site crosses the model-predicted curve, partial attainment of the water quality goals is indicated.
    - If 80% or more of the monitored curve is below the model curve, adequate attainment is indicated.
    - If 20% or less of the monitored curve is below the model curve, additional measures must be developed and implemented.
    - If between 20% and 80% of the monitored curve is below the model curve, review must consider the annual concentrations that exceed the target (i.e. are above the model curve).
    - If the "exceedance" concentrations are less than 30 micrograms per liter (µg/L), or 0.030 mg/L, those concentrations are not considered exceedances of the water quality goals because they are less than the algal-limiting annual concentration determined by TMDL studies in the watershed. Other monitored points above the model curve should be assessed with some regard to the change from previous year plots, e.g. has the newest point shifted the monitored curve towards a "better" or "worse" profile.

      In this situation, change towards "better" is regarded as indicating probable progress towards water quality goals, and may justify continuing the current implementation phase. Change towards "worse" is regarded as possibly indicating either insufficient management measures, or the effects

of unusual weather conditions. However, if three years in a row indicate a trend towards "worse", additional management measures should be developed and implemented.

Comparison of monitored data to historical data regressions

- Annual average flows, in cubic feet per second (cfs), are compiled for each index site. Determination of annual average flows may use records of established stream gaging stations, or may use individual flow measurements performed as water quality samples were collected, depending on what is available to represent the site.
- Annual average flows are transformed by calculating the base-10 logarithm for each one.
- The annual average concentrations and the transformed annual average flows provide a set of two values for each year at each site being analyzed. For discussion purposes, the monitored annual average concentration will be represented as "y_m", the log-transformed annual average flow will be represented as "x_m", and the annual average concentration predicted by the regression equations will be represented by "y_e".
- A single set of annual data points can be directly compared to the appropriate regression equation mathematically. To do this, the x_m value is used in the equation to calculate y_e. If y_e is larger than y_m, that indicates the recent conditions are relatively better than historical data for similar annual flows. Conversely, if y_e is smaller than or equal to y_m, that indicates the recent conditions are worse or no different than historical data for similar annual flows.
- Sets of annual data points can also be compared to the appropriate regression equations graphically, using graphs similar to Figures 14 through 18. For this method, the line on each graph represents y_e. The set of y_m and x_m values are used as axis values to plot a point on the graph. If the point falls below the y_e line, that indicates the recent conditions are relatively better than historical data for similar annual flows. Conversely, if the point falls above or on the y_e line, that indicates the recent conditions are worse or no different from historical data for similar annual flows.
- Graphics similar to Figures 14 through 18 can also record and summarize multiple years of monitored results, by plotting all the appropriate sets of annual data on a single chart. Over a period of time, the accumulation of annual data points on graphs of this type may provide insights about the effect of annually varying weather and flow conditions, or about the efficacy of implementation measures under differing annual flow conditions.

Other Activities

Refinement of the Watershed Model

The TCEQ will initiate efforts to refine the model analyses upon which the North Bosque River TMDLs are based. The first goal of model refinement efforts will be to increase the resolution of the model analyses by reducing the size of subwatershed compartments for which output values are calculated and reported by the model. The finer resolution is expected to provide more detailed predictions of water quality conditions in tributary streams and small flood-control reservoirs within the subwatersheds, and thus allow more detailed assessments of contributing sources that can focus control efforts more precisely.

A second goal of the model refinement efforts will be to enhance model simulations by incorporating any applicable and appropriate results from monitoring within the North Bosque River watershed and reviews of pertinent information from other sources. Those additional sources of information may lead to modifications of source characterizations, management practice simulations, model hydrology or hydraulics, kinetic rates used within the model, or other factors yet to be identified.

When the model has been suitably refined, it will be used to review the TMDLs that were based on the previous model analyses. Evaluation of the refined model results will also be influenced by the water quality data collected up to that time. If review of the data and the refined model suggests changes that would better support attainment of water quality goals, the TCEQ will revise the TMDLs and/or the implementation plan for the North Bosque River watershed as appropriate. Review of the refined model and decisions regarding the need for TMDL modification will be coordinated with stakeholders, and any changes to the TMDLs or implementation plan will utilize the appropriate public review processes.

Model refinement work will be performed by a contractor hired by the TCEQ. More detailed work plans for the model refinement effort will be developed as the work proceeds. The TCEQ will also seek input from others regarding the type and extent of model revisions that should be attempted.

Schedule

Funding for the model refinement work is expected to become available in fiscal year 2003 (which begins September 1, 2002). Pre-contracting activities will begin during calendar year 2002 in anticipation of establishing the contract and beginning work during FY2003. The goal of the TCEQ is that model refinement and review of the TMDLs will be completed by the end of calendar year 2006.

Assurance

The TCEQ plans to use some Federal grant funds to support the model refinement work. Possible sources include some combination of §106 funds, which are 100% Federal, and/or §319 grant funds, which are 60% Federal with 40% State match.

Effluent Trading Study

The concept of effluent trading has often been discussed as a way to increase the efficiency of TMDL implementation and/or provide more flexibility for sources required to achieve extreme load reductions. In the context of TMDL implementation, "effluent trading" refers to theoretical trading of discharge allocations (e.g. permitted loads) among local or regional sources, and generally does not mean physical transfers of actual effluent discharge. Arranging effluent trades amongst watershed sources typically would require that some entity tracks the trades and keeps the account balanced to remain within the TMDL allocation. The accounting entity may also need to mediate legal agreements, or disagreements, between trading partners.

The TCEQ will encourage and support efforts to establish and operate an effluent trading arrangement within the North Bosque River watershed, but does not intend to lead such efforts nor to serve as the accounting entity. Federal funding may become available to investigate the feasibility of, or to establish, effluent trading programs for specific TMDL watersheds. If reasonable and suitable proposals to study or establish an effluent trading program for the North Bosque River watershed should be developed, the TCEQ will cooperate and participate to the extent possible.

Schedule

Action with regard to effluent trading studies or plans will depend largely on the initiative of others, and the TCEQ cannot stipulate when or if such efforts will occur. However, the TCEQ will attempt to cooperate with such efforts in a timely and helpful manner.

Assurance

Study or development of an effluent trading program is optional. Any such effort that uses §319 grant funding will have the assurance provided by the grant stipulations.

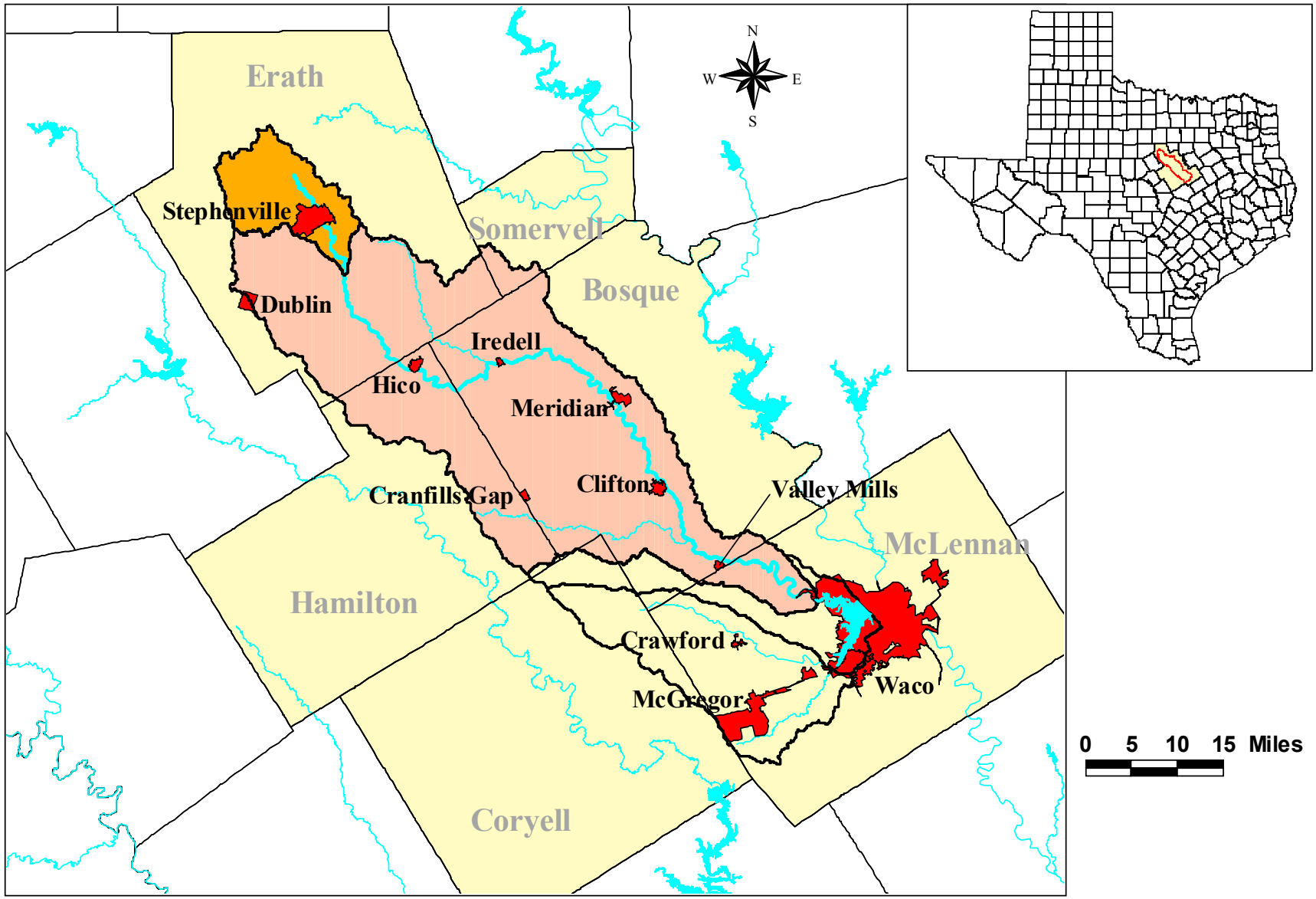
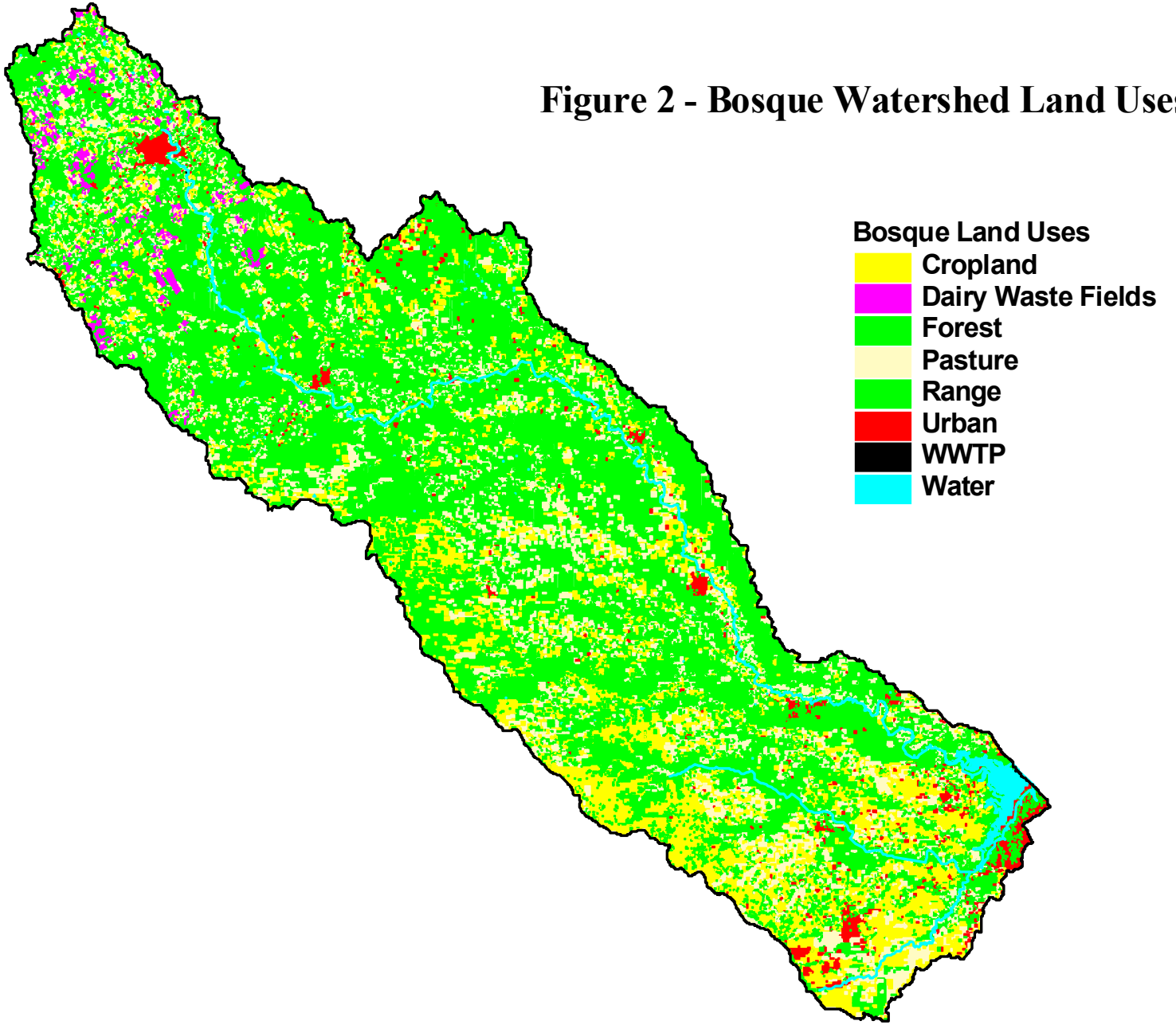
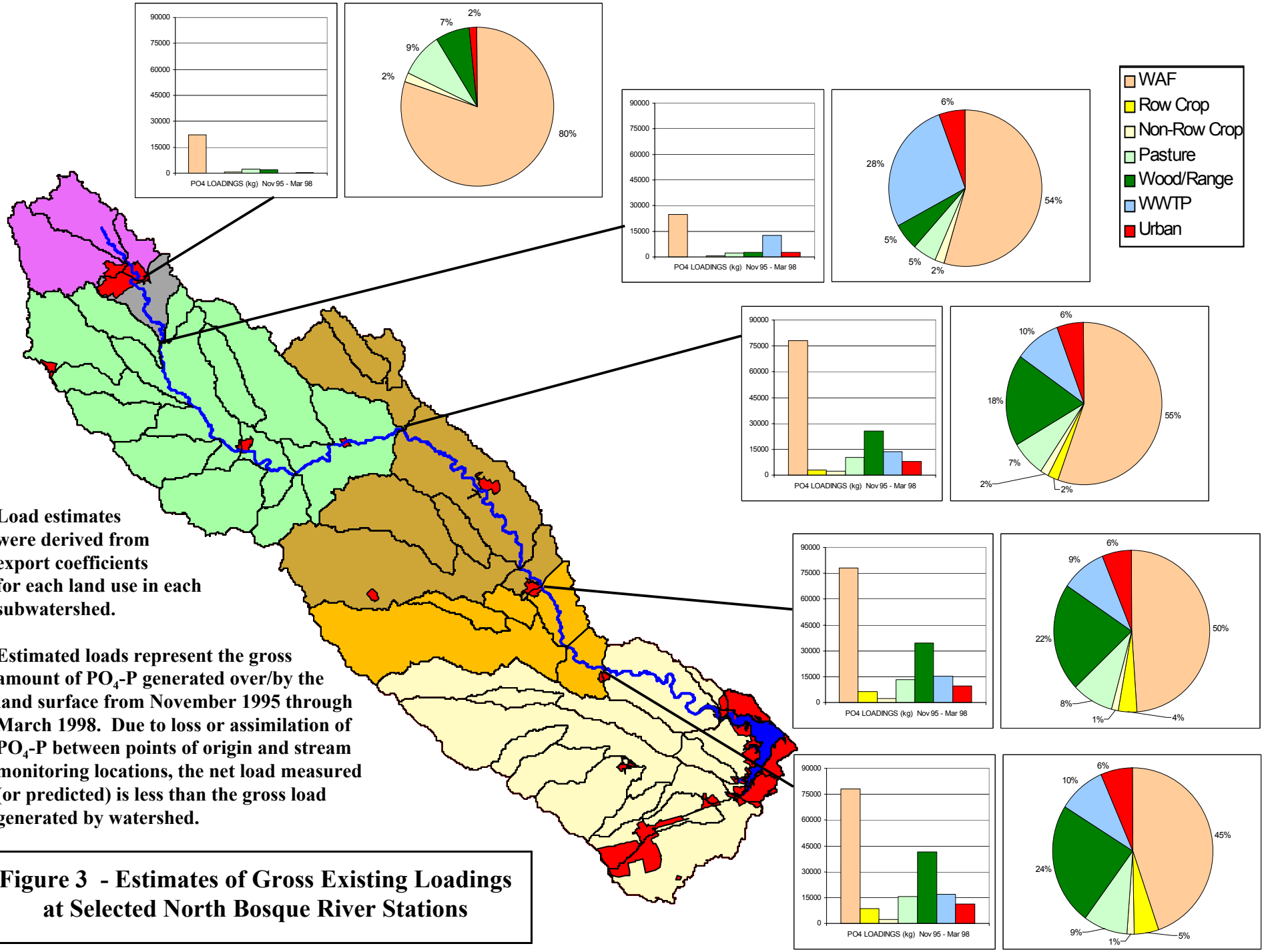


Figure 1 - North Bosque River Watershed

Figure 2 - Bosque Watershed Land Uses

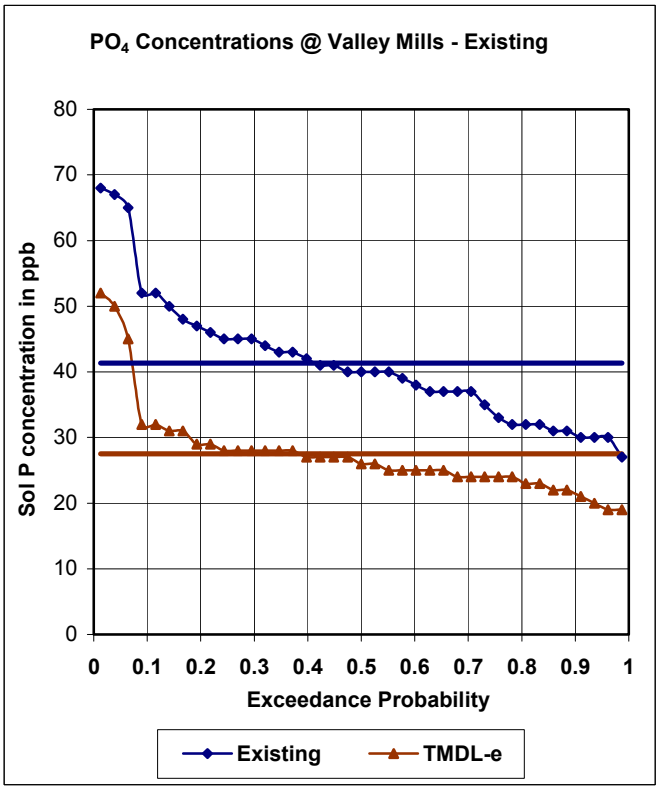


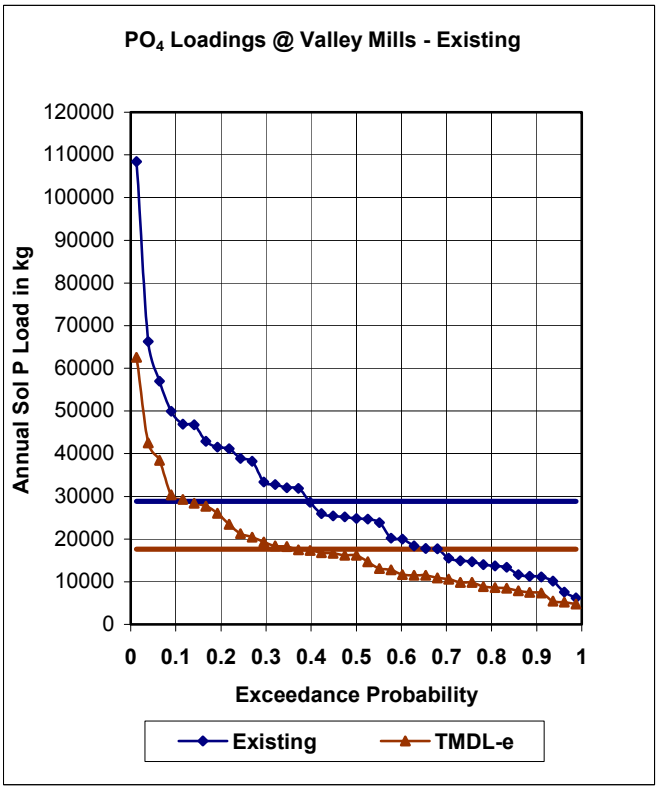


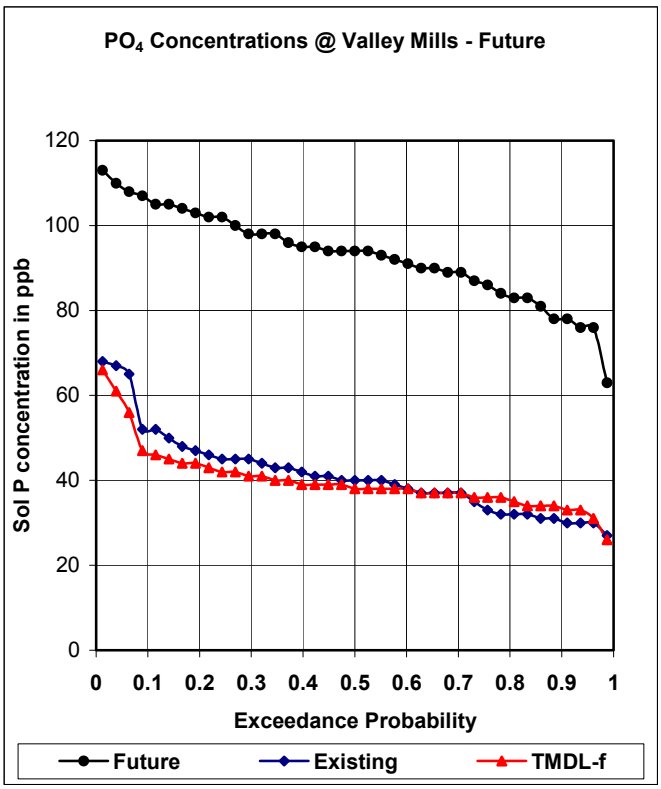
Load estimates were derived from export coefficients for each land use in each subwatershed.

Estimated loads represent the gross amount of PO_4-P generated over/by the land surface from November 1995 through March 1998. Due to loss or assimilation of PO_4-P between points of origin and stream monitoring locations, the net load measured (or predicted) is less than the gross load generated by watershed.

Figure 3 - Estimates of Gross Existing Loadings at Selected North Bosque River Stations







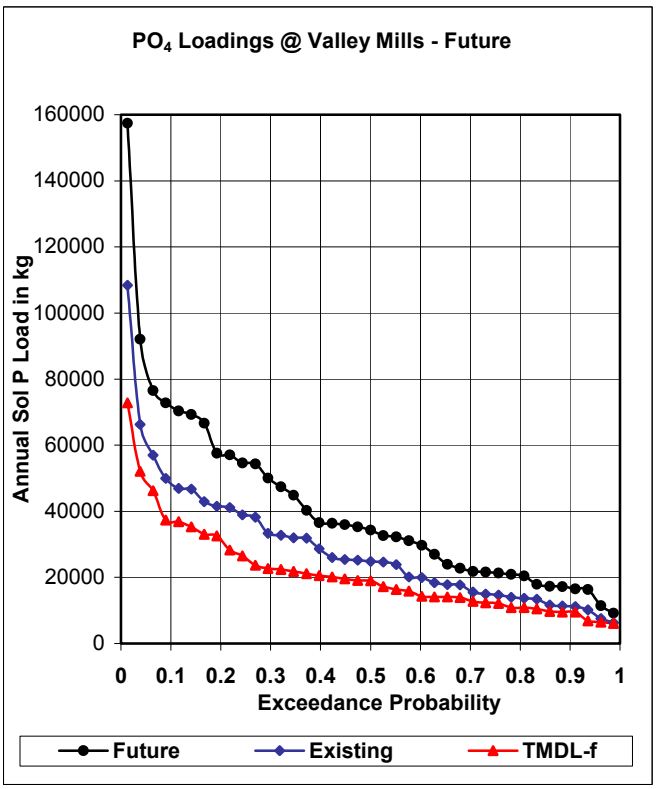
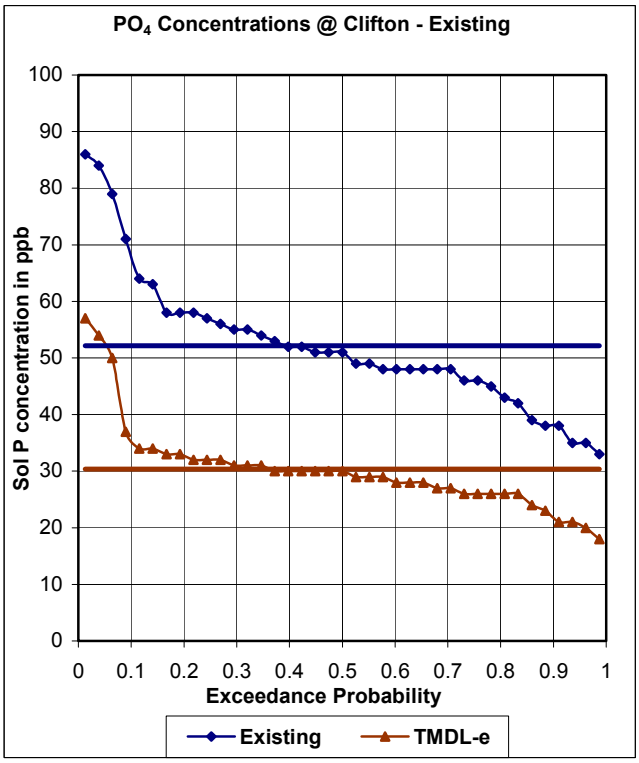
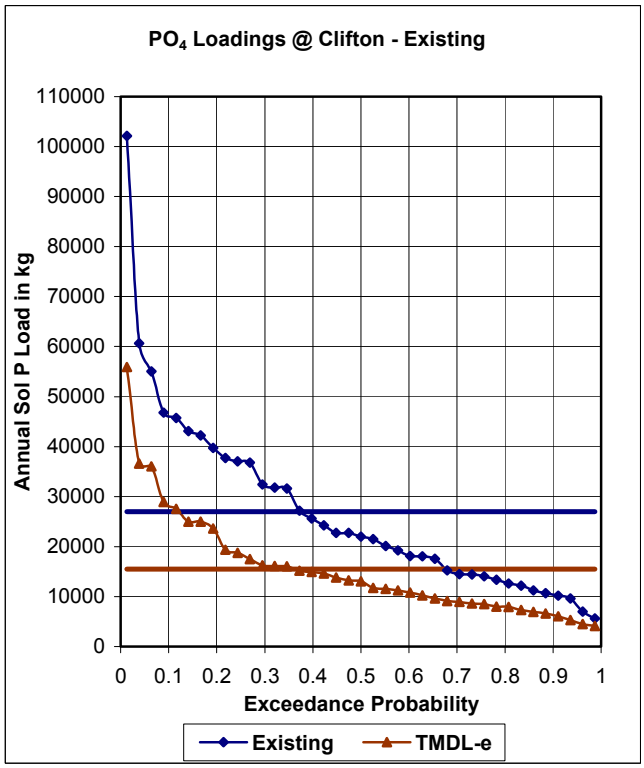
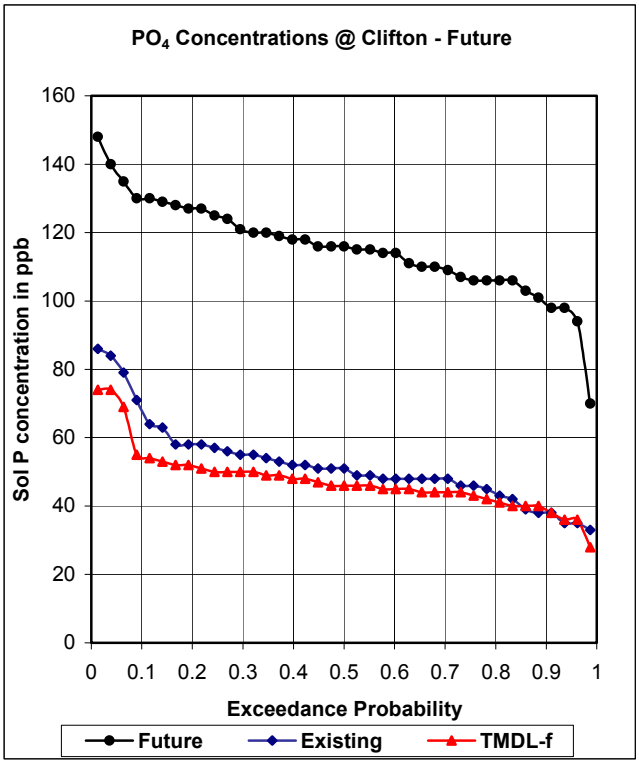


Figure 4 - SWAT Model results at Valley Mills







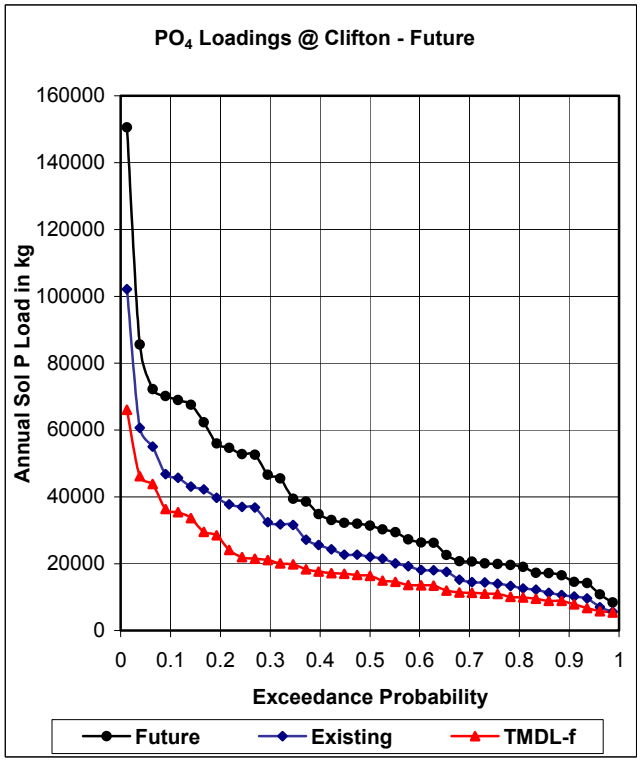


Figure 5 - SWAT Model results at Clifton

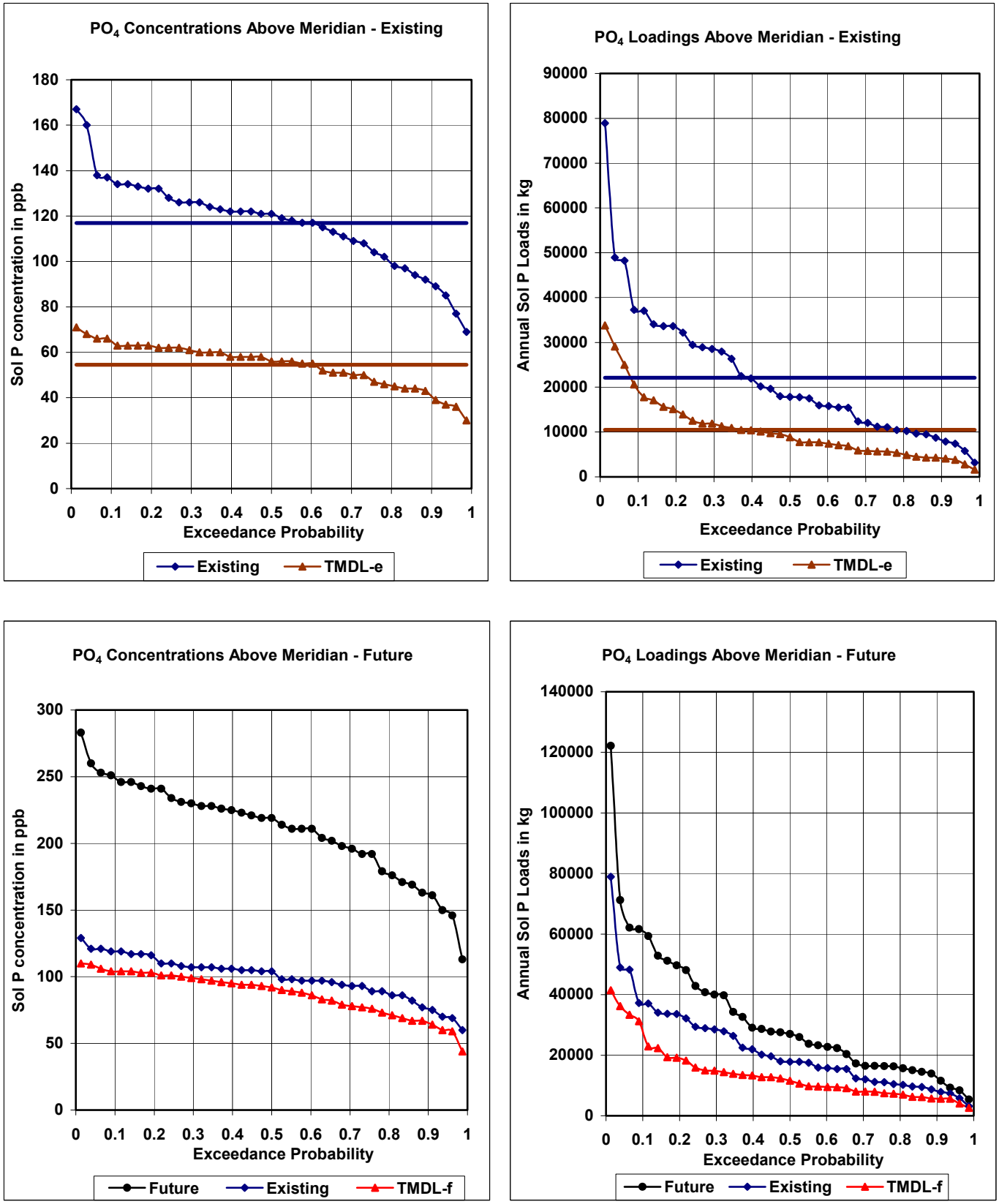
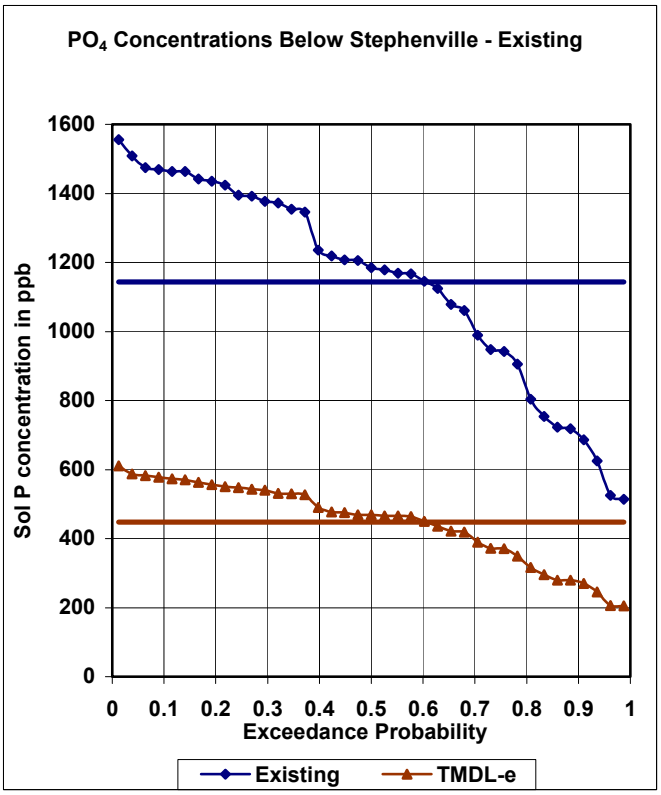
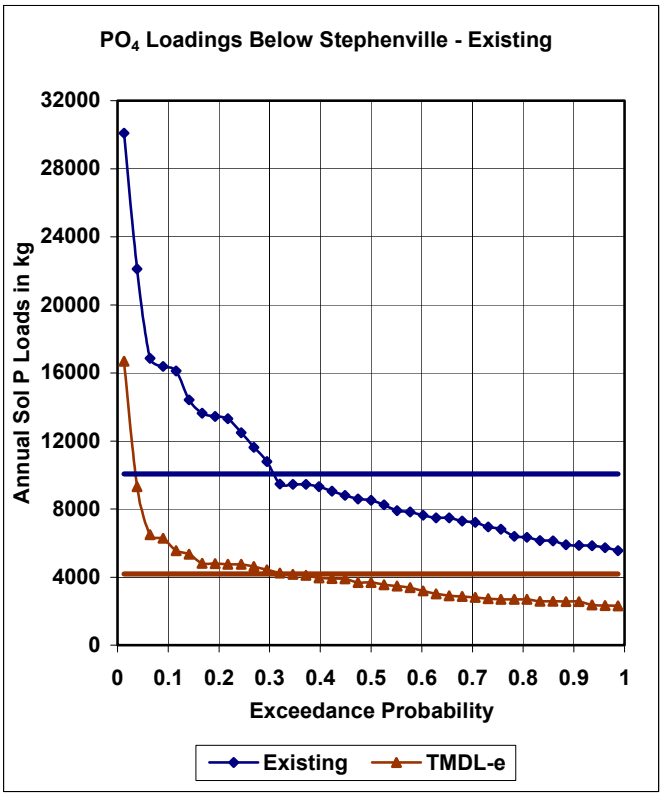
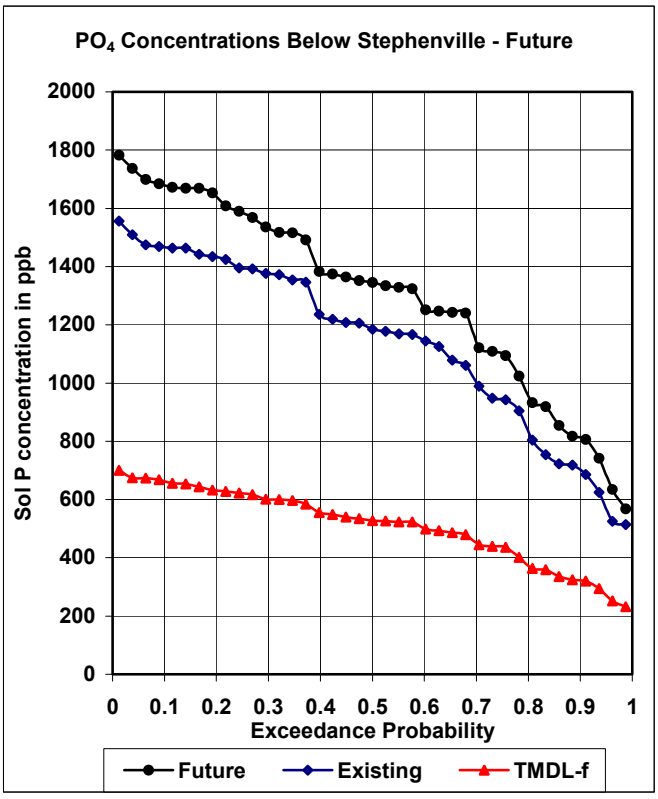


Figure 6 - SWAT Model results Above Meridian







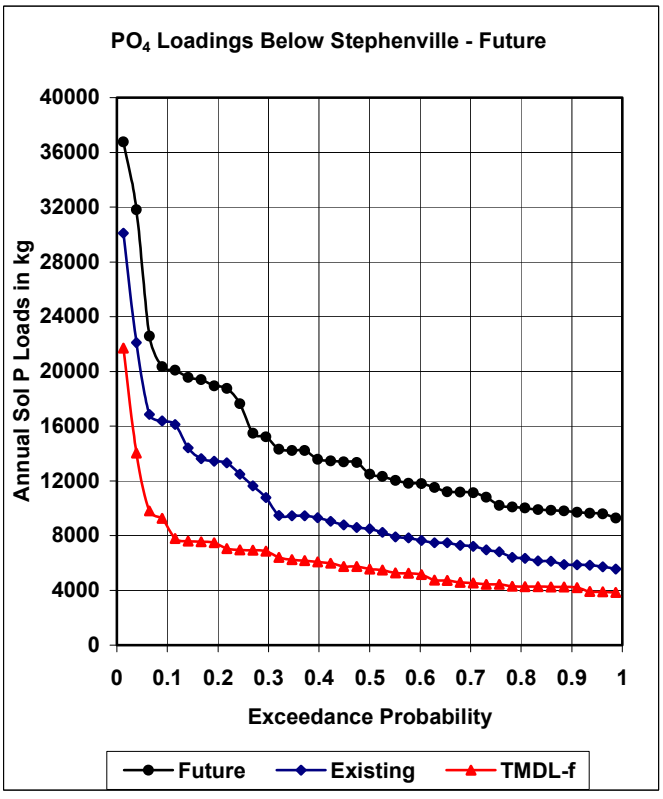
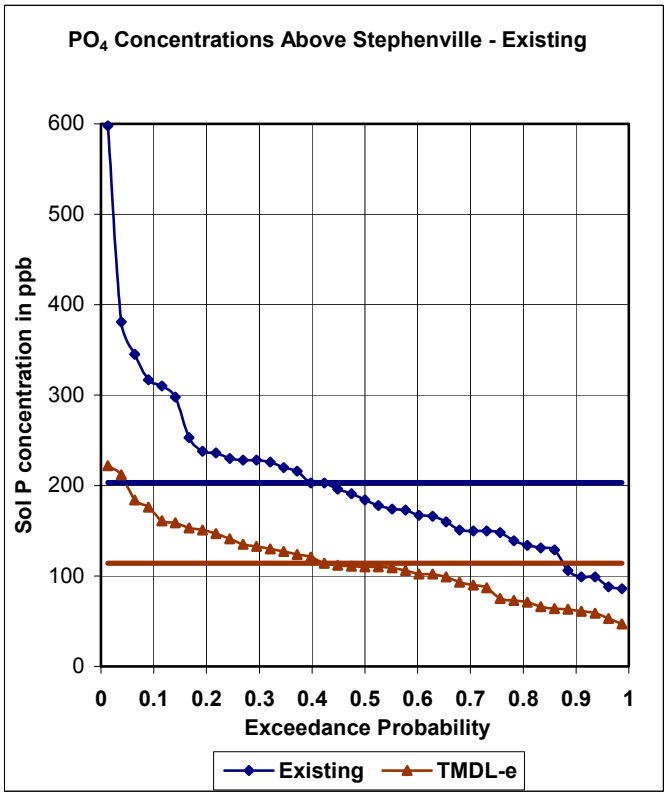
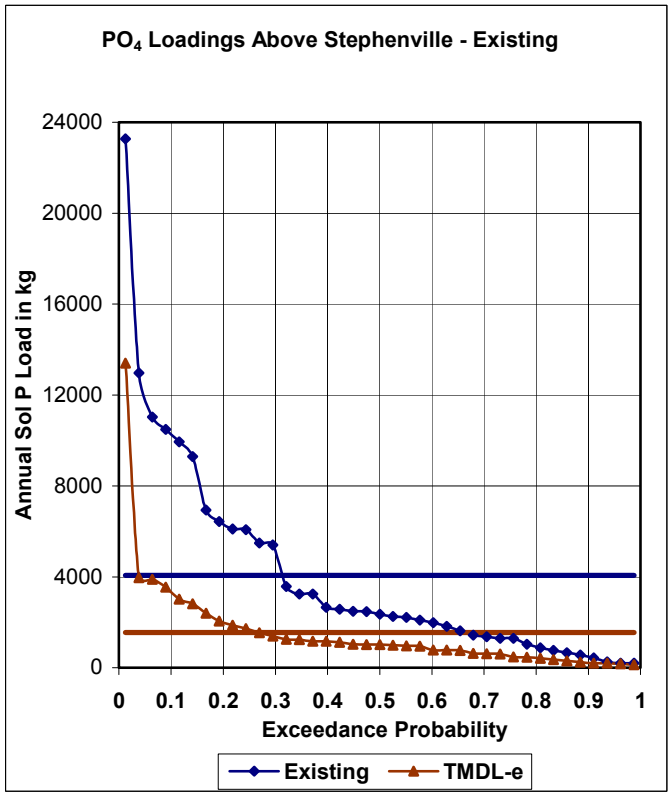
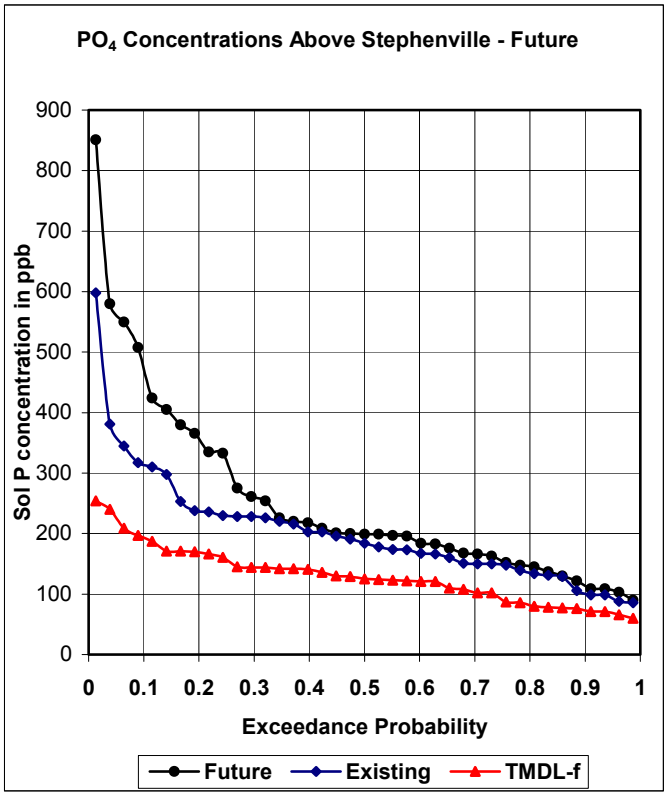


Figure 7 - SWAT Model results Below Stephenville







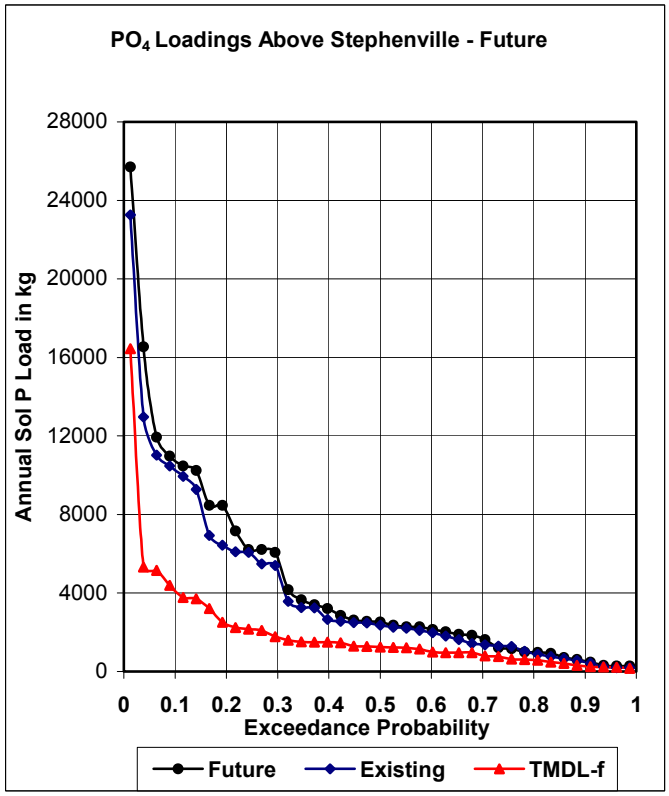


Figure 8 - SWAT Model results Above Stephenville

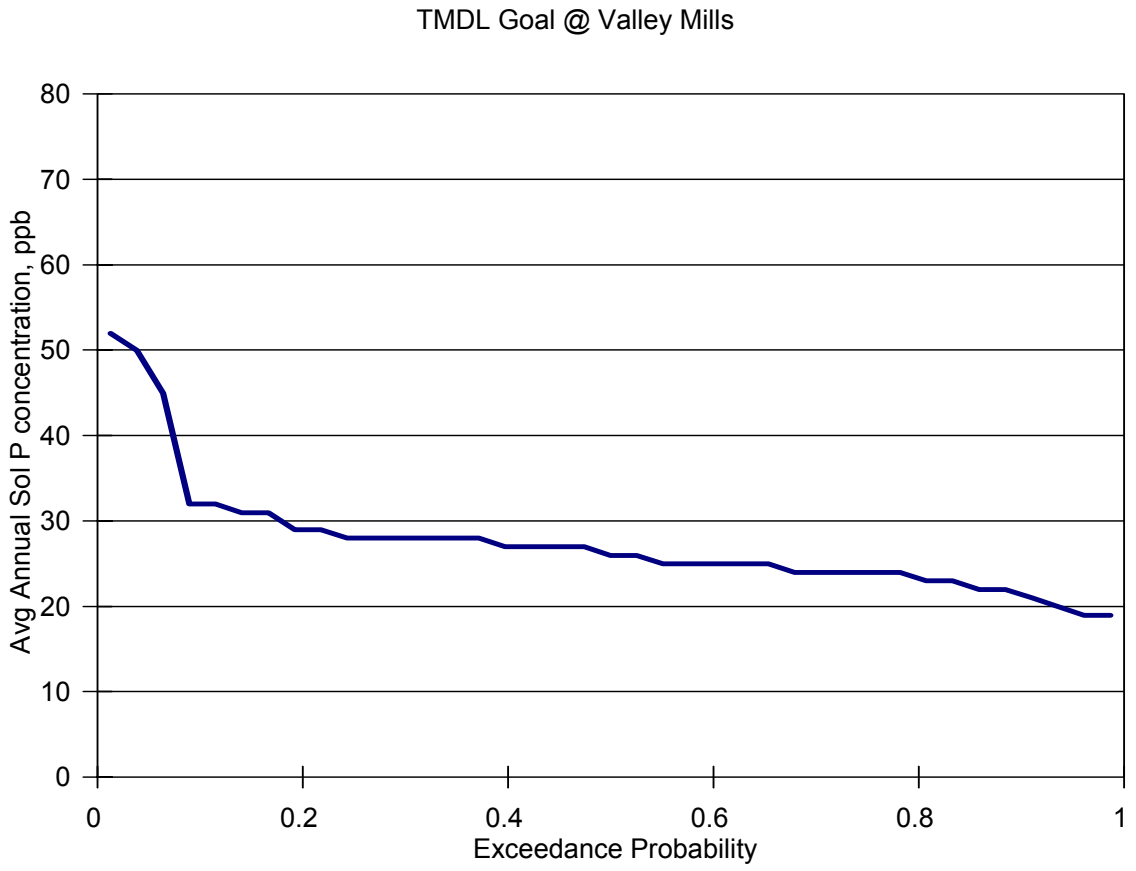


Figure 9. TMDL goal probability curve for index site at Valley Mills

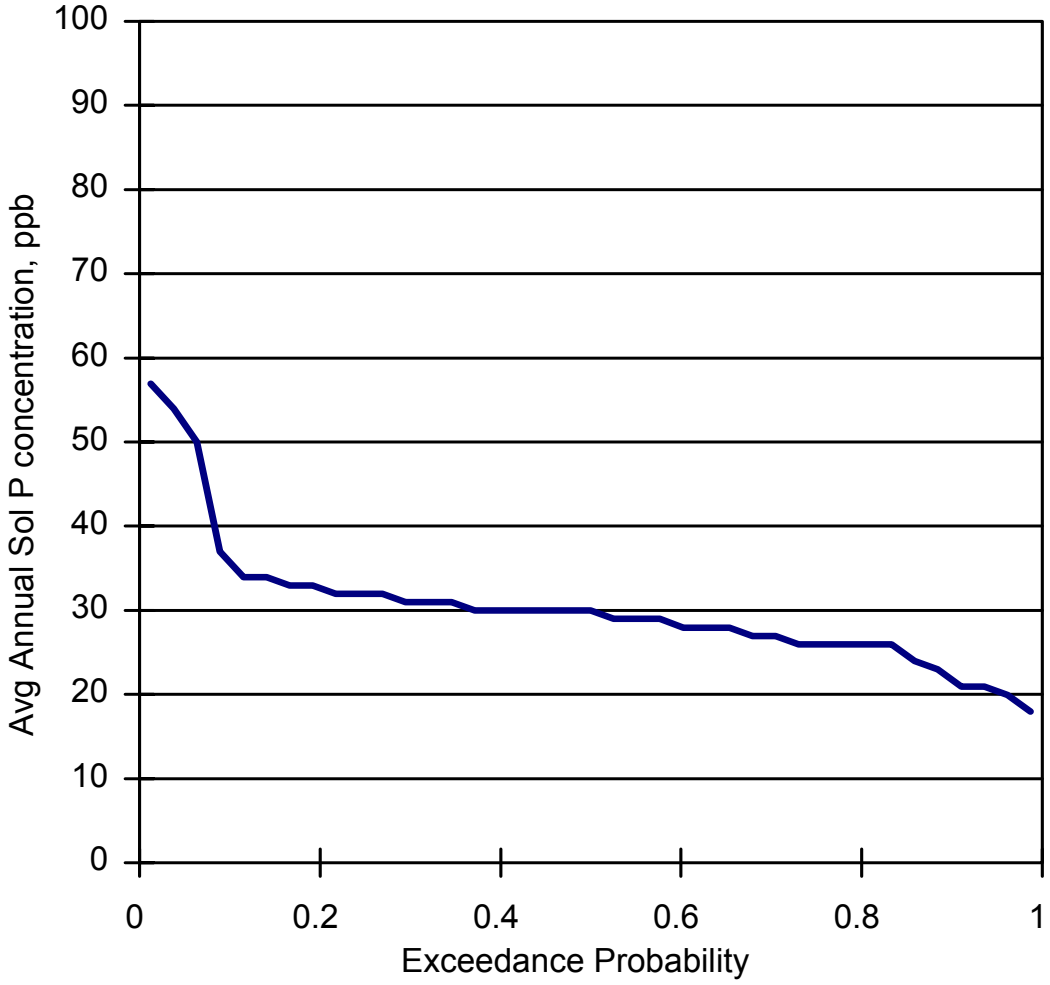


Figure 10. TMDL goal probability curve for index site at Clifton

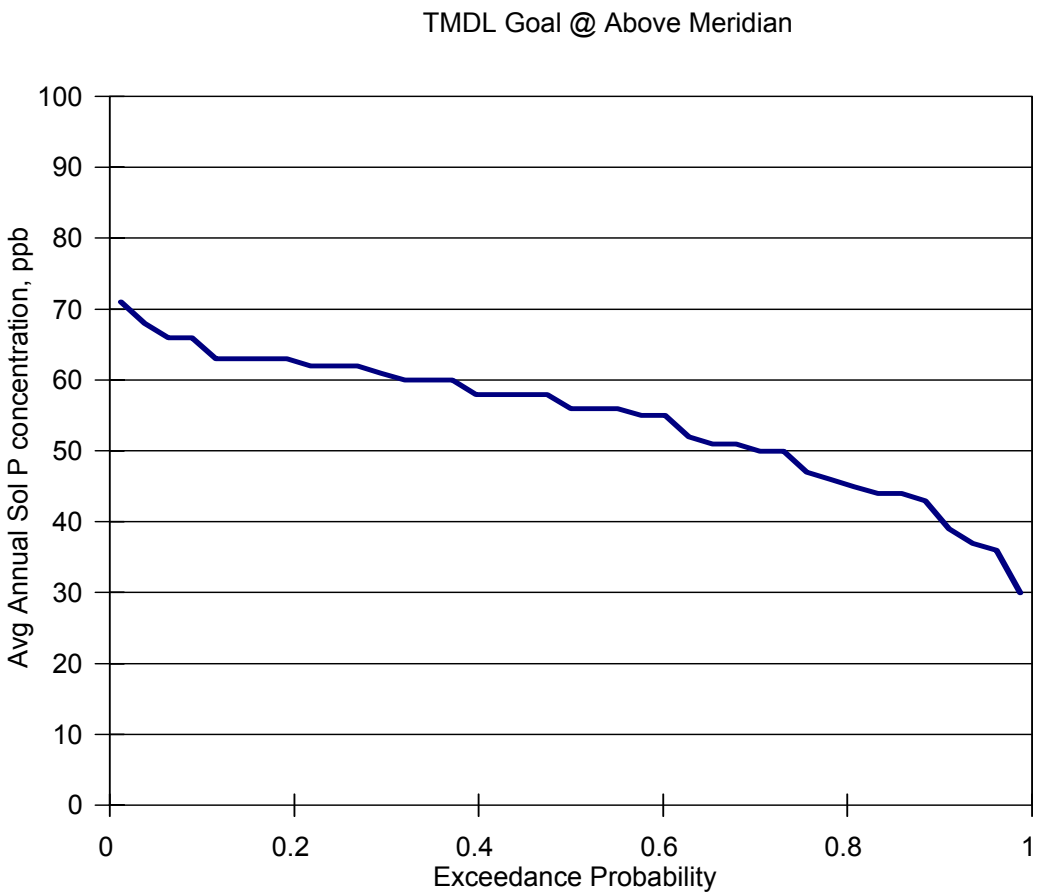


Figure 11. TMDL goal probability curve for index site Above Meridian

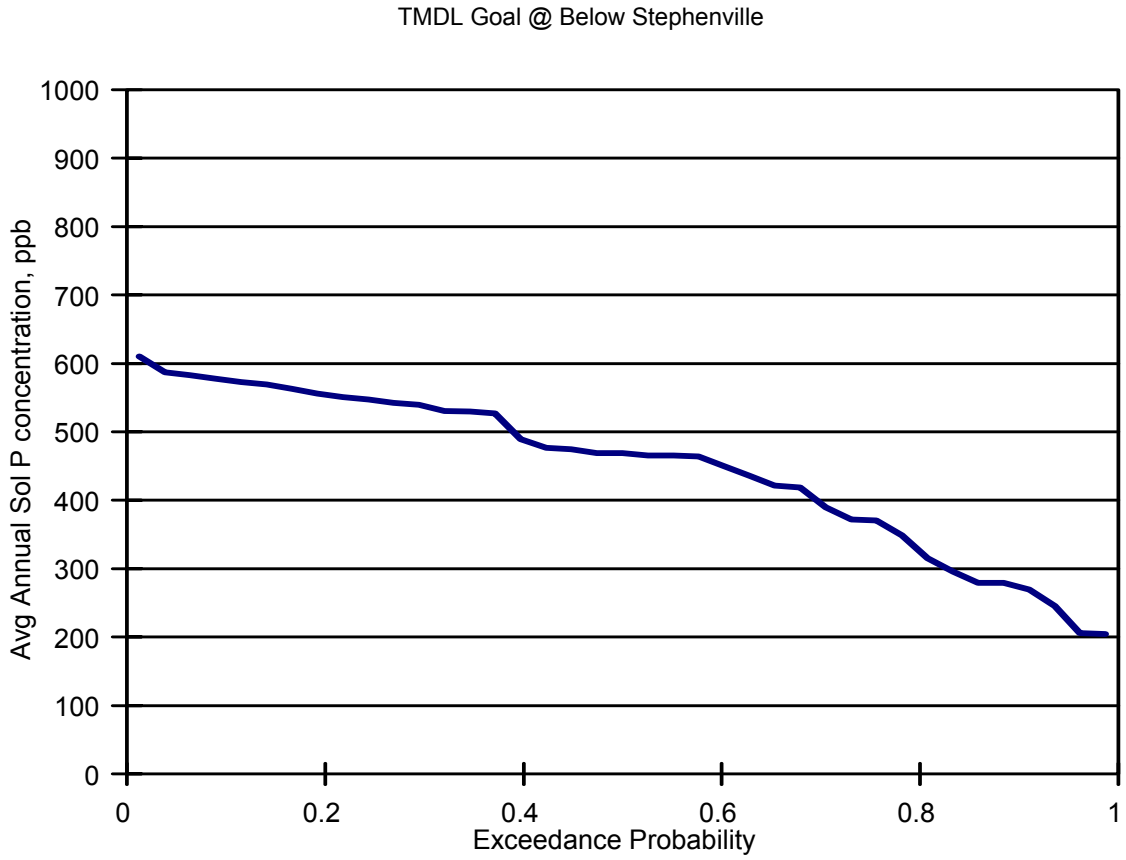


Figure 12. TMDL goal probability curve for index site Below Stephenville

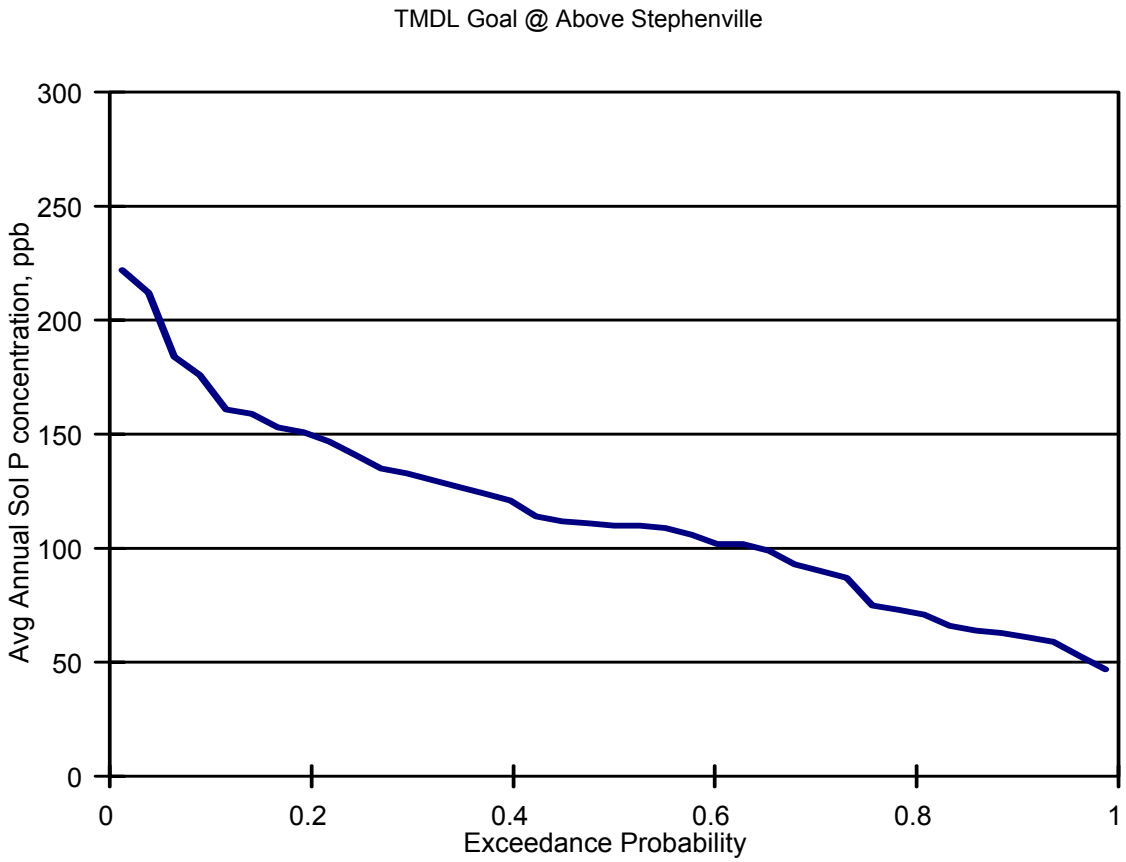


Figure 13. TMDL goal probability curve for index site Above Stephenville

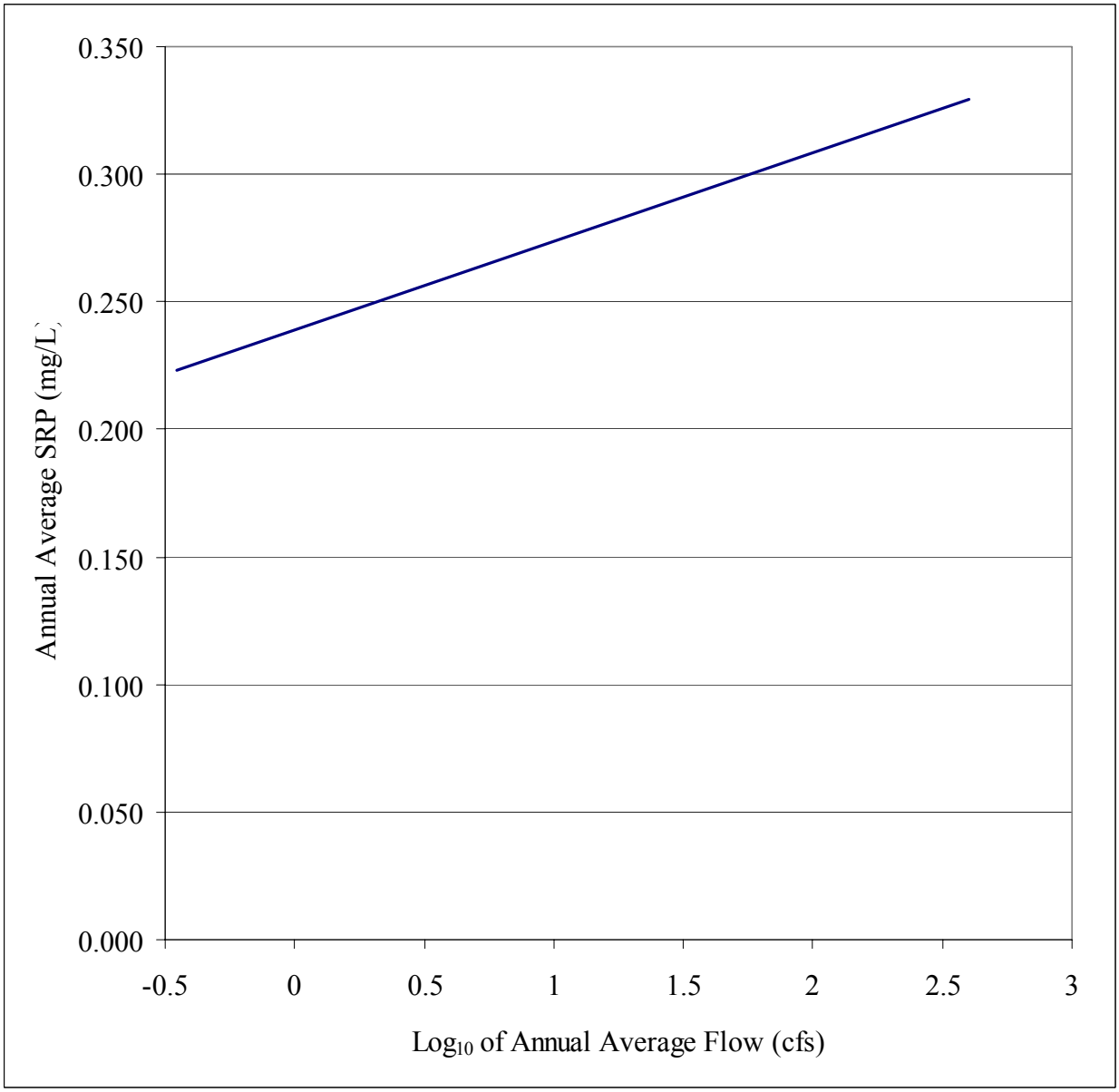


Figure 14. Regression curve at index site above Stephenville

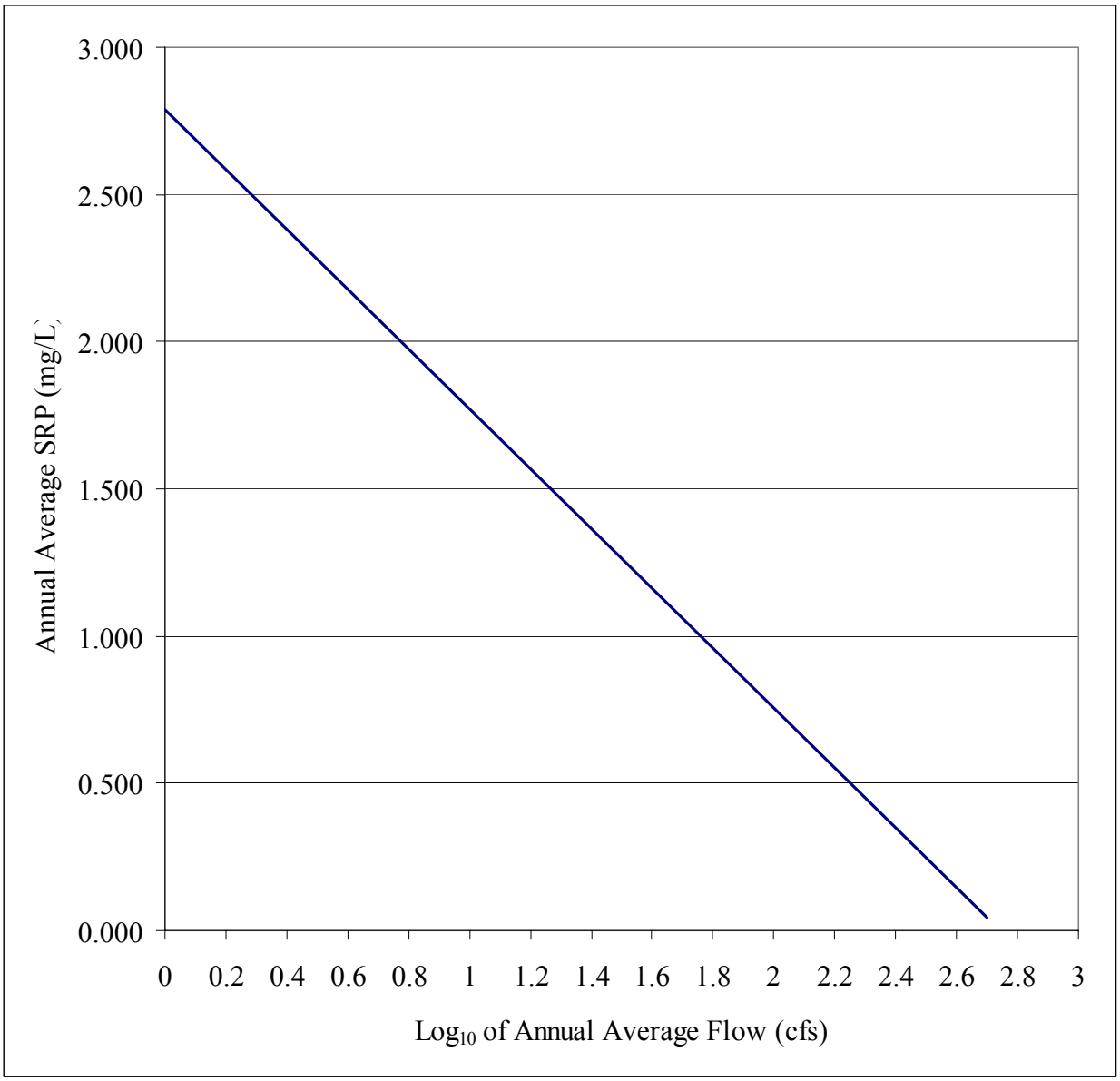


Figure 15. Regression curve at index site below Stephenville

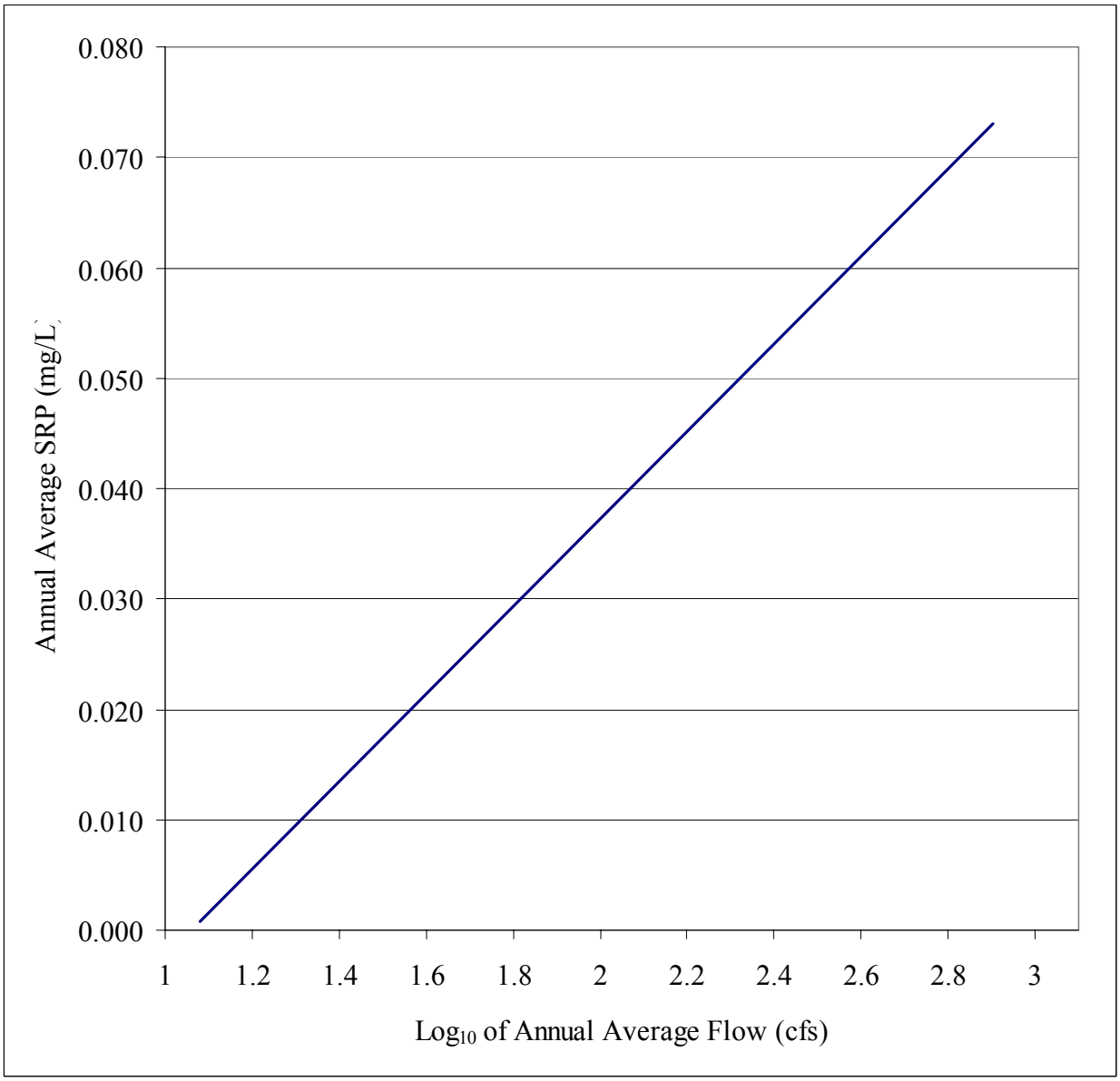


Figure 16. Regression curve at index site above Meridian

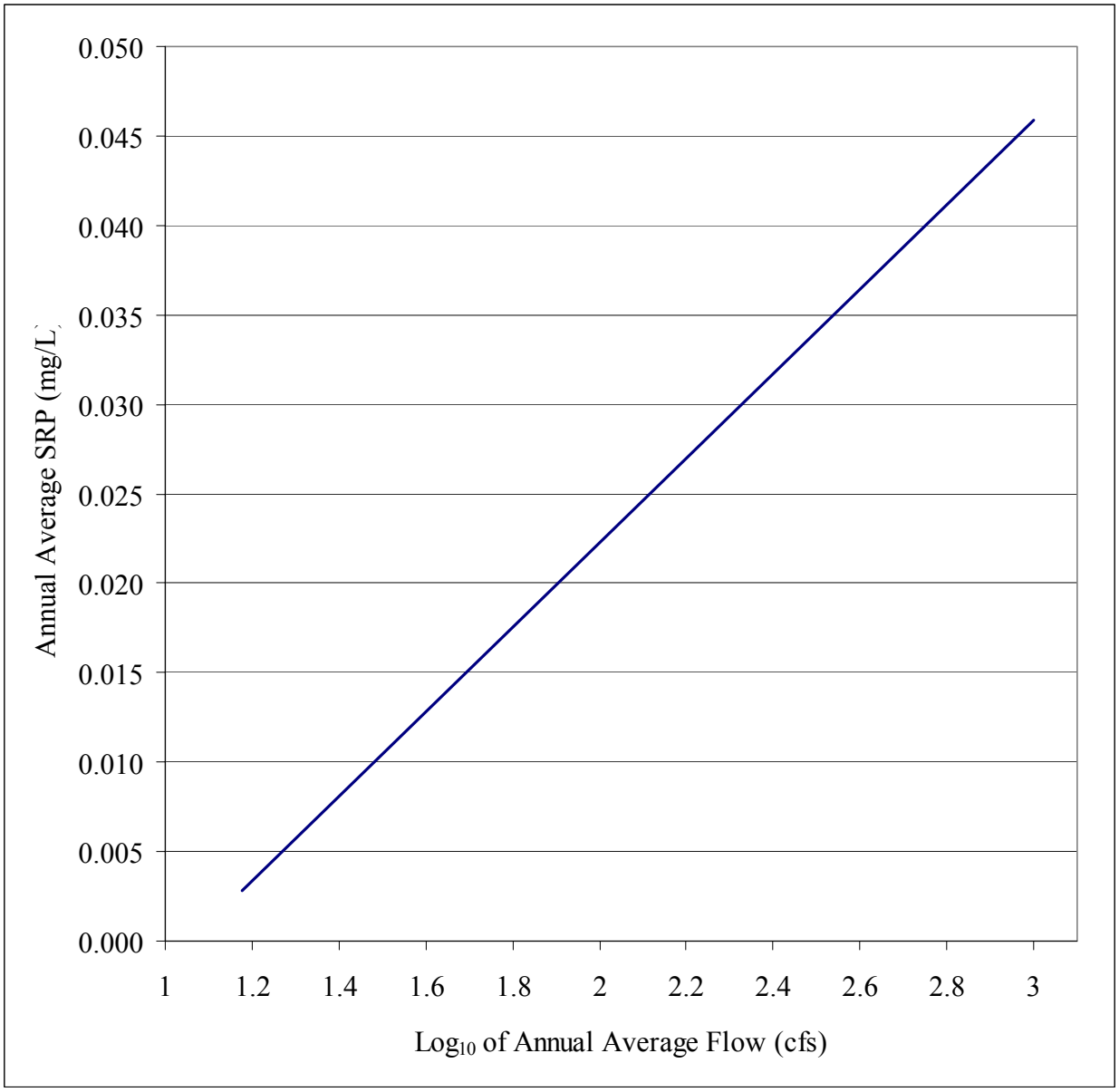


Figure 17. Regression curve at index site Clifton

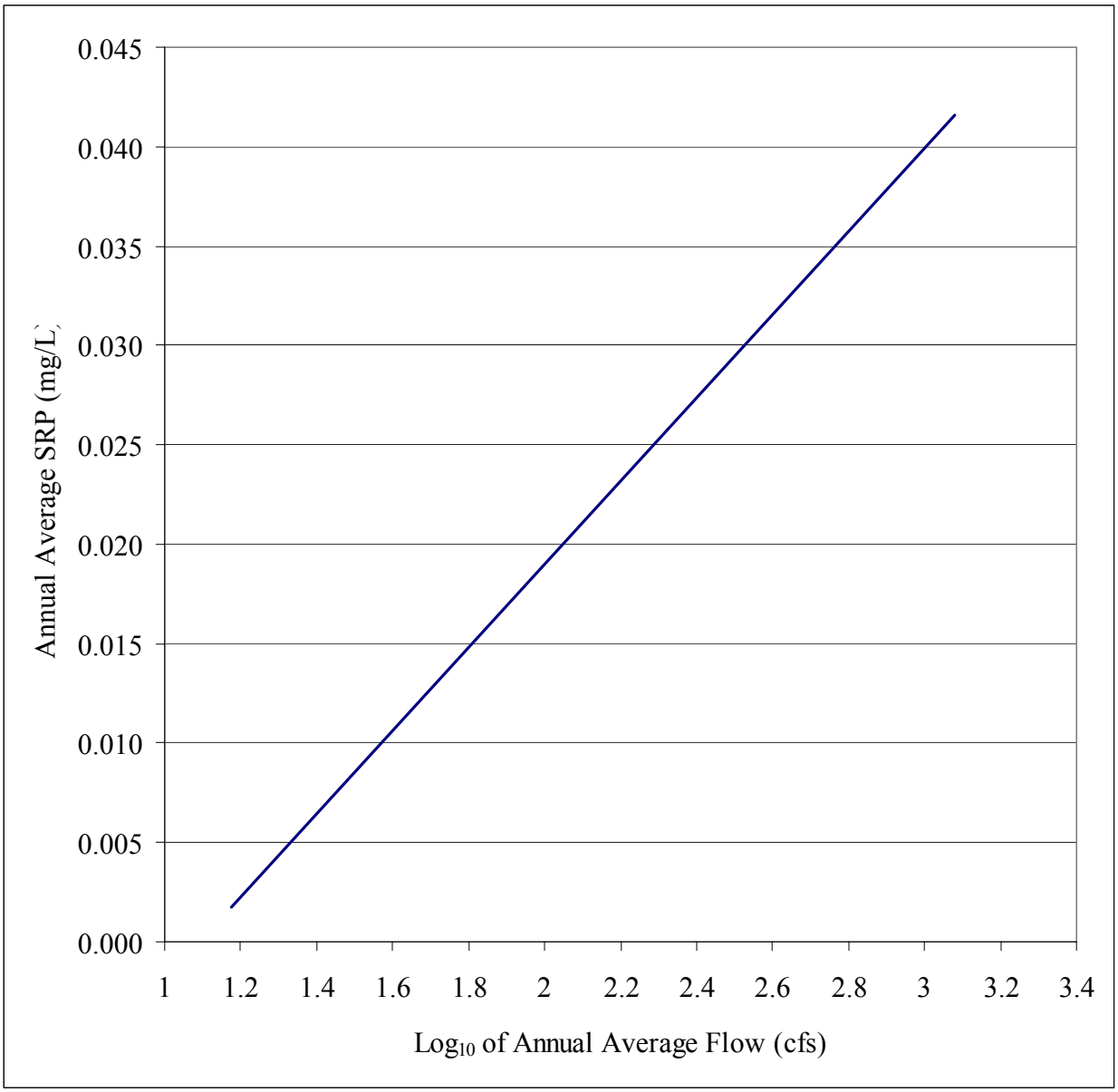


Figure 18. Regression curve at index site Valley Mills

Other Sources of Information

Texas Commission on Environmental Quality (TCEQ)

TCEQ Total Maximum Daily Load Program 512-239-4900
http://www.tnrcc.state.tx.us/water/quality/tmdl/

TCEQ Wastewater Permits
Main line / Switchboard 512-239-4671
Agriculture Permits 512-239-1552
Municipal Permits 512-239-4540
Industrial Permits 512-239-4515
Storm Water Permits 512-239-4527
http://www.tnrcc.state.tx.us/permitting/waterperm/wwperm/

TCEQ Composting Program
Small Business & Environmental Assistance 512-239-6774
Water Quality Planning & Assessment 512-239-4411
http://www.tnrcc.state.tx.us/water/quality/nps/compost/

TCEQ Regional Offices
Region 4, Dallas/Fort Worth
Switchboard 817-588-5800
Water 817-588-5901
Stephenville Special Project Office 254-965-5624
or 1-800-687-7078

Region 9, Waco
Switchboard 254-751-0335
Water 254-761-3007

http://www.tnrcc.state.tx.us/admin/directory/region/reglist/

TCEQ Information About Reporting Environmental Problems
http://www.tnrcc.state.tx.us/enforcement/complaints.html

TCEQ Internet Site Links to State Regulations
http://www.tnrcc.state.tx.us/oprd/index.html

TCEQ Water Quality Standards Online
http://www.tnrcc.state.tx.us/permitting/waterperm/wqstand/

Texas State Soil and Water Conservation Board (TSSWCB)

Switchboard (Temple, Tx) 254-773-2250
or 1-800-792-3485

Water Quality Management Plan Program
http://www.tsswcb.state.tx.us/programs/wqmp.html

Total Maximum Daily Load Program
http://www.tsswcb.state.tx.us/programs/tmdl.html

Bosque/Leon Composting Program
http://www.tsswcb.state.tx.us/programs/bosqueleon.html

SWCD Assistance Program
http://www.tsswcb.state.tx.us/programs/swcdassistance.html

Texas Water Development Board (TWDB)

Assistance Programs 512-463-7857
http://www.twdb.state.tx.us/assistance/assistance_main.htm

US Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS) - Texas Office

Switchboard (Temple, Tx) 254-742-9800
http://www.tx.nrcs.usda.gov/

References Cited

Camp Dresser & McKee Inc. May 2001. *North Bosque River Phosphorus Removal Study*. Prepared for the Brazos River Authority. Waco, Tx.

McFarland, A. and Hauck, L. 1999. *Existing Nutrient Sources and Contributions to the Bosque River Watershed*. TIAER Report # PR9911. Stephenville, TX: Texas Institute for Applied Environmental Research, Tarleton State University.

Metcalf & Eddy, Inc. 1979. *Wastewater Engineering: Treatment Disposal Reuse*, Second Edition. McGraw-Hill Book Company, Boston, Massachusetts.