MANUALLY SIGNED COPY

Upper North Bosque River Watershed Plan

and

Environmental Assessment

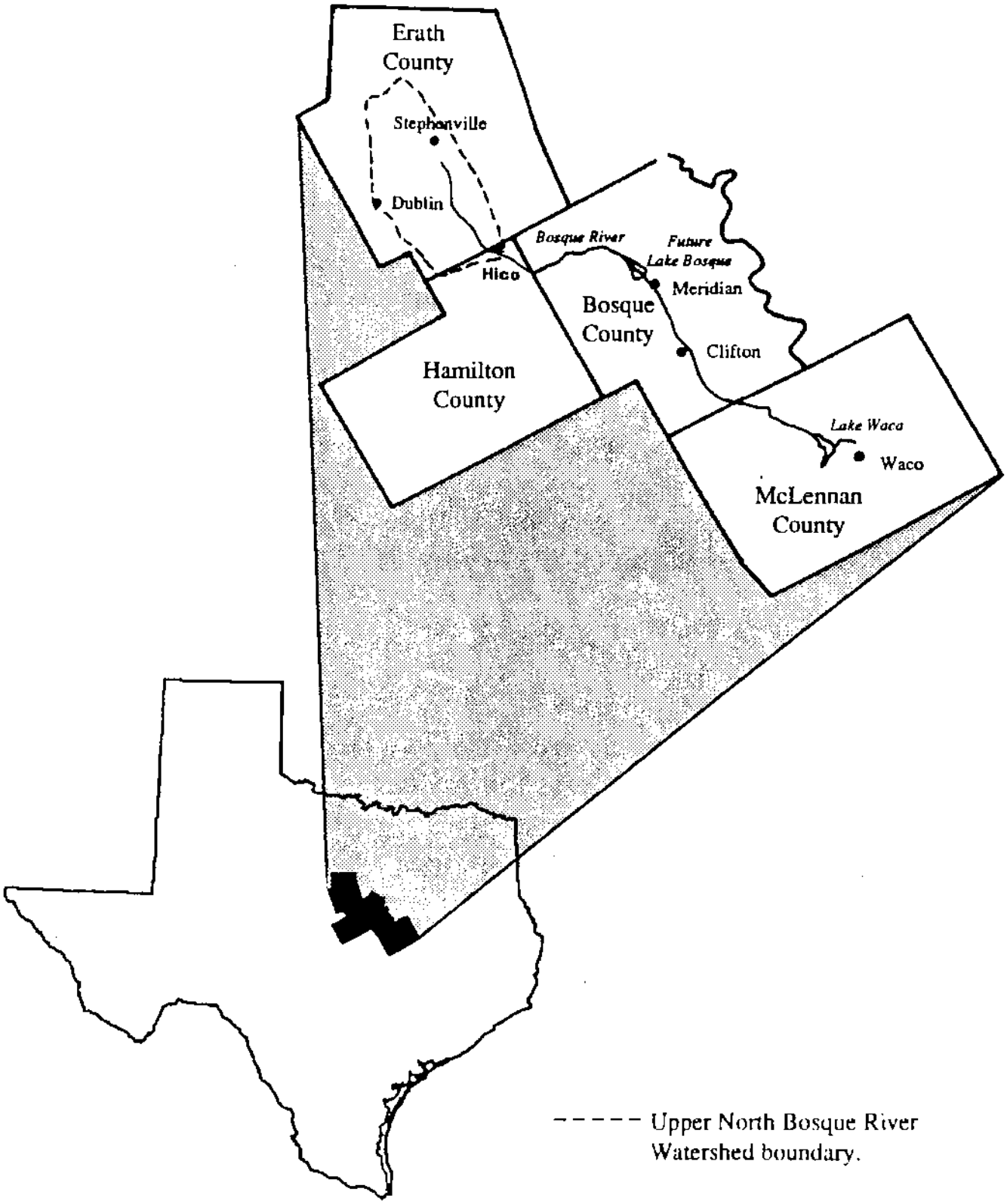
Erath and Hamilton Counties

Texas

U.S. Department of Agriculture
Soil Conservation Service
Temple, Texas

August 1992

Vicinity Map



----- Upper North Bosque River Watershed boundary.

WATERSHED PLAN and ENVIRONMENTAL ASSESSMENT

UPPER NORTH BOSQUE RIVER WATERSHED

Erath and Hamilton Counties, Texas

August 1992

Abstract

This document describes a project to improve surface and ground water quality in and below the watershed by assisting in a program to reduce the pollutant load from dairies by 70 percent. The plan will provide financial and technical assistance to install animal waste management systems and associated land treatment practices on 31 dairy farms. Implementation of the plan will be accomplished through the local soil and water conservation districts. This project will be supplemented by the Upper North Bosque River Hydrologic Unit Project in the watershed. The plan will be applied during a ten year period.

Total project costs are $2,050,400 of which $1,448,000 will be paid from Public Law 566 funds and $602,400 from local funds.

Federal assistance will be provided under authority of Public Law 83-566, 83rd Congress, 68 Stat. 666, as amended (16 U.S.C. 1001-1008).

Prepared by:

Cross Timbers Soil and Water Conservation District;
Hamilton-Coryell Soil and Water Conservation District;
Upper Leon Soil and Water Conservation District, and
USDA Soil Conservation Service, Planning Staff, Temple, Texas

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WATERSHED AGREEMENT

Between the

Cross Timbers Soil and Water Conservation District
Hamilton-Coryell Soil and Water Conservation District
Upper Leon Soil and Water Conservation District
(Referred to herein as sponsors)

State of Texas

and the

Soil Conservation Service
U.S. Department of Agriculture
(Referred to herein as SCS)

WHEREAS, application has heretofore been made to the Secretary of Agriculture by the sponsors for assistance in preparing a plan for works of improvement for the Upper North Bosque River Watershed, State of Texas, under the authority of the Watershed Protection and Flood Prevention Act (16 U.S.C. 1001-1008); and

WHEREAS, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to SCS; and

WHEREAS, there has been developed through the cooperative efforts of the sponsors and SCS a plan of works of improvement for the Upper North Bosque River Watershed, State of Texas, hereinafter referred to as the Watershed Plan - Environmental Assessment, which plan is annexed to and made part of this agreement;

NOW, THEREFORE, in view of the foregoing considerations, the Secretary of Agriculture, through SCS, and the sponsors hereby agree on this plan, and that the works of improvement for this project will be installed, operated, and maintained in accordance with the terms, conditions, and stipulations provided for in this watershed plan and including the following:

1. Cost-sharing rate for the establishment of enduring land treatment practices is 65 percent of the average cost of installing the enduring practices in the selected plan. The estimated total financial assistance cost for enduring practices is $1,745,000.

No practices in the selected plan are approved for incentive payment.

2. The SCS will assist the sponsors in providing technical assistance to landowners or operators to plan and install practices shown in the plan. Percentages of technical assistance costs to be borne by the sponsors and SCS are as follows:

Works of Improvement	Sponsor (percent)	SCS (percent)	Estimated Technical Assistance Cost (dollars)
Waste management systems (Water Quality) accelerated and associated land treatment	0	100	305,400

3. The sponsors will obtain applications from owners and operators of not less than 10 percent of the dairies eligible to participate in the project indicating that they will carry out the planned land treatment measures. Applications will be obtained before the first long-term contract is executed.

4. The sponsors will obtain agreement with landowners or operators to operate and maintain the planned practices for the protection and improvement of water quality in the watershed.

5. The sponsors and SCS will bear the cost of project administration that each incurs, estimated to be $8,600 and $39,300 respectively.

6. The costs shown in this plan are preliminary estimates. Final costs to be borne by the parties hereto will be actual costs, not to exceed average costs or an approved variation will be used for payment determinations.

7. This agreement is not a fund obligating document. Financial and other assistance to be furnished by SCS in carrying out the plan is contingent upon the fulfillment of applicable laws and regulations and the availability of appropriations for this purpose.

8. A separate agreement (long-term contract) will be entered into between SCS and landowners and operators before either party initiates work involving funds of the other party. Such agreements will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

9. This plan may be amended or revised only by mutual agreement of the parties hereto, except that SCS may deauthorize or terminate funding at any time it determines that the sponsors have failed to comply with the conditions of the agreement. In this

case, SCS shall promptly notify the sponsors in writing of the determination and the reasons for deauthorization of project funding, together with the effective date. Payments made to the landowner or operator through long-term contracts or recoveries by SCS shall be in accord with legal rights and liabilities of the parties when project funding has been deauthorized. An amendment to incorporate changes affecting a specific measure may be made by mutual agreement between the SCS and the sponsor having specific responsibilities for the measure involved.

10. No member of or delegate to Congress or resident commissioner shall be admitted to any share or part of this plan, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

11. The program conducted will be in compliance with all requirements respecting nondiscrimination, as contained in the Civil Rights Act of 1964, as amended, and regulations of the Secretary of Agriculture (7 CFR 15), which provide that no person in the United States shall, on the grounds of race, color, national origin, sex, age, handicap, or religion, be excluded from participation in, be denied the benefits of, or otherwise be subjected to discrimination under any program or activity conducted or assisted by the Department of Agriculture.

12. Certification Regarding Drug-Free Workplace Requirements (7 CFR 3017, Subpart F).

By signing this watershed agreement, the sponsors are providing the certification set out below. If it is later determined that the sponsors knowingly rendered a false certification, or otherwise violated the requirements of the Drug-Free Workplace Act, the SCS, in addition to any other remedies available to the Federal Government, may take action authorized under the Drug-Free Workplace Act.

Controlled substance means a controlled substance in Schedules I through V of the Controlled Substances Act (21 U.S.C. 812) and as further defined by regulation (21 CFR 1308.11 through 1308.15);

Conviction means a finding of (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statues;

Criminal drug statute means a Federal or non-Federal criminal statute involving the manufacturing, distribution, dispensing, use, or possession of any controlled substance;

Employee means the employee of a grantee directly engaged in the performance of work under a grant, including: (i) all direct charge employees; (ii) all indirect charge employees unless their impact or involvement is insignificant to the performance of the grant; and, (iii) temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the grantee's payroll. This definition does not include workers not on the payroll of the grantee (e.g., volunteers, even if used to meet a matching requirement; consultants or independent contractors not on the grantees' payroll; or employees of subrecipients or subcontractors in covered workplaces).

Certification:

A. The sponsors certify that they will or will continue to provide a drug-free workplace by:

(1) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(2) Establishing an ongoing drug-free awareness program to inform employees about--

(a) The danger of drug abuse in the workplace;

(b) The grantee's policy of maintaining a drug-free workplace;

(c) Any available drug counseling, rehabilitation, and employee assistance programs; and

(d) the penalties that may be imposed upon employees for drug abuse violations occurring in the workplace.

(3) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (1);

(4) Notifying the employee in the statement required by paragraph (1) that, as a condition of employment under the grant, the employee will--

(a) Abide by the terms of the statement; and

(b) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;

(5) Notifying the SCS in writing, within ten calendar days after receiving notice under paragraph (4)(b) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer or other designee on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;

(6) Taking one of the following actions, within 30 calendar days of receiving notice under paragraph (4)(b), with respect to any employee who is so convicted--

(a) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or

(b) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency.

(7) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (1), (2), (3), (4), (5), and (6)

B. The sponsors may provide a list of the site(s) for the performance of work done in connection with a specific project or other agreement.

C. Agencies shall keep the original of all disclosure reports in the official files of the agency.

13. Certification Regarding Lobbying (7 CFR 3018)
(applicable if this agreement exceeds $100,000)

(1) The sponsors certify to the best of their knowledge and belief, that:

(a) No Federal appropriated funds have been paid or will be paid, by or on behalf of the sponsors, to any person for influencing or attempting to influence an officer or employee of an agency, member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(b) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(c) The sponsors shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

(2) This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

14. Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions (7 CFR 3017).

(1) The sponsors certify to the best of their knowledge and belief, that they and their principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State, or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or local) terminated for cause or default.

(2) Where the primary sponsors are unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this agreement.

CROSS TIMBERS SOIL AND
WATER CONSERVATION DISTRICT
Star Route
Box 372
Stephenville, TX 76401

By Kenneth Lesley
Kenneth Lesley, Chairman
Date 9/3/92.

The signing of this agreement was authorized by a resolution of the governing body of the Cross Timbers Soil and Water Conservation District adopted at a meeting held on 9/3/92.

Douglas C. Eberhart, Secretary
239 South Virginia
Stephenville, TX 76401

HAMILTON-CORYELL SOIL AND
WATER CONSERVATION DISTRICT
Route, Box 177G
Hamilton, TX 76531

By
N. Foote, Chairman
Date 9-8-92

The signing of this agreement was authorized by a resolution of the governing body of the Hamilton-Coryell Soil and Water Conservation District adopted at a meeting held on 9-8-92.

Moody E. Courtney
Moody Courtney, Secretary
Route 1, P.O. Box 81
Jonesboro, TX 76538

UPPER LEON SOIL AND
WATER CONSERVATION DISTRICT
Box 205
Sidney, TX 76474

By Norman Moore
Norman Moore, Chairman

Date 9-16-92

The signing of this agreement was authorized by a resolution of the governing body of the Upper Leon Soil and Water Conservation District adopted at a meeting held on 9-16-92.

J.W. Sadberry
J.W. Sadberry, Secretary
Route 1, Hwy. 3381
Comanche, TX 76442

Soil Conservation Service
United States Department of Agriculture

Approved by:

Harry W Oneth
HARRY W. ONETH
State Conservationist

Date 9/24/92

x

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

CONVERSION FACTORS

English Units to Metric (SI) Units

ENGLISH UNIT	x	CONVERSION FACTOR	=	METRIC (SI) UNIT
Acre		0.4047		hectare
Acre-foot		1.234		cubic decameters
Inch		2.540		centermeters
Degrees Fahrenheit (F)		(F -32)0.5556		degrees Celcius
Foot		0.3048		meter
Gallon		3.785		liters
Mile		1.609		kilometers
Pound		453.6		grams
Square Mile		2.590		sq. kilometers
Ton (short)		0.9072		megagram
Tons/acre		2.242		megagram/hectare

SUMMARY

Project Name: Upper North Bosque River Watershed
Counties: Erath and Hamilton Counties
State: Texas
Sponsors: Cross Timbers Soil and Water Conservation District
Hamilton-Coryell Soil and Water Conservation District
Upper Leon Soil and Water Conservation District

Description of Recommended Plan:

This plan will provide financial and technical assistance to install animal waste management systems and associated land treatment practices on 31 dairy farms. Implementation of plan measures will be accomplished through the local soil and water conservation districts. It will improve surface and ground water quality in and below the watershed by reducing the pollutant load from dairies by 70 percent. Project installation period is ten years. This plan will be supplemented by the Upper North Bosque River Hydrologic Unit Project.

Resource Information

Size of watershed: 229,760 acres (359 square miles).

Land Use:		
Cropland	20,720 acres	9%
Rangeland	135,950 acres	59%
Pastureland	55,370 acres	24%
Water	2,680 acres	1%
Other 1/	15,040 acres	7%

1/ Includes 1,340 acres of dairy barns, pens, etc.

Land Ownership (percent): Private, 99 percent; Federal & State, 1 percent

Farms (number) : 1600 in Erath County

Average Size (acres) : 350 acres

Endangered Species:
Whooping crane (*Grus americana*)
Black-capped vireo (*Vireo atricapillus*)
Golden-cheeked warbler (*Dendroical chrysoparia*)

Cultural Resources: None are expected to be disturbed.

Problem Identification: Immense quantities of untreated animal waste are generated by 96 of the 110 dairies in the watershed. The 96 dairies have about 21,520 confined milking cows. The unmanaged animal waste produced by this number of confined animals has degraded water, land, air, plant and animal resources in and below the watershed. An estimated 1.12 billion pounds of wet animal waste is accumulating each year. This amount of untreated manure is enough to fill the Astrodome in a three-year period. Untreated waste washing from the dairies severely effects esthetics, domestic and social resources, aquatic habitat and recreation related to land, air, and water resources.

About 190 miles of stream channels and 25 floodwater retarding structures in the Upper North Bosque River Watershed (PL-566 program) are affected by polluted water from dairy runoff. Fecal coliform concentrations up to 270,000 cells per 100 milliliters of water have been measured in storm runoff within the watershed. A fecal coliform concentration in excess of 200 cells per 100 milliliters of water is an indication of unsafe water quality.

Publicly owned treatment works for municipal and domestic wastes has been identified as an actual or potential non-agricultural related problem in the watershed. Failed on-site sewage treatment systems (septic tanks and filter fields) was also identified as a water quality problem.

Stephenville's sewage treatment plant discharges treated effluent into the North Bosque River near the southern edge of the City. This sewage effluent is a major contributor to the North Bosque River base flow during the summer months. A growing population in Stephenville has caused the treatment plant to run at capacity load. Projected population growth will cause excessive loadings and degraded water quality in the River unless the enlarged sewage treatment plant planned by the City is installed.

Candidate Plans Considered:

1. No action plan.

2. A program of animal waste management and associated land treatment practices.

Project Purpose:

1. Improve water, land, air, plant and animal resources.

2. Reduce water use impairment to increase opportunities for recreation and other social uses of the environment.

3. Reduce the health hazards because of contaminated water.

Principal Project Measures:

Animal waste management systems and associated land treatment practices for 31 dairies.

Total Project Costs:

	PL 566 Funds	Other Funds	Total
Waste Management Systems	$1,142,600 1/	$ 602,400 1/	$1,745,000
Technical Assistance	305,400	0	305,400
Total	$1,448,000	$ 602,400	$2,050,400

1/ Includes Project Administration cost

INTRODUCTION

Water quality has been degraded within the watershed and downstream in the North Bosque River because of immense quantities of animal waste being produced in the watershed and washing into the stream system. Water quality problems have been documented by the Texas State Soil and Water Conservation Board and Texas Water Commission through the Section 319 assessment process. Each year, an estimated 1.12 billion pounds of dairy animal waste is produced and not all is properly managed. It is transported by runoff water to stream channels where the contaminants restrict or prohibit use of the water. Animal waste is also a threat to contaminate aquifers and restrict ground water use. Animal waste is washed from the dairies and contaminates and impairs water, land, air, plant and animal resources.

The Upper North Bosque River Watershed is located in west central Texas about 60 miles west of Fort Worth. The 359 square mile watershed is within the Brazos River Basin in Erath and Hamilton Counties, Texas. The watershed drains into the upper portion of stream segment No. 1226 as delineated by the Texas Water Commission. Lake Waco, an existing municipal water source, is about 90 miles downstream. Lake Bosque, a proposed reservoir in final stages of planning, will be located 37 miles downstream from the watershed. When Lake Bosque is completed, the two lakes will provide domestic water for about 136,000 people in central Texas.

The watershed is within the Cross Timbers Soil and Water Conservation District, Hamilton-Coryell Soil and Water Conservation District, and Upper Leon Soil and Water Conservation District. The district directors are dedicated to solving and preventing present and future resource problems. They have resolved to work with dairy operators and cooperate with other agencies and interested individuals to implement a project to reduce the resource problems.

The PL-566 watershed plan will be supplemented by the Upper North Bosque River Hydrologic Unit Project (HUP), a major water quality improvement and maintenance effort in the area. The HUP is a result of President Bush's Water Quality initiative directed at protecting the Nation's ground and surface water from contamination by agricultural chemicals and wastes. The Upper North Bosque River HUP is a cooperative effort under the joint leadership of the SCS, Agricultural Stabilization and Conservation Service (ASCS), Texas State Soil and Water Conservation Board (TSSWCB), and Texas Agricultural Extension Service (TAEX). Each agency is applying its expertise, funds, and authority to protect and improve the quality of water and other natural resources in the watershed.

The HUP plan calls for construction and operation of animal waste management systems and related land treatment practices. Special project funding is being made through ASCS and SCS programs. This PL-566 project is needed to provide additional technical and financial assistance to facilitate installation of animal waste management systems and associated land treatment.

SETTING

Upper North Bosque River Watershed is comprised of 229,760 acres (359 square miles) located in west central Texas. North Bosque River originates in north-central Erath County and flows in a south-southeasterly direction through the city of Stephenville. From Stephenville, the North Bosque River flows southward to the town of Hico in extreme northern Hamilton County. The location of the U.S. Geological Survey (USGS) stream gage No. 08094800 at Hico is considered to be the lower most extremity of the Upper North Bosque River Watershed (Appendix B). From Hico, the North Bosque River flows about 93 miles to confluence with the Brazos River near Waco, Texas.

Two flood prevention and watershed protection projects with a total of 40 floodwater retarding structures are located in the watershed area. Upper North Bosque River Watershed has 27 dams constructed under PL-566 and Green Creek Watershed, a Pilot Project built with conservation operations funds, has 13 dams constructed.

Lake Waco, a major lake on the North Bosque River, is located about 90 miles downstream from the mouth of the watershed. Constructed by the Army Corps of Engineers (COE), the lake supplies water for the city of Waco. Another major lake, to be called Lake Bosque, will be located about 37 miles downstream from the watershed. This new lake is being planned on the North Bosque River by the Brazos River Authority (BRA). Lake Bosque will supply water for the cities of Bellmead, Clifton, Hewitt, Lacy-Lakeview, Meridian, Waco, and Woodway, and the McLennan Water Control and Improvement District No. 2. The two lakes will provide domestic water for about 136,000 people.

Stephenville, the county seat of Erath County, is located in the north-central portion of the watershed and has a population of 15,450. Dublin is on the central-western edge of the watershed and has a population of 3,177. Hico, population 1,275, is at the mouth of the watershed in Hamilton County.

Tarleton State University, with an enrollment of about 5,000 students, is located in Stephenville. It is a state supported institution of higher learning with BS and MS levels of study. The Texas Institute for Applied Research, also located in Stephenville, is associated with Tarleton State University and is involved in agricultural and environmental research.

Climate

The watershed and surrounding vicinity has a warm-temperate, subhumid climate. The daily mean temperature ranges from a high of 96 degrees Fahrenheit in July to a low of 36 degrees Fahrenheit

in January. The passage of cold fronts can cause temperature readings to be in the teens for short durations. The average growing season is 238 days.

Average annual precipitation at Stephenville is 30.1 inches, of which an average of 1.7 inches fall in January and 4.5 inches fall in May, the smallest and largest monthly amounts, respectively. The area is subject to high intensity, short duration rainfall events which can result in large volumes of runoff.

Geology

Geologic strata cropping out in the watershed, from the oldest to the youngest, are Lower Cretaceous sedimentary rocks in the Glen Rose Formation; Paluxy Formation; Walnut Formation; Pleistocene fluviatile terrace deposits; and Recent alluvium.

Geologic Strata Cropping Out in the Watershed

System	Series	Stage
Quaternary	Recent	Alluvium
	Pleistocene	Fluviatile Terrace
Cretaceous	Lower Cretaceous	Walnut Formation
		Paluxy Formation
		Glen Rose Formation

The "Abilene" and "Brownwood" sheets of the "Geologic Atlas of Texas" describe and display in detail the geology of the watershed and surrounding area. The following lithologic descriptions are extracted from the Abilene sheet:

Recent Alluvium - sand, silt, and clay on the floodplain areas, very poorly indurated to nonindurated.

Fluviatile Terrace - gravel, sand, silt, and clay; small isolated areas on the outer fringes of the North Bosque River floodplain.

Walnut Formation - interbedded hard limestone and calcareous claystone; relatively erosion resistant; crops out at the eastern and western divides and higher elevations in the watershed.

Paluxy Formation - poorly indurated, friable, fine-grained sandstone interbedded with sandy to silty claystone; locally subject to accelerated erosion and rapid infiltration of storm runoff; geologic erosion has removed Paluxy strata from the interior of the watershed exposing the Glen Rose Formation.

Glen Rose Formation - alternating hard, evenly bedded limestone, and recessive marl and claystone; crops out in the interior of the watershed in a dendritic configuration; topography over formation is typically a "stair-step" or terraced profile due to differential erosion.

There are no igneous intrusions, volcanics, faulting, etc... in the watershed to influence the topography, runoff, or groundwater. Sedimentary lithology, soils characteristics and climatic conditions are the primary natural phenomena affecting surface runoff and groundwater.

Aquifers in the Paluxy Formation and Recent Alluvium receive recharge from watershed storm runoff. The Recent Alluvium is capable of furnishing ground water during favorable climatic conditions. However, it is not a dependable water source under drought conditions and it is not extensively used. The Paluxy Aquifer is generally unconfined, and is an important water source within the watershed and adjacent area. It furnishes water mostly for rural domestic uses.

The Twin Mountains Formation underlies the Glen Rose Formation in the watershed vicinity. The Glen Rose Formation serves as an effective aquitard, or barrier, for the Trinity Aquifer in the Twin Mountains Formation. The Twin Mountains Formation does not crop out in the watershed, and natural recharge does not occur from watershed storm runoff. The Trinity Aquifer, which is also in the Travis Peak Formation to the south of the watershed, is a regional aquifer furnishing large amounts of high quality water. Stephenville and Hico obtain municipal water from wells tapping the Trinity Aquifer. Dublin obtains water from a surface impoundment outside the watershed.

Soils

Soils mapped in the watershed are described in detail in the Soil Survey of Erath County, Texas, SCS, 1973. Portions of the watershed are in the West Cross Timbers and Grand Prairie Major Land Resource Areas. Windthorst-Duffau and Nimrod-Selden associations are in the West Cross Timbers Land Resource Area. The Windthorst-Duffau association is comprised of moderately deep and deep, gently sloping to sloping, sandy and loamy soils that have reddish, loamy and clayey layers in the lower part. The Nimrod-Selden association is comprised of deep, nearly level to sloping, sandy soils that have mottled, loamy layers in the lower part. Both of these associations are comprised of residual soils developed from sandy, silty, and clayey materials in the Paluxy Formation.

Houston Black-Denton-Purves and Maloterre-Purves-Dugout associations are in the Grand Prairie Major Land Resource Area. Soils in the Houston Black-Denton-Purves association are nearly level to gently sloping and clayey and are deep to shallow over limestone and marl. Soils in the Maloterre-Purves-Dugout association are shallow, stony and gravelly over limestone. Soils in these associations have formed over the Walnut Formation and Glen Rose Formation, respectively.

PROBLEMS AND OPPORTUNITIES

General

Poor water quality in and below the watershed has been widely publicized as the worst agriculture-related pollution problem in Texas. The rapid growth of the existing dairy industry in the watershed in the past few years has created a problem due to immense quantities of animal waste generated by about 28,400 milking cows. The result is tremendous amounts of raw animal waste both at the dairy sites and downstream from the dairies. Many of the dairies have a management system to dispose of the waste, but most dairies have inadequate systems to deal with the quantities of liquid and solid waste and wash water from normal dairy operations. Water, land, air, plant, and animal resources in the area have been degraded and will continue to be damaged in the future by the animal waste loadings from dairy operations in the area. The Texas Water Commission (TWC), the state agency charged with enforcing state water quality laws, has insisted that dairies plan immediately to reduce the problem.

About 190 miles of stream channels and 25 floodwater retarding structures in the Upper North Bosque River Watershed (PL-566 Program) are affected by polluted water from dairy runoff. Fecal coliform concentrations up to 270,000 cells per 100 milliliters of water have been measured in storm runoff within the watershed. A fecal coliform concentration in excess of 200 cells per 100 milliliters of water is an indication of unsafe water quality.

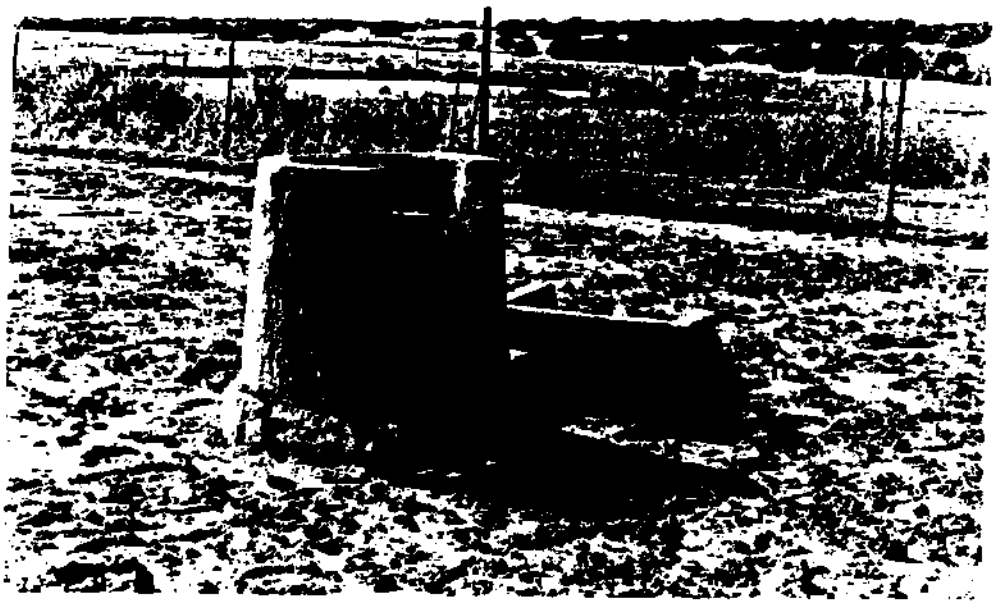
Publicly owned treatment works for municipal and domestic wastes has been identified as an actual or potential non-agriculturally related problem in the watershed. Failed on-site sewage treatment systems (septic tanks and filter fields) was also identified as a water quality problem.

Stephenville's sewage treatment plant discharges treated effluent into the North Bosque River near the southern edge of the City. This sewage effluent is a major contributor to the North Bosque River base flow during the summer months. A growing population in Stephenville has caused the treatment plant to run at capacity load. Projected population growth will cause excessive loadings and degraded water quality in the River unless the enlarged sewage treatment plant planned by the City is installed.

The water quality problem has been publicized in metropolitan newspapers and television networks throughout the state. A story in the Houston Chronicle, on October 20, 1991 quotes a resident living downwind from an Erath County dairy, "Its like living next to an open cesspool....The odor would literally make you throw up it's so bad. It's sickening." "Milk's dark side", an article in the Fort Worth Star Telegram, June 18, 1989, stated "The same

dairy farms that pump millions of dollars into Erath County's economy also routinely dump untreated animal waste into its streams, stock ponds, and rivers - a growing problem that experts say could threaten Central Texas reservoirs and aquifers." Similar news articles and editorials have appeared in media outlets in Austin, Dallas, Dublin, Stephenville, Waco, and other cities across Texas.

Poor water quality in and below the watershed has been publicized as the worst agriculture-related pollution problem in Texas. Huge amounts of untreated animal waste, generated by thousands of closely penned dairy cows is being washed onto adjacent lands (photo above), roads (photo below), and into the stream system. Of the 110 dairies in the watershed, 96 do not have adequate systems to manage the animal waste produced on their dairies.



Animal waste from dairies is affecting ground water quality through improperly installed or managed well heads and percolation of polluted water in the recharge area. Contaminants such as nitrates and fecal coliform find direct access to the aquifer when unprotected well heads are located in dairy pens (photo above). About 190 miles of stream channels in the watershed are adversely affected by polluted water from dairy runoff (photo below).

Dublin Concerned Citizens is a local group of about 125 members organized to address the problems of water contamination in Erath County. The group was formed in 1989 as the result of water well testing that revealed high nitrate content. The stated purpose of the organization is "...not to slam the dairy industry, but to insure that the quality of the water supply is not tainted by its waste or any other industry's operation." The group's efforts resulted in a hearing by a subcommittee of the U.S. House of Representatives on June 30, 1989. The panel consisted of Rep. Charles W. Stenholm (D-Tex), Rep. George E. Brown, Jr. (D-Calif), Rep. Pat Roberts (R-Kan), and Rep. Arlan Strangeland (R-Minn). The meeting was held at Tarleton State University in Stephenville.

Public concern continues to grow, especially during the past few months when extraordinary rainfall has washed animal wastes from some dairies onto adjacent properties and roadways. The problem is an every-day experience for many residents who see the quality of their natural resources degrading.

Projections concerning the growth of dairy industry in the watershed show that while the number of dairies is expected to remain at about 110, the number of milking cows in the watershed is expected to increase from 28,400 to about 40,500. The problem of untreated animal wastes is expected to increase in relation to the increase in number of milking cows in the watershed. The following tabulation shows the projected increase in number of milking cows per dairy in the watershed.

Growth in Size of Dairies in the Watershed

Number of Milking Cows	Number of Dairies	
	Present	Future
0 - 125	51	23
126 - 250	26	40
251 - 500	21	26
501 - 750	2	9
751 - 1000	4	6
More than 1000	6	6
Total Dairies	110	110

There are 110 dairies in the watershed with a combined herd of about 28,400 milking cows. The number of cows is influenced by milk prices and other economic and physical factors affecting dairy operations. Of the 110 existing dairies, 96 do not have adequate systems to manage the animal waste produced on their dairies. These 96 dairies have about 21,520 confined milking cows that produce an estimated 1.12 billion pounds of wet animal waste each year. This amount of manure is enough to fill the Astrodome in a three-year period.

Manure produced by dry and replacement cows and heifers is deposited on pasture and cropland since these animals are usually not confined. Manure produced by these animals is fully utilized in crop and pasture management systems.

Most dairy operations maintain high animal concentrations in confined pens or corrals on small acreages. Typical animal spacing in confined pens is about 600 square feet per cow. A problem is created when the accumulating animal waste washes from the pens.

A testing program conducted by Texas Agricultural Extension Service and published in Proceedings of the Sixth International Symposium on Agricultural and Food Processing Wastes was used to determine the impact of dairy wastes on the quality of surface runoff from the dairies. The results were then used to estimate the total effects on the natural resources in and below the watershed (Appendix D-2).

Water quality problems exist when the intended use of the water is denied or impaired because of contaminants in the water. For water quality problems to deny or impair use, the water's chemical properties could be unacceptable, offensive foreign matter could be present, or the water's condition could prevent the use of another resource. Impaired use can be caused by one or any combination of the following: (1) the water contains and is disseminating pathogenic organisms; (2) the water is nonpotable for human or animal consumption; (3) the water is unfit for aquatic habitat; (4) the water does not meet standards for body contact recreation; and, (5) esthetics in the area are degraded due to odors, accumulation of raw animal waste on roadways, property of others, etc.

Water resources in the watershed are categorized as stream channel flow, impounded water, and groundwater. Figures B1, B2, and B3 (Appendix B) are problem location maps indicating existing or expected damages from dairy animal waste to these resources. Downstream water resources affected are North Bosque River flow, and the impoundments of Lake Waco and proposed Lake Bosque.

The runoff from dairies transports animal waste and soil pollutants in solution and in suspension to adjacent lands and streams. The pollutant load consists of dissolved salts and suspended solids, including bedload and floating solids. The pollutant load originating from the study area consists of about 114 million pounds per year of total solids (Appendix D-2).

Upland storm runoff transports untreated animal waste to the stream channels and results in water quality degradation and water use impairment. Untreated animal waste is the largest contributor to water quality problems in and below the watershed. Runoff has transported untreated solid waste from confinement

areas, leaving deposits on adjacent property, roads and in roadside ditches. Many feeding and watering facilities are located near stream channels. These locations increase the potential for surface runoff pollution.

The following tabulation shows the animal waste loadings in the average annual runoff from dairies with inadequate management systems in the watershed.

Summary of Animal Waste Loadings From Dairies With Inadequate Waste Management Systems 1/

Item	On-Site	Off-Site 2/
Number of Cows	21,520	same
Animal Waste (wet - lbs/yr)	1,121,665,440	same
Total Solids (lbs)	456,517,840	114,129,450
Volatile Solids (lbs)	118,896,540	594,480
TKN (lbs)	6,056,980	30,290
P_2O_5 (total - lbs)	2,916,330	11,680
K_2O (total - lbs)	5,047,500	151,420
Na (lbs)	852,460	59,670

1/ Appendix D contains tables showing a more detailed listing of animal waste loadings in the watershed.

2/ Animal waste loadings in average annual runoff below the dairies.

There are about 420 miles of stream channels in the watershed of which about 190 miles are adversely affected by contaminated water from dairy runoff. Water quality is impaired for recreation, aquatic habitat, social, domestic, and esthetic uses. The impairment ranges from slight to severe. Extremely high fecal coliform concentrations have been measured in storm runoff within the watershed. Water use impairment also ranges from moderate to severe in the North Bosque River below the watershed to Lake Waco, a distance of about 90 miles.

The TSSWCB's, "Management Program for Agricultural and Silvicultural Nonpoint Source Water Pollution in Texas," which includes the Section 319 pollution assessment process, states that the North Bosque River has excessive fecal coliform concentrations. Seven of the nine water samples collected within the Upper North Bosque River watershed by the TWC during 1987 and 1988, exceeded 200 coliforms per 100 milliliters of water. The highest coliform count was 270,000 per 100 milliliters. The TSSWCB's document also states that the watershed is an area "...where agricultural nonpoint source loadings were contributing to a fecal coliform problem."

TWC report Use Attainability Analysis of North, Middle, and South Bosque Rivers Segments 1226 and 1246 identifies "confined" dairy operations as a threat to State water quality standards in the North Bosque River. The report states that most of the contamination from dairy wastes can be expected to occur during high flow or storm runoff conditions. Two samples collected at the mouth of the watershed during May and July of 1989 indicate this problem. The sample taken in May, a relatively high rainfall month, had a fecal coliform concentration of 2,150 cells per 100 milliliters of water. The sample taken in July, usually a lower rainfall month, had only 90 fecal coliform cells per 100 milliliters of water.

On August 13, 1991, after a 3-day 10-inch rain, the TWC took samples of storm runoff in the watershed. The samples were taken in Green Creek near its confluence with the North Bosque River, in North Bosque River at U.S. Highway 377 in Stephenville, and at Hico near the mouth of the watershed (Appendix B-1). These samples contained fecal coliform concentrations of 92,000, 80,000, and 123,000 cells per 100 milliliters, respectively.

Fecal coliform bacteria indicate animal-source pollution and the potential presence of harmful pathogenic organisms. A fecal coliform concentration in excess of 200 cells per 100 milliliters of water is an indication of unsafe conditions for body contact recreational use. Safe drinking water contains no coliform contamination.

Algae blooms have been observed in the North Bosque River during summer months. This indicates excessive nitrate, phosphate, and potassium concentrations, as well as deficient dissolved oxygen. These conditions degrade aquatic life habitat and reduce or eliminate recreational opportunities.

Upper North Bosque River Watershed drains into Lake Waco. The planned Lake Bosque will impound most of the runoff leaving the watershed. Lake Bosque water will be used for domestic water supply in Central Texas. Contaminants in the water require additional time, money, and resources to treat for domestic use, thereby increasing the cost to the consumer.

The following tabulation is a general appraisal of stream channel base flow and storm runoff use impairment.

Use Impairment of Stream Channel Flow
Present Conditions

Attribute	Evaluation Reach 1/							North Bosque River to Lake Waco
	1	2	3	4	5	6	7	
Recreation	S	S	S	S	S	S	M	S
Aquatic Habitat	S	S	S	S	S	S	S	S
Social	S	S	S	S	S	S	S	S
Domestic	S	M	L	L	L	M	L	M
Aesthetics	S	S	S	S	S	S	S	S

Impairment: L = slight; M = moderate, S = severe

1/ Appendix B-1 - Problem Location Map, Stream Flow

Aquatic habitat is degraded and recreational opportunities are limited in water impoundments in the watershed. Some impoundments are totally unsuitable for fishing or other recreational activities because of pollutants washing into the reservoirs. Algae blooms and fish kills identified in the reservoirs of two floodwater retarding structures indicate excessive nutrient concentrations and deficient levels of dissolved oxygen in the water. Air quality and visual attributes in the vicinity of the structures have also been degraded by accumulations of untreated animal waste.

Fecal coliform concentrations greatly exceed Texas Department of Health (TDH) standards in water samples taken from many of the impoundments. The TDH stipulates that water used for cooking, washing dishes, bathing, etc., must meet the same standards set for drinking water, which should contain no coliform cells. Contamination of water in these reservoirs has limited their use for domestic purposes even in emergency situations.

There are 40 floodwater retarding structures in the watershed impounding about 6,110 acre-feet and 1,200 surface acres of water in their sediment pools (Appendix B-2). Twenty-five of these structures impound runoff from dairies as indicated in the following tabulation.

Floodwater Retarding Structures and Impounded Water Affected By Animal Waste Present Conditions

Item	Dairies in Evaluation Reach 1/							
	1	2	3	4	5	6	7	Total
Structures (No.)	5	2	5	5	1	6	1	25
Water Surface (Acres)	111	66	161	189	45	151	26	749
Water Volume (Acre-Feet)	658	217	726	813	198	963	199	3,774

1/ Appendix B - Problem Location Map, Impounded Water

The following tabulation shows the animal waste loadings in runoff from dairies with inadequate management systems above the 25 floodwater retarding reservoirs affected by animal waste.

Animal Waste Loadings From Dairies With Inadequate Management Systems Above Flood Prevention Structures in the Watershed 1/

Item	On-site	Off-site 2/
Number of Cows	13,560	same
Animal Waste (wet - lbs/yr)	706,774,320	same
Total Solids (lbs)	287,657,140	71,914,290
Volatile Solids (lbs)	74,918,080	374,590
TKN (lbs)	3,816,590	19,090
P_2O_5 (total - lbs)	1,837,610	7,340
K_2O (total - lbs)	3,180,490	95,410
Na (lbs)	537,150	37,600

1/ Appendix D contains tables showing a more detailed listing of animal waste loadings in the watershed.

2/ Animal waste loadings in average annual runoff immediately below the dairies.

When excess nutrients, like those in animal waste, find their way into impounded water, blooms or overabundant growth of algae and other aquatic plants can result. Algae blooms at the surface can interfere with photosynthesis of submerged plants by blocking

sunlight, causing them to die. When this happens, dissolved oxygen levels near the bottom drop abruptly because oxygen demand by decomposing plants is great while little or no oxygen is being produced by the dying plants. Some species of fish, as well as other animals lower in the food chain, die because of the low levels of oxygen.

Water use impairment in floodwater retarding structures in the watershed is moderate to severe. Nutrient levels in some of the impoundments are excessive as evidenced by algae blooms and fish kills. Elevated fecal coliform concentrations exceed standards for safe swimming conditions. The following is an appraisal of use impairment of impounded water in floodwater retarding structures in the watershed and in Lake Waco.

Use Impairment of Impounded Surface Water
Present Conditions

Attribute	Evaluation Reach 1/							Lake
	1	2	3	4	5	6	7	Waco
Recreation	S	S	S	S	S	S	S	L
Aquatic Habitat	S	S	S	S	S	S	S	L
Social	S	S	S	S	S	S	S	L
Domestic	S	S	S	S	S	S	S	L
Aesthetics	S	M	M	S	M	M	M	L

Impairment : L = slight; M = moderate; S = severe

1/ Appendix B-2 - Problem Location Map, Impounded Water

Animal waste from dairies is also affecting groundwater quality in the shallow Paluxy Aquifer, which has an extensive recharge area in the watershed. Impairment of water from the Paluxy Aquifer for social, domestic, and esthetic uses is slight to moderate. The potential for fecal and nitrate contamination is high because of improper well head installation and percolation of contaminated water in the recharge area. The deeper Trinity Aquifer does not have a recharge area in the watershed but is subject to contamination through improperly installed well heads. Groundwater can be polluted by leachate from ponds, streams, or by improper land disposal of wastewater and solid manure.

Nitrate and fecal contamination are major causes of groundwater use limitations. These contaminants render water unsafe for drinking and other domestic uses. Excessive nitrate in drinking water has been blamed for a deadly blood disorder of newborn babies called methemoglobinemia (blue babies). Fecal contamination indicates the likelihood of pathogenic organisms in the water and the potential for human health problems.

The perched water table in flood plain alluvium is also subject to animal waste contamination. This water table is closer to the ground surface and does not have the benefit of filtration through thick layers of soil material as does the Trinity Aquifer. The Trinity Aquifer underlies the Glen Rose Formation which serves as a barrier to percolating water. Contaminants originating in the watershed reach the Trinity Aquifer mainly due to inadequate well-head protection and maintenance of areas surrounding the well-head. These contaminants flow directly into the aquifer with only minor filtration that would remove or lessen the pollutants.

Application of large volumes of manure and wastewater on cropland and grassland in the recharge zone is a common method of disposing animal wastes. Proper application provides a way to utilize the nutrients in manure, but excessive rates of application can cause nitrogen, phosphorous, and potassium to percolate to the underlying aquifer.

The following tabulation is an appraisal of use impairment of groundwater in the watershed because of water percolating through the recharge zone into the aquifer.

Use Impairment of Groundwater
Present Conditions 1/

Attribute	Impairment
Social	M
Domestic	M
Aesthetics	L

Impairment: L = slight; M = moderate; S = severe

1/ Appendix B - Problem Location Map - Groundwater

SUMMARY OF DAMAGED RESOURCES

Damaged Resource	Affected Use	Degree of Adverse Affect	Damaging Element	Causative Element
Water (Streams & Lakes)	Fishing, swimming, domestic, irrigation, esthetics	Severe, depending on accumulation of contaminants. Short and long term affect.	Animal waste residue containing nutrients, fecal coliform, salts, and sediment, sewage effluent, solid wastes.	Dairies lacking animal waste management systems. Improper public and private sewage treatment.
Water (Aquifer)	Domestic, irrigation.	Moderate, depend- on accumulation of contaminants. Perhaps long-term affect.	Animal waste residue containing nutrients, fecal coliform, nitrates, salts, sewage effluent	Improperly designed well head, improper septic system, improper spreading of animal waste on aquifer recharge zone.
Land	Agriculture production, recreation, urban development, esthetics	Severe, depending on accumulation of contaminants. Perhaps permanent affect.	Animal waste residue spread on surface by man or water runoff. Excessive nutrients and salts.	Improper disposal of animal waste.
Air	Social	Severe, depending on amount and distribution of raw animal waste and weather conditions such as temperature, rainfall, and wind.	Raw animal wastes, solids and liquids.	Improper disposal of animal waste.
Plants	Vegetative cover	Severe, depending on nutrient and salt content of runoff from dairies.	Raw animal wastes, solids and liquids washing from dairies.	Improper disposal of animal waste.

INVENTORY AND FORECASTING

Scoping of Concerns

Numerous meetings have been held by the sponsors to gain input from individuals and to inform the general public. The purpose of the meetings was to discuss the potential project in order to determine the scope of issues to be addressed and to establish objectives. The landowners and sponsors in attendance expressed their desire to develop animal waste management systems on dairies in the watershed. The concern expressed by all in attendance is the degradation of the water, land, air, plant, and animal resources as well as to prevent further deterioration of these resources.

A subcommittee of the U.S. House of Representatives conducted a congressional hearing at Tarleton State University, of which U.S. Representative Charles Stenholm was a panelist. The hearing was called to review the dairy waste problem and explore methods to reduce water contamination. The meetings and hearing have provided state and local officials, dairy owners and managers, and concerned local organizations and citizens a forum to express their interest and involvement with water quality and related problems.

The local news media has been actively involved with editorials expressing opinions and positions on various aspects of the problem. News media in Fort Worth, Dallas, Waco, and other metropolitan areas across Texas have also reported and editorialized on animal waste conditions in the area.

A broad range of environmental, economic, and social factors was considered during the scoping process to determine the needs of the project. The degree of significance to decision making determined the intensity for each factor studied during project planning. The following is a list of factors considered and their degree of significance.

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EVALUATION OF IDENTIFIED CONCERNS

Economic, Environmental, and Social Factors	Degree of Significance to Decision Making 1/
Land management	High
Prime farmland soils	Low
Erosion	Low
Sedimentation	Low
Water quality	High
Floodwater damages	Low
Water conservation	Low
Municipal water	Low
Recreation	High
Streams and lakes	High
Ground water	High
Fish and wildlife	Low
Wetlands	Low
Endangered species	Low
Social and cultural	High
Transportation	Low
Archaeological resources	Low
Air quality	High
Visual resources	High
Human health and safety	High
Mineral resources	Low

1/ High - Must be considered in the analysis of alternatives

Low - Consider, but not too significant

Land Resources

The 110 dairies in the watershed are operating with a herd of 28,400 milking cows. The following tabulation indicates the number of cows and animal waste produced annually in each evaluation reach.

Current Dairy Herd and Animal Waste Production Present Conditions

Reach	Cows No.	Animal Waste tons/year
1	4,240	110,650
2	630	16,340
3	4,120	107,630
4	555,830	152,150
5	900	23,540
6	12,190	318,020
7	490	12,790
TOTAL	28,400	741,120

The combined dairy herd in the watershed contributes to Erath County's status as Texas' leading county in milk production. Fourteen dairies, with about 6,880 milking cows, have implemented adequate animal waste management systems and associated land treatment practices.

Water Resources

There are about 420 miles of stream channels in the watershed. The following tabulation indicates miles of stream channel per evaluation reach (Appendix B) affected by runoff from dairies.

Stream Channels Affected by Dairy Runoff Present Conditions

Reach	Total Miles	Affected Miles	% of Total
1	103	52	50
2	17	12	74
3	43	17	40
4	76	26	34
5	34	18	53
6	120	50	38
7	17	15	88
TOTAL	420	190	45

There are 90 miles of North Bosque River channel from the mouth of the watershed to Lake Waco. Lake Waco impounds 151,900 acre-feet of water covering 7,270 surface acres.

Water covers 2,680 surface acres in the watershed. The floodwater retarding structures sediment pools account for about 1,200 acres.

The Paluxy Aquifer and the Trinity Aquifer are important sources of groundwater for watershed and area residents. The Paluxy Aquifer is relatively shallow and has an extensive recharge area in the watershed (Appendix B). It furnishes water mostly for rural domestic uses. The Trinity Aquifer is delineated on the "Major Aquifers Of Texas" map as published by the Texas Water Development Board. It is a vast aquifer furnishing large quantities of high quality municipal, industrial, agricultural, and rural domestic water for a large portion of central Texas. A perched water table is present in Recent Alluvium (Appendix B) during wet seasons.

Land Use

Following is an estimate of current land uses within the watershed.

Current Estimated Watershed Land Use

Land Use	Acres	Percent
Cropland	20,720	9.0
Rangeland	135,950	59.0
Pastureland	55,370	24.0
Water	2,680	1.0
Other 1/	15,040	7.0
Total	229,760	100.0

1/ Includes 1,340 acres for dairy barns, pens, etc.

Wildlife Resources

The majority of the watershed consists of upland areas of sandy soils, much of which has been converted from cropland to grass. The main crops grown in cultivated areas are small grain, forage sorghum and peanuts. Abandoned cropland and fields converted to grass have been invaded by post oak and blackjack oak. The principal grasses are little bluestem, indiangrass, sand lovegrass, purpletop and wildrye. Wild plum motts enhance the habitat for bobwhite quail. Large numbers of mourning dove, bobwhite quail and a few Rio Grande turkey utilize the habitat.

Whitetail deer occupy areas with woody vegetation which provides food and cover. Other wildlife in the watershed are songbirds, fox squirrel, cottontail rabbit, nine-banded armadillo, bobcat, coyote, raccoon, opossum, and red and gray fox.

Another upland habitat consisting of more clayey soils over limestone is intermingled with the sandier areas. This habitat is a combination of cultivated areas, open prairie, and steep limestone hills. Crops grown include small grains and sorghum. Open prairies support native grasses such as bluestems, indiangrass, sideoats grama, switchgrass, tall grama, and Texas wintergrass, and scattered motts of liveoak trees. Ashe-juniper has invaded the oak woodlands on the steep limestone hills. These steep areas normally exhibit better range condition than most of the other sites with grass composition similar to the open prairies. Sparse cover in the majority of this habitat limits numbers of deer except in the steeper areas. Raccoon, bobcat, rabbit, skunk, coyote and fox also occupy this habitat. Quail and dove are plentiful, songbirds are common and turkey are scarce.

Riparian habitat on deep, loamy flood plain soils along the North Bosque River supports the greatest plant diversity and is of the highest value to wildlife. Much of this habitat is farmed in peanuts, small grain, and sorghum. The frequently flooded areas are mostly in bermudagrass pastures and pecan trees. Native grasses in this area are indiangrass, switchgrass, little bluestem, Canada wildrye, Texas wintergrass and vine mesquite. Liveoak, elm and hackberry are also present on this site. Significant numbers of deer, squirrel and turkey are found in this habitat. Waterfowl and wading birds utilize areas adjacent to the major streams.

Wildlife is scarce in the vicinity of the dairies. Dairy facilities generally consist of milking barns, feed lots, confinement areas and waste storage ponds. Livestock remain confined to these areas which are generally devoid of all vegetation. Most vegetation in these areas is along fence rows and is mostly invading grasses and forbs such as johnsongrass, threeawn, dropseed, buffalograss, ragweed, croton, broomweed and carelessweed. This vegetation provides some habitat elements for mourning dove, bobwhite quail, various song birds, rodents, and small mammals. Livestock are excluded from waste storage ponds, most of which have their embankments established to bermudagrass. Waterfowl and wading birds have been observed utilizing waste storage ponds and surrounding areas.

Fishery Resources

The North Bosque River, farm ponds, and floodwater retarding structures provide the major fishery habitats in the project area. Numerous small intermittent streams are also present. However, these small streams provide very little, if any, fishery habitats.

Impoundments providing suitable habitats are generally stocked with black bass, channel catfish, blue catfish, and sunfish.

The North Bosque River and other bodies of water under pristine conditions in the watershed supported a viable fishery population. However, contaminated water has destroyed the suitable habitat and eliminated most of the fishery resources in the watershed.

Threatened and Endangered Species

An informal consultation on endangered species within the project counties was conducted with the U.S. Fish and Wildlife Service in August 1991. According to this consultation, three endangered species may occur in Erath and Hamilton Counties: the whooping crane (*Grus americana*), the black-capped vireo (*Vireo atricapillus*), and the golden-cheeked warbler (*Dendroica chrysoparia*).

The whooping crane is known to migrate through the area in the vicinity of the Upper North Bosque River Watershed. The whooping crane winters on the Texas Gulf Coast; however, during migration it has been known to occur along rivers, shallow wetlands, reservoirs, as well as in croplands such as small grain fields.

Black-capped vireo habitat consists of small motts of scattered trees (mainly oaks and small cedar) and numerous dense clumps of brush growing to ground level, interspersed with open areas of bare ground and rocks. Associated plant species are Texas oak, cedar, sumac, persimmon, elbow bush, deciduous holly, and yaupon.

The golden-cheeked warbler prefers woodlands which contain mature junipers (cedars) for use in nest building and an oak/mixed hardwood component for foraging activities. In addition to mature cedars, associated plant species include Texas, live, or Spanish oak; elms, hackberry, and ash. Some or all of these types of vegetation occur in places in the watershed. However, the dairy pens and areas that might be disturbed by this project have been denuded and do not contain habitat for any of the listed species.

Wetlands

Natural wetlands in the project area are intermittent Riverine systems occurring along the North Bosque River. Limnetic and Littoral Lacustrine Wetlands (man-made wetlands) occur in the numerous farm ponds and flood prevention sediment pools in the watershed. Many of the wetlands are adversely affected by animal wastes from the dairies.

Local Economy

Agricultural production and related businesses dominate the economy of the watershed and surrounding area. Over 80 percent of the $48 million average annual income in Erath County is from

dairy products, beef cattle, and other livestock. Another major agricultural enterprise in the area is horticultural products such as trees and ornamental plants. Crops produced in the area are small grains, fruit, melons, sorghums and peanuts.

Farms in Erath County are typically small family operated units. Products from each farm have an average market value of $70,300. Production expenses averaged $52,400 per farm. There are about 1,600 farms in Erath County, which is representative of the watershed. The average size farm is 350 acres which is less than the state average of 690 acres. About 90 percent of the farms are operated by the owners and 10 percent by tenants. Most of the dairies operating in the area have relatively small tracts of land and utilize an intensive pen (confined) feeding system.

The dairy industry is a major component of the area's economy and is continuing to expand each year. Erath County is the leading county in Texas in the production of milk products and is second in the number of dairy cattle. The dairy industry has spawned related enterprises in the area. Suppliers of dairy equipment, feed, veterinary services, and a cheese production plant are examples of industries located in the area.

The transportation industry is also important to the area's economy. The watershed has 449 miles of roads. Approximate distances from Stephenville to major urban areas are: Fort Worth-Dallas, 70 miles; Waco, 80 miles; Austin, 140 miles; Abilene, 90 miles; and San Antonio, 200 miles.

Income Distribution

County-wide, the unemployment rate is 4.7 percent. Per capita income is $13,391 with an average weekly wage of $281.43. Estimated local tax base is $1,174,853,000.

With 16.9 percent of the population under the poverty level in 1991, Erath County spent $5,706,000 on welfare.

Cultural and Historic Resources

Early history of the watershed area dates back to the aboriginal populations of Central Texas. Four broad stages of development have been recorded:

Paleo-Indian	10,000 - 6,000 B.C.
Archaic	6,000 B.C. - A.D. 500
Late Prehistoric	A.D. 500 - A.D. 1600
Historic	A.D. 1600 to Present

The earliest evidence of human occupation was by Clovis hunters (9500 - 9000 B.C.). Evidence for Early and Middle Archaic periods occupation is based on projectile point styles that have been recovered. However, no archaeological sites of this period have been excavated and reported in this watershed.

Populations of the area seems to have increased during the Late Archaic period. In the Late Prehistoric period, sites tend to cluster around water sources and rock shelters become extensively occupied. There is little evidence of occupation of the area during the period A.D. 1500 to 1750.

Only 28 archaeological sites have been recorded in Erath County. Most of the recorded sites are indicative of sporadic occupation and short term utilization by hunting and gathering groups. All sites are relatively small.

European settlement of the area was attempted as early as 1825 but it was not until 1854 that settlers under John M. and William F. Stephen founded the city of Stephenville. Railroads came to Erath County in the 1880's. In 1886 William and Harvey Johnson purchased the 2,302 acre Pedro Herrera Survey in Erath and Palo Pinto Counties and organized the Johnson Coal Company. After two years the mine was sold to the Texas Pacific Coal Company which operated until 1921. The manufacture of brick and tile was also an early industry in the town of Thurber in northwest Erath County. Oil production was a major industry in the late 1940's.

The Thurber Historic District, located a few miles north of the watershed, is on the National Register of Historic Places as are the Bluff Dale Suspension Bridge, Col. John D. Berry House in Stephenville, and the Erath County Courthouse in the public square in Stephenville.

The project area and surrounding areas are known to contain Indian campsites, chipping stations, rock shelters, burned rock middens and historical sites relating to the early railroad, coal, oil, cotton and tile/brick industries.

Recreational Resources

A 30-acre park on the North Bosque River provides facilities for year-round recreational opportunities to area residents. The City of Stephenville has plans for an additional 30 acres to expand the park due to increasing demand for outdoor and water-related recreation. Facilities in the park include:

Tennis Courts - 4
Ball Fields - 10
Picnic sites - 40
Camper sites - 12 permanent and 20 temporary
Pavilion - covered - 2
Gazebo - 1
Stage area - 1 (used for concerts and other entertainment)
Walking trail along the river - 1.2 miles
Foot bridge across the river - 1
Fishing pier - 1 (closed, not being used because of poor water quality)
Play ground - 1 (swings, see-saw, climbing)
Motorcycle trail

Physical exercise area - 1 (chining bars, parallel bars, etc.)
Horseshoe pits - 20
Washer pits - 40
Restrooms - 3
Swimming pools - 1 (concrete)

The park is available for use 12 months per year, 24 hours per day. The park is used throughout the day and evenings. Visitors come to eat or just enjoy the river walk. It is estimated that over 100 people use the facilities for picnic purposes daily. Much of the use consists of these unorganized activities. Organized activities are provided through the City Park and Recreation Department and are very popular with area residents. Local officials estimate the total visitor days to be 478,000 annually.

The river through the park contains water all year. One area of the river has water estimated to be 12 feet deep. Water is used for irrigation in the park during dry periods.

City officials report complaints about unpleasant odors in the park. The river in the park has been declared not suitable for water contact activities. Activities have been relocated from the water's edge because of the poor water quality and odors.

The proposed park expansion will provide needed area for additional facilities. Present facilities receive heavy use, but City officials stated that improving the quality of the water in the river "would improve the park 100 percent."

Forecasted Conditions

The future without project conditions, based on the existing technical and financial assistance programs, including the HUP activities, will improve water quality. However, untreated animal waste from at least 31 dairies will continue to contaminate resources in and below the watershed. The combined herd of the 110 dairies, depending on market conditions, is expected to increase from the current 28,400 cows to 40,500 cows. Consequently animal waste production could increase from 741,120 tons to about 1,056,700 tons per year.

Plans by the City of Stephenville to enlarge the City's sewage treatment plant will improve water quality below the City, especially during the summer months. During summer months, stream flow in the North Bosque River below the City is augmented by treated effluent from the sewage treatment plant. Enlarging the sewage treatment facilities will remove potential water quality problems related to population increases in the City.

Information programs through the HUP for improved installation and management of household septic tanks and well-head protection will reduce the possibility of groundwater contamination from these sources.

Public Involvement and Interagency Coordination

It is common knowledge that an extensive source for water pollution exists in the watershed due to the immense quantities of animal waste produced each year. As a result of this public awareness, city, county, state, and federal agencies are working to prevent surface runoff and ground water contamination. The resources of local, county, state and federal agencies are needed to solve and prevent water quality problems. The complexity of the problems require a multidisciplinary approach to formulating and implementing solutions. The general awareness of water quality problems has resulted in private and public application of expertise, authority, and funds in a comprehensive water quality resource plan. The Upper North Bosque River HUP, along with this PL-566 plan, is an integral part of the water quality resource plan.

The project objective is to improve and maintain good water quality in and below the watershed. This objective is supported by the TWC, TDH, the Brazos River Authority (BRA), and the U.S. Environmental Protection Agency (EPA).

Local residents are determined to prevent water quality problems. This is evidenced by general awareness of the problems and the willingness to express their concerns in public meetings. Also, local units of government in conjunction with state and federal agencies are working to resolve existing water quality problems.

The Erath County Commissioners Court has enacted rules and standards for installation and maintenance of private sewage systems in the county. New systems must obtain a license for installation after an acceptable design, considering site-specific conditions, has been submitted to county authorities. The standards for design are those published by the TDH.

The watershed and vicinity are within an area proposed for detailed study by the TWC for designation as a "critical area" relative to potential underground water problems. The TSSWCB, under contract with the TWC, has carried out a rural domestic water well monitoring program to establish a data base for determining cause-and-effect of current and potential contamination sources. Unprotected wells are a direct conduit to ground water. Consequently the TWC has published rules and established standards for well-head design and installation. The rules and standards are applicable to all water wells.

The TWC has statutory authority to publish water quality standards and establish rules to enforce the standards when applicable to

streams affected by runoff and effluent from dairy operations in Texas. With reference to the 25-year frequency, 24-hour duration storm, the TWC states in its rules for livestock and poultry production operations, "It is the policy of the Texas Water Commission that there shall be no discharge of waste/or wastewater from concentrated animal feeding operations into the waters in the state, but rather these materials shall be retained and utilized or disposed of on agricultural land".

The TWC requires dairies with a confined herd of more than 250 milking cows to submit an acceptable animal waste management plan and obtain an operational permit. Dairies with fewer than 250 confined milking cows should obtain a "letter of concurrence" from the TWC. Dairies not in compliance with applicable rules and standards are subject to TWC fines.

The Farmers Home Administration (FmHA) is requiring TWC operational permits or "letters of concurrence" as a condition for processing loans for dairy operations. Many commercial lenders have also implemented similar policies. As dairies comply with TWC rules, they may be considered for loans from these lending agencies.

The local soil and water conservation districts, the TSSWCB, and SCS are assisting dairies in installing animal waste management systems. At the request of the individual dairy operation, SCS technical assistance is provided in designing and implementing animal waste management systems and related best management practices (BMPs). Also, several engineering consultants are designing waste management systems for the larger dairies. However, the urgent need and demand for assistance exceeds that which can be provided under existing programs.

The SCS, TSSWCB, TAEX, ASCS, TWC, BRA, Texas Air Control Board (TACB), and the project sponsors (local soil and water conservation districts) are emphasizing the urgent need for implementation of adequate animal waste management systems and associated BMPs. This emphasis is indicated by SCS, TAEX, TSSWCB, and ASCS co-leadership in the Upper North Bosque River HUP.

Agricultural Conservation Program (ACP) funds, ACP Special Funds and Great Plains Conservation Program (GPCP) funds are being utilized for cost-share installation, but they are not sufficient to fulfill the need and demand. Other sources of cost-share funds, such as PL-566 funds, are needed to compliment and accelerate the implementation of adequate waste management systems and associated land treatment practices.

FORMULATION OF ALTERNATIVES

General

Project formulation followed the specifications in the "Principles and Guidelines for Water and Related Land Resource Problems". Formulation also followed the inventory, forecasting, and analysis of water and land resource conditions relevant to the identified problems and opportunities.

It was assumed that non-agriculture-related sources of water quality pollution will be addressed by other plans and actions on-going in the area. Water quality problems caused by non-agricultural activities, such as effluent from Stephenville's sewage treatment plant, are being addressed by the City of Stephenville.

The watershed was studied in detail to determine the location and extent of the problems. Following this study, the scoping process was used to identify problems relevant to project action. Water quality problems caused by dairies with inadequate animal waste treatment facilities was determined to be the problem that could be treated with a PL-566 project. Assessments identified 96 of the 110 dairies in the watershed in need of one or more practices or system of practices that relate to water quality. These dairies are the ones that warrant project action.

A PL-566 Watershed Protection Plan, ACP Special funds, and GPCP funds in addition to on-going SCS conservation operations in the watershed are needed to correct the identified water quality problem within an acceptable timetable. The public's desire to prevent further water quality impairment and maintain good water quality in and below the watershed incited the need to develop alternatives for immediate action.

The sponsors determined that a 70 percent minimum reduction in dairy pollutant load would achieve the sponsors' objectives. To accomplish this goal at least 81 existing dairies will need to implement effective animal waste management systems. It was determined PL-566 funds could assist 31 dairies implement animal waste management systems and ACP special funds and GPCP funds would assist an additional 50 dairies install waste management systems.

Alternatives considered for PL-566 plan selection adhere to applicable federal and state statutes. Preauthorization and post-authorization planning activities have been carried out in accordance with the National Watershed Manual, as revised, which includes National Environmental Policy Act planning criteria. Planning was coordinated with federal, state, and local agencies, private organizations and individuals with interests relative to water quality problems. Alternatives considered the desires and needs expressed by individuals and the public in general.

SCS planning activities for protecting and preserving cultural resources will be in accordance with the Programmatic Memorandum of Agreement with the Advisory Council on Historic Preservation. The procedures published in the SCS General Manual, Title 420, Part 401, will be followed. In addition, impact areas will be evaluated by SCS prior to disturbance to determine if cultural resources may exist. If found, SCS will take appropriate action to avoid adverse effects on them.

For maximum effectiveness, planning and design of on-site waste management systems and associated land treatment practices must be based on individual site conditions such as: soil type, topography, distance to stream channels, land use, vegetative types, management techniques and size of dairy operation. As needed, data from soil and water sample analyses will be utilized to design waste management systems for site-specific conditions. Utilization of wastes on agricultural land will be within environmentally acceptable procedures to assure nitrogen, phosphorus, and potassium balance on pastureland, rangeland, and cropland.

On-site waste management systems include waste storage ponds constructed on individual dairies with a minimum capacity to impound applicable surface runoff from a 25-year, 24-hour rainfall event in addition to dairy operations effluent. The waste management systems would generally: (1) divert runoff volume away from pens and corrals; (2) decrease the use of uncontaminated water and recycle wash and flush water; (3) decrease, or eliminate, contaminated runoff and wastewater discharging into watercourses; (4) minimize solid waste transport to watercourses; and (5) utilize nutrients in animal wastes by applying it to cropland and pastureland.

Where applicable and practical, new concepts and technologies in waste management systems will be incorporated into viable alternatives. It is anticipated the research at Tarleton State University and the Upper North Bosque River HUP now in progress will generate new and unique methods and designs for treating animal waste. For example, "constructed wetlands" are being evaluated for treatment of liquid wastes. Also, adapted computer models, such as SWRRB, EPIC and GRASS, are expected to be useful in planning waste management systems and measuring their effectiveness.

Transport of animal wastes to an off-site composting and processing facility is an alternative in lieu of on-site waste management and treatment. However, the TWC rule with respect to no surface runoff from the 25-year, 24-hour storm would remain in effect for the participating dairies and the composting locations.

Studies are on-going by TAES and TAEX to develop a functional off-site method for composting, processing, and recycling of dairy waste. The purpose of the research is to evaluate the economic feasibility of large scale (off-dairy) alternatives for recycling

and treating animal wastes. Methods being studied are dehydration, custom hauling to agricultural fields, and composting.

Off-site composting and processing would consist of one or more locations with required facilities. This includes buildings, machinery and adequate acreage. Dependable quantities of suitable bulking agents such as newspaper, cardboard, peanut hulls, cotton gin trash, cornstalks, straw, pecan shells, wood chips, municipal solid waste, sewage sludge, etc., would be necessary. Temporary storage and drying facilities would be needed at the individual dairy locations. A means of transporting the waste solids to the composting plant also would be required. A sustained long-term market and use or disposal area for treated waste would be necessary. Current research indicates a 720 cow dairy using this process would produce 10,758 tons of compost per year.

Because of the complex problems and uncertainties, the long-term studies needed to arrive at a conclusion, and the urgency for immediate action, off-site animal waste disposal is not considered a viable alternative for this PL-566 project.

DESCRIPTION, COSTS, AND EFFECTS OF ALTERNATIVES

Alternative 1: No PL-566 Watershed Protection Project Action

This course of action will continue without the financial and technical assistance a PL-566 watershed protection plan would provide. Government agencies, federal, state and local, will continue to be active in implementing their standards and programs for improving water quality.

The TWC can be expected to assert its statutory authority to determine and publish water quality standards and enforce applicable rules relative to dairy runoff and well-head protection. Erath County will proceed with enforcement of its rules and standards governing the installation of septic tank systems. The city of Stephenville can be expected to carry out its planned expansion of the sewer treatment plant and storm runoff drainage system.

The Sponsor's soil and water conservation programs, the Leon-Bosque RC&D Project and the Upper North Bosque River HUP will continue. Other programs will continue to function as funded. These sources of technical and financial assistance will be inadequate for timely implementation of animal waste management systems for about one-third of the dairies in the watershed. Inadequately managed and untreated animal waste from these dairies will continue to impair surface and groundwater quality.

There would be no PL-566 project related installation and implementation costs. All PL-566 watershed protection project benefits would be foregone.

Alternative 2: A program of on-site animal waste management and land treatment practices.

This alternative would function in concert with ACP Special cost-share funds, GPCP cost-share funds, and SCS conservation operations to implement a program to improve water quality in and below the watershed. This alternative would provide technical and financial assistance to 31 dairies in the Upper North Bosque River Watershed to install adequate animal waste management systems.

The systems would consist of practices such as waste storage ponds, diversion terraces, grassed waterways, and pond sealing or lining. Other related practices include nutrient management, waste utilization, crop residue use, conservation cropping sequence, pasture-hayland management, proper grazing use, and deferred grazing. Appendix D-3 contains a case study of animal waste management systems.

State rules and standards for confined dairy animal waste treatment and management are published by TWC. If disposal is by

land application, untreated solid wastes must be properly distributed on agricultural land. State rules and standards require that dairy runoff from a 25-year, 24-hour storm be impounded on-site. The waste storage ponds designed to hold this runoff must also meet minimum permeability specifications to prevent excessive seepage and aquifer contamination. By containing animal wastes in an area with restricted permeability, less pollutants will be available to contaminate surface and groundwater.

This alternative would provide PL-566 funds to 31 dairy operators with inadequate on-site animal waste management systems. Financial assistance will be available to existing dairies only. Cost-share rates will be 65 percent of the average cost of installing enduring practices in the animal waste management systems and associated land treatment practices. Management practices are not eligible for financial assistance. Technical assistance will be provided for the design, installation, and management of animal waste management systems and associated land treatment practices.

Costs

The installation period is ten years. Total installation cost is shown in Table 1. The evaluation period will be 25 years.

Preliminary estimates indicate annualized off-site benefits, at an 8.5 percent discount rate, to be $187,370. Annualized costs, including operation and maintenance, are calculated to be $155,810. Therefore, the benefit-cost ratio would be 1.2:1.0.

Effects

This alternative will provide off-site and downstream water quality related benefits in addition to on-site benefits realized for individual dairy operations. These public benefits relate to enhanced recreational opportunities, aquatic habitat, social and esthetic attributes, and domestic uses. Water quality in and below the watershed will be improved by a 70 percent reduction in contaminants washed from the dairies.

The following tabulation lists the damaged resources, primary use of the resource, and major contaminants that will be reduced by installation of project measures.

Summary of Benefits From Implementing Alternative 2

Damaged Resource	Use of Resource 1/	Contaminants Reduced 2/
Water		
Streams	a,b,c,d,e,f,g,h	1,2,3,4,5,6,7,8
Lakes	a,b,c,d,e,f,g,h	1,2,3,4,5,6,7,8
Aquifer	d,g,h	1,2,3,5,6
Soils	a,c,d,e,f,i	1,3,4,5,8
Air	a,c,d,e	9,10
Plants	a,b,d,e,f	1,3,4,5,8
Animals	a,b,c,d,e,f	3,5,8,9,10

1/ a - recreation
b - aquatic habitat
c - social uses
d - domestic uses
e - esthetics
f - wildlife habitat
g - livestock water
h - irrigation
i - crop production

2/ 1 - nutrients
2 - fecal
3 - salts
4 - sediment
5 - pesticides
6 - septic effluent
7 - municipal effluent
8 - solid waste
9 - ammonia
10 - dust

This alternative will provide for sustained long-term water quality improvement in and below the watershed as well as on-farm soil and water quality improvement. It will improve recreational opportunities in area lakes and on the North Bosque River. Major benefits will accrue to the Stephenville City Park where visitor days will be enhanced because of elimination of objectionable odors and poor water quality.

The visual resource will be enhanced by changing manure-clogged streams to streams with improved water quality. It will eliminate unsightly deposits of animal wastes from roadways and other property downslope of the treated dairies.

This alternative will enhance the dairy industry locally by making treated dairy pens and associated real estate free from unmanaged animal wastes. It will encourage sustained operations and expansion of related enterprises. Metropolitan areas in Texas will continue to be supplied with milk and milk products that are produced within the local area.

Summary of Plans

Alternative 1 will allow the future without project conditions to occur. On-going programs for soil conservation technical assistance and limited financial assistance will be inadequate. Untreated animal waste will accumulate and impair water, land, and other resources in and below the watershed.

Alternative 2 will provide for technical and financial assistance to install animal waste management systems on 31 dairies in the watershed in a timely manner. Animal waste loadings in watershed runoff will be reduced by about 70 percent. Water, land, air, plant, and animal resources will be improved.

SUMMARY AND COMPARISON OF PLANS

Effects	Alternative 1 (No PL-566 Action)	Alternative 2
Description of Alternative	No treatment	Animal waste mgt. systems on 31 dairies
Project Investment	0	$ 2,050,400
Adverse Annualized	0	$ 155,810
Beneficial Annualized	0	$ 187,370
Net Monetary Benefits	0	$ 31,560
Water	Continued degradation of water quality because of increasing load of nutrients, fecal coliform, salts, sediment, pesticides, etc.	Sustained, long-term improvement of water quality because of reduced discharge of pollutants from untreated dairy pens.
Land	Continued degradation of land due to accumulation of animal waste.	Sustained, long term improvement of soil resources because of implementation of plans to manage application of animal waste.
Air	Continued degradation of air quality due to uncontrolled dust and gasses such as ammonia from dairies.	Improved air quality because of management of animal waste.
Fish and Wildlife	Continued degradation of fish and wildlife habitat due to untreated animal waste on land and in water.	Improved fish and wildlife habitat because of management of animal waste.

Area Economy	Danger of economic failure due to adverse effect of increasing problems of accumulating amounts of animal waste.	Protection and improvement of area economics through continued expansion of dairy industry and related enterprises.
Human Resources	Degradation of quality space for people to live, work, and play due to impairment of natural resources in area.	Improvement of environment for people to live, work, and play.

Project Interaction

This project will work in concert with the Upper North Bosque River HUP which is a cooperative plan to deal with animal waste problems in the acre watershed. The Soil Conservation Service, Texas Agricultural Extension Service, Agricultural Stabilization and Conservation Service, and Texas State Soil and Water Conservation Board are lead agencies in the project. The purpose of the project is to significantly reduce or prevent pollution in surface water and groundwater.

The HUP plan calls for construction and operation of animal waste management systems and related land treatment practices. Special project funding is being made through ASCS and SCS programs. This PL-566 project is needed to provide additional technical and financial assistance to facilitate animal waste management systems and associated land treatment.

This plan will accelerate land treatment and technical assistance without duplication of current programs.

Risk and Uncertainty

All data used in evaluating and establishing future conditions in the watershed are based on recent history. Agricultural production estimates are based on local records of farm and ranch units. The net benefits of the recommended plan exceed the cost of the planned measures without consideration of any projections. Therefore, the uncertainty aspects of projections for project justification are not applicable. The participation of individual land users is entirely voluntary. Interviews with community leaders and land users indicate that 31 dairies with identified problems will participate in this project.

Rational for Plan Selection

Alternative 2 is the recommended plan. It provides for waste management practices that are acceptable to the land users, project sponsors, and SCS. These practices, when properly applied and maintained, will accomplish the project goals. There are no unresolved conflicts or objections to the recommended plan.

RECOMMENDED PLAN

General

The recommended plan consists of applying best management practices to adequately manage animal waste on 31 dairies. The practices consist of waste storage ponds, diversion terraces, grassed waterways, and pond sealing. Associated land treatment practices include nutrient management, waste utilization, crop residue use, conservation cropping sequence, pasture-hayland management, proper grazing use, and deferred grazing. Appendix D-3 contains a case study of animal waste management systems.

Animal waste management systems will assure that dairy runoff from a 25-year, 24-hour storm would be impounded on-site. The holding pond reservoirs for this runoff will meet minimum permeability specifications to prevent excessive seepage and aquifer contamination. By containing animal wastes in an area with restricted permeability, less pollutants will be available to contaminate surface water and groundwater.

Cost and Benefits

Preliminary estimates indicate annualized off-site benefits, at an 8.5 percent discount rate, to be $187,370. Annualized costs, including operation and maintenance, are calculated to be $155,810. Therefore, the benefit-cost ratio would be 1.2:1.0.

The PL-566 cost-share rate will be 65 percent. Either the actual cost, not to exceed established average cost, or the average cost, will be used to determine payment per practice. Cost-share payments to land users will be made by SCS after a planned eligible practice in the contract has been completed and certified. Payment will be based on cost-share documents prescribed by SCS. Participants must file a claim to SCS for payment.

Operation and maintenance costs are the responsibility of the individual land user who agrees to apply the practices according to the long-term contract between the land user and the SCS. Upon completion of the contract, the land user is expected to continue the operation and maintenance through an agreement with the local soil and water conservation district.

Purpose and Summary

The recommended plan is Alternative 2. Purpose of the project is to improve water quality in and below the watershed. The project will provide assistance to 31 dairies to implement a waste management system designed to reduce off-farm runoff of pollutants from the 25-year, 24-hour storm event. Project installation period is ten years.

Plan Elements

Funds provided by this plan will be used to design and install animal waste management systems and related land treatment practices. The existing ASCS cost-sharing programs will be unaffected by the actions of this watershed plan.

Project funds will made available to provide technical assistance for conservation planning and/or application. Additional funds will be available for cost sharing to install conservation practices. The project map (Appendix E) shows the location of the dairies eligible for project participation. Specific locations of identified dairies eligible for cost-share assistance are on file in the local SCS field offices.

Animal waste management systems will be planned on-site with the owner. Studies show that management practices and enduring practices are needed to reduce the pollutant load leaving the dairy. The management and enduring practices which proved to be economically feasible and environmentally perferable are listed below.

Management practices:	Enduring practices:
Pest Management	Waste Treatment Lagoon
Nutrient Managment	Waste Storage Structures
Waste Utilization	Terraces
Conservation Cropping Sequence	Diversions
Crop Residue Use	Sediment Basins
Pasture-Hayland Management	Grassed Waterways
Proper Grazing Use	Pond Sealing
Deferred Grazing	Critical Area Planting
Contour Farming	Ponds
Irrigation Water Management	Irrigation Systems
Waste Management Systems	Waste Storage Pond

Other approved practices listed in the Field Office Technical Guide may be used if they are economically and environmentally feasible and meet the goals of the project.

Permits and Compliance

Section 404 of the Clean Water Act regulates the discharge of dredged and fill material into waters of the United States, including wetland. The need to obtain a Section 404 permit will be determined by individual dairy owners before any work begins. Landowners should obtain permits from the Texas Water Commission and the Texas Air Control Board and other state agencies as required.

Installation and Financing

Project practices have been planned and funds scheduled to be obligated during a 10 year period. Technical assistance is included for the last three years to maintain contracts still in effect. The following tabulation shows the obligations for each year during the installation period.

Schedule of Obligations

Year	Element	PL-566 Funds (dollars)	Other Funds (dollars)	Total Funds (dollars)
1	Waste Management Systems	142,400	76,600	219,000
	Project Administration	5,100	1,100	6,200
	Technical Assistance	17,600	0	17,600
	Subtotal	**165,100**	**77,700**	**242,800**
2	Waste Management Systems	142,400	76,600	219,000
	Project Administration	5,100	1,100	6,200
	Technical Assistance	31,000	0	31,000
	Subtotal	**178,500**	**77,700**	**256,200**
3	Waste Management Systems	142,400	76,600	219,000
	Project Administration	5,100	1,100	6,200
	Technical Assistance	31,000	0	31,000
	Subtotal	**178,500**	**77,700**	**256,200**
4	Waste Management Systems	177,900	95,800	273,700
	Project Administration	6,300	1,400	7,700
	Technical Assistance	42,800	0	42,800
	Subtotal	**227,000**	**97,200**	**324,200**
5	Waste Management Systems	177,900	95,800	273,700
	Project Administration	6,300	1,400	7,700
	Technical Assistance	45,600	0	45,600
	Subtotal	**229,800**	**97,200**	**327,000**
6	Waste Management Systems	177,900	95,800	273,700
	Project Administration	6,300	1,400	7,700
	Technical Assistance	48,700	0	48,700
	Subtotal	**232,900**	**97,200**	**330,100**
7	Waste Management Systems	142,400	76,600	219,000
	Project Administration	5,100	1,100	6,200
	Technical Assistance	46,000	0	46,000
	Subtotal	**193,500**	**77,700**	**271,200**
8	Technical Assistance	21,700	0	21,700
	Subtotal	**21,700**	**0**	**21,700**
9	Technical Assistance	14,400	0	14,400
	Subtotal	**14,400**	**0**	**14,400**
10	Technical Assistance	6,600	0	6,600
	Subtotal	**6,600**	**0**	**6,600**
TOTAL		**1,448,000**	**602,400**	**2,050,400**

Responsibilities

Animal waste management systems will be planned and established during the project installation period by land users in cooperation with their soil and water conservation district. Governing bodies of these districts will arrange for meetings to promote installation of conservation practices. A conservation plan of operations (long-term contract) will be developed between individual land users and SCS. The conservation plan of operations will specify practices to be installed, an installation schedule, and an operation and maintenance agreement.

Land users will be responsible for making all necessary arrangements to assure planned work is started and completed in accordance with the conservation plan of operations.

Technical assistance will be provided by SCS to plan and apply land treatment practices.

Contracting

Conservation practices will be applied by means of long-term contracts between the SCS and participants. Eligible practices will be cost-shared. The conservation plan of operations will be used as a basis for developing the long-term contract to solve identified problems. The plan is to include a combination of conservation practices that, when installed, will provide the treatment required to solve the identified problems to the degree needed to meet the objectives of the project. Cost-shared amounts and formulation of the contracts will follow the guidance in the SCS General Manual and the National Contracts, Grants, and Cooperative Agreements Manual which is in existence at the time the contract is written.

Cultural Resources

SCS planning activities for protecting and preserving cultural resources will be in accordance with the Programmatic Memorandum of Agreement with the Advisory Council on Historic Preservation and the State Historic Preservation Officer. The procedures published in the SCS General Manual, Title 420, Part 401, will be followed. In addition, impact areas will be evaluated by SCS prior to construction to determine if cultural resources may exist. If significant resources exists, SCS will take appropriate action to avoid adverse effects on them.

If any cultural resource is discovered during application of the planned practices, the resource will be protected from further disturbance. The SCS will notify the land user and the State Historic Preservation Officer. The SCS will take appropriate action to protect any significant cultural resources and avoid adverse effects on them.

Financing

Federal assistance will be provided under authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666), as amended. The balance of funds will be furnished locally.

Federal assistance is subject to the appropriation of funds for the application of project practices.

Noncost-shared management practices, such as crop residue use, contour farming, and conservation cropping sequence, will be required as a condition to cost-shared assistance for other practices to achieve project objectives. Noncost-shared management practices will be installed concurrently with cost-shared enduring practices.

Operation and Maintenance

Operation is the administration, management, and performance of non-maintenance actions needed to keep a completed conservation practice safe and functioning as planned.

Maintenance includes preventing deterioration of applied conservation practices and repairing damage to, or replacement of the practice, if one or more of its components fail. Damages to completed practices caused by normal deterioration, drought, rainfall in excess of design rainfall, or vandalism is considered maintenance.

The land user will be responsible for operation and maintenance (O&M) of installed practices. O&M requires effort and expenditures by the land user throughout the life of the practice to maintain safe conditions and assure proper functioning.

The O&M requirements will be documented in the conservation plan of operations. The cooperator must agree to a conservation plan of operations (long-term contract) which provides adequate and sound arrangements for proper operation, prompt and appropriate performance of needed maintenance, and financing the costs of operation and maintenance. The cooperators should carry out the provisions of the agreed-to plan in a manner consistent with the spirit, intent, and purpose of the plan and project.

The conservation plan file should reflect the actions required and taken. After termination of the long-term contract, the cooperator is expected to continue the O&M requirements for practices in the same manner as prescribed for other conservation practices covered by the district agreement. Requirements for O&M will be incorporated in the cooperator's conservation plan of operations.

Representatives of the soil and water conservation districts will periodically inspect the conservation practices. The districts will encourage land users to perform needed maintenance, replace damaged measures, and in planning and installing new measures to maintain an adequate level of protection. Special maintenance may be necessary to repair damage from unusual storms.

Table 1

ESTIMATED INSTALLATION COST

Upper North Bosque River Watershed

Installation Cost Item	Unit	Number	Dollars 1/ Public Law 566 Funds	Other Funds	Total
Waste Mgt. Systems (Water Quality) Accelerated	Dairy	31	2/ 1,142,600	3/ 602,400	1,745,000
Technical Assistance SCS	Staff Years	5.2	305,400	0	305,400
TOTAL			1,448,000	602,400	2,050,400

1/ Price Base: 1992

2/ Includes $39,300 for Project Administration

3/ Includes $8,600 for Project Administration

TABLE 2

ANNUALIZED ADVERSE EFFECTS

Upper North Bosque River Watershed, Texas

Item	Annualized Installation Cost (dollars)	Operation and Maintenance Cost (dollars)	Total
Waste Mgt.Systems (Water Quality) Accelerated	132,580	23,230	155,810
TOTAL	132,580	23,230	155,810

1/ Price Base: 1992, discounted and annualized at 8.5 percent for 35 years

Table 3

COMPARISON OF BENEFITS AND COSTS

Upper North Bosque River Watershed, Texas

Item	Total Annualized Benefits (dollars)	Annualized Cost (dollars)	Total
Waste Mgt. Systems (Water Quality) Accelerated	187,370	155,810	1.2:1.0
TOTAL	187,370	155,810	1.2:1.0

1/ Discounted and annualized at 8.5 percent for 35 years

2/ Price Base: 1992

EFFECTS OF RECOMMENDED PLAN

General Effects

This section describes the economic, environmental, and social effects of the recommended plan. Only those factors that received a high significance rating in the "Concerns Section" are discussed in this section.

The total cost of the project is shown in Table 1. The ratio of annualized benefits to the annualized cost is shown on Table 3. In addition to monetary benefits, the project will improve off-site social benefits by improving the environment to make the area a better place to live, work, and play.

The goal of the project is to significantly reduce or prevent pollution in surface runoff and groundwater. The project activities will include planning, designing, and construction supervision of selectively cost-share practices for adequately treating animal wastes on or off-site. The ultimate goal is to accomplish measurable reductions in contaminant levels in surface and groundwater within the watershed.

A description of the project impacts is presented in the following paragraphs. Appropriate baseline data has been included to establish needed perspective. Areas of impact believed to be of key importance to decision making are summarized for the alternatives in the "Summary and Comparison of Candidate Plans".

Land Management

Soil testing programs and development of recommended nutrient application rates will result in appropriate disposal of solid animal waste. The solid manure will be used as a fertilizer source. Land application rates will be monitored to assure the runoff or leaching of nutrients will be minor.

Land resources will be protected and improved by proper application of animal waste. Proper application of animal waste will reduce the effects of excessive nutrients and eliminate the potential of placing excessive salts on cropland. This practice will also improve soil tilth through additions of organic matter to the soil. Sustained, long-term use of the soil resources will be assured by implementation of the project measures.

Water Quality

Use impairment of stream channel flow, impounded surface water, and groundwater will be slight with the project installed. Pollutants that wash into the stream system following a storm greater than the 25-year, 24-hour storm is considered to be a slight impairment because of the infrequent occurence of the event. Water quality in and below the watershed will be improved by a 70 percent reduction in contaminants from the dairies.

Social and Cultural

The social and economic environment of the watershed and surrounding areas will be improved by the project. The community will benefit from savings and increased value of the sustained dairy enterprises. There will be minor benefits from increased employment and opportunities for dairy related businesses.

Visual Resources

Untreated animal wastes washing from dairies onto adjacent properties and roadways will decrease because of project action. The visual resources will be enhanced by well managed dairy operations.

Human Health and Safety

Health hazards will be reduced by improving water quality. The threat of infection from polluted water will be reduced. Improved resources will provide a safer place for residents to live, work, and play.

Significant and Unavoidable Environmental Impacts

The following adverse impacts cannot be substantially mitigated during implementation of project measures.

- Dust generation, noise, and traffic obstructions during construction will adversely impact adjacent residents.
- Temporary wind and water erosion may occur during construction, until the ground cover becomes established.
- Milk production losses may occur during construction, along with increased movement of milking cows to avoid construction areas.
- Additional truck traffic may be generated to haul solid wastes to cropland or pastureland fields for final disposition.

Irreversible and Irretrievable Commitment of Resources

Construction, operation and maintenance of the planned practices and systems will require irretrievable commitments of energy, material and financial resources.

Short-Term versus Long-Term Use of Resources

The recommended plan is compatible with the projected future long-term uses of the area's land, water, and other resources. The plan also conforms to the presently established goals of the Upper

North Bosque River HUP to affect measurable reductions in non-point source contaminants in surface runoff and groundwater within and below the Upper North Bosque River Watershed.

Unacceptable surface water and groundwater quality in and below the watershed has been caused by untreated animal wastes washing into the stream system. Assessment of long-term effects indicates improved water quality resulting from the project. In addition, positive impacts will occur to land, air, plant and animal resources from project action.

Relationship to Other Plans and Policies

The recommended plan conforms to the general land use plans and policies of the Counties of Erath and Hamilton. The plan also conforms to and supplements the flood prevention projects in place in the watershed. This plan accomplishes the sponsor's objective of improving water quality in the watershed.

The recommended plan conforms to long-range plans of the Brazos River Authority to improve water quality and other natural resources in the watershed. The Brazos River Authority has stated it's support of the objectives of the plan.

This plan complies with various federal environmental statutes that mandates protection of the natural resources.

CONSULTATION AND PUBLIC PARTICIPATION

The plan was developed in consultation and cooperation with all interested agencies and individuals. Prior to initiation of planning and during the planning phase, informational meetings were held by local organizations. It was recognized during the early planning stages that a PL-566 watershed project would be compatible with the Upper North Bosque River HUP which is a cooperative project of the SCS, TAEX, TSSWCB, and ASCS.

The Upper North Bosque River Watershed application for assistance under PL-566, as amended, was authorized for planning assistance by the Chief of the SCS in December 1991. Contacts were made with numerous agencies and individuals during planning to obtain information and assistance during the planning process. Meetings were held by the Sponsors to inform the general public and involved landowners and to gain opinions and information from interested individuals. Newspapers serving the watershed area published articles announcing public meetings.

The U.S. Fish and Wildlife Service responded to a request for informal endangered species consultation for the watershed on September 18, 1991.

In addition, a field trip was conducted with biologists of the U.S. Fish and Wildlife Service and the Texas Parks and Wildlife Department in April 1992. Suggestions from these biologists were used to formulate the project and assure consideration of fish and wildlife habitat needs and protection of all resources in plan development.

The following agencies and organizations were requested to comment on the Draft Plan and Environmental Assessment:

U.S. Army Corps of Engineers
U.S. Environmental Protection Agency (Region 6)
U.S. Fish and Wildlife Service (Regional Office)
North Central Texas Council of Governments
Texas State Soil and Water Conservation Board
Texas Historical Commission
Texas Agricultural Experiment Station
Texas Agricultural Extension Service
City of Stephenville
Texas Association of Dairymen
Cross Timbers Concerned Citizens
Forest Service (Regional Office)
Agricultural Research Service
Agricultural Stabilization and Conservation Service
Office of the Governor
Central Texas Council of Governments
North Central Texas Council of Governments

Texas Parks and Wildlife Department
Texas Water Commission
Brazos River Authority
Institute for Applied Environmental Research
Associated Milk Producers, Inc.
USDI Heritage Conservation and Recreation Service
Texas Campaign for the Environment

The Responding Agencies' and Organizations' comments and the disposition of each are as follows:

Department Of The Army, Corps of Engineers

Comment: The Corps stated that they concur that this project will improve surface water and ground water quality in and below the watershed by assisting in a program to reduce the pollutant load.

Response: Noted.

Comment: The Corps stated that the Permits and Compliance Section states that "no federal permits are required for project action" and that practices described for inclusion in the recommend plan include waste storage ponds, diversion terraces, grassed waterways, fencing, and pond sealing and lining. The Corps stated that any of these practices could require a permit in accordance with Section 404 of the Clean Water Act. They stated that Under Section 404, the U.S. Army Corps of Engineers regulates the discharge of dredged and fill material into waters of the United States, including wetlands. The Corps advised that the need for any Section 404 permits be addressed on a case by case basis.

Response: Most animal waste management plans and associated land treatment measures to be planned with individual dairy operators under this project are covered under the Nation-wide 404 permit issued by the Corps. However, any structure planned for installation that might discharge dredged and fill material into waters of the United States, including wetlands, will address the need for a Section 404 permit before construction begins. Wording has been added under the Permits and Compliaance Section to require consideration of the need for a Section 404 permit.

U.S. Environmental Protection Agency (Region 6)

Comment: The Agency stated that confined animal feeding operations may be subject to NPDES permitting requirements (40 CFR 122.23). They stated that EPA

Region 6 is currently working on a general permit for these operations and expects the Federal Register notice to be published shortly.

Response: Permitting requirements are a responsibility of the project sponsors or the landowner. However, these requirements will be a consideration in developing a resource plan and animal waste management systems with the individual landowner.

Comment: The Agency stated that based on the expected benefits of this proposal in reducing the pollutant load within the North Bosque Watershed, EPA has no objections on the Plan-EA.

Response: Noted.

U.S. Fish and Wildlife Service (Regional Office)

Comment: The Service stated that the U.S. Fish and Wildlife Service is supportive of the plan which will improve water quality by providing funding and technical assistance for wastewater control and treatment structures for pollution abatement from numerous dairies that are concentrated in this watershed.

Response: The project sponsors and the SCS are appreciative of the support and cooperation of the Fish and Wildlife Service during the early stages of project planning. Suggestions and recommendations from the Service were used as guidelines in plan development. Quality plans are the result of interagency cooperation which will ensure accomplishment of the goal of improved water quality and other natural resources in the watershed.

Comment: The Service stated that "identification and evaluation of concerns ... listed fish and wildlife, wetlands, and endangered species as 'low' for degree of significance to decisionmaking."

Response: These resources are rated "low" for degree of significance to decisionmaking for plan development. While these resources are not the primary concern of the overall plan, they are and will be a strong consideration in developing animal waste management plans as technical assistance is provided to individual dairy operators.

Comment: The Service stated that the plan reported wildlife is scarce in the vicinity of the dairies. The Service agrees that the focus of the plan should be on land management and improvement of water quality and that cooperating dairies should be encouraged to allow areas of natural cover to develop with diverse vegetation, and to provide wildlife habitat whenever possible.

Response: The project will provide technical assistance in the planning and implementation of animal waste management systems and associated land treatment on 31 dairy farms. A resource management plan will be developed with each cooperating dairy owner to develop areas with diverse vegetation or other practices which will provide and improve wildlife habitat.

Comment: The Service also stated that "County and watershed management plans should include the optimization of wildlife habitat such as riparian corridors, forested bottomlands, and wetlands. Emergent wetlands should be developed as a part of the waste management systems, as they have been shown to be excellent nutrient assimilators."

Response: Optimization of wildlife habitat will be emphasized as technical assistance is provided to the dairy owners. Animal waste loadings in watershed runoff will be reduced by about 70 percent. Water, land, air, plant and animal resources will be improved.

Comment: The Service stated that studies are needed to evaluate possible contaminant buildup (nutrient, trace elements, i.e. selenium, zinc) in wastewater lagoons, sediments, and in soils to which manure is applied. They further stated that bird use of wastewater lagoons or created wetlands should be monitored and that the presence and effects of other potential feed additivies or veterinary supplies should be investigated. They stated that a long term commitment to monitor the effectiveness of the plan is necessary.

Response: The Institute for Applied Environmental Research, an organization associated with Tarleton State University at Stephenville, has been awarded a grant for long-term studies of animal waste problems and to monitor the effectiveness of various animal waste management systems in relation to water quality. In addition, the Upper North Bosque River HUP will address many of these concerns.

Comment: The Service stated it appreciates the opportunity to review and comment on the plan and they applaud the initiative of the SCS in providing leadership and resources to address the needs of this industry.

Response: Noted.

North Central Texas Council of Governments (NCTCOG)

Comment: The Council stated NCTCOG regional review process has determined that this project meets the review criteria specified in the rules of the Texas Review and Comment System and that favorable consideration of the project is recommended.

Response: Noted.

Texas State Soil and Water Conservation Board

Comment: The Board stated they had received and approved the application for assistance on this project and assigned it a priority on September 20, 1989.

Response: Noted.

Comment: The Board stated their involvement with the sponsors and SCS on this project has lead them to believe the objectives of the sponsors can be satisfied by implementation of this watershed plan and the selected alternative is the best practicable solution to the agriculturally related water quality problems in the watershed.

Response: Noted.

Comment: The Board urges all associated with this project to seek expeditious implementation of this plan.

Response: Noted.

Texas Historical Commission

Comment: The Commission stated that based on the information in the Draft Plan and Environmental Assessment, they concur with the recommendations that cultural resources investigations should be undertaken prior to any ground-disturbing activities related to this project. The Commission stated they will continue to review the project upon receipt of an archeological survey report.

Response: Impact areas will be evaluated by SCS prior to construction to determine if cultural resources may exist. If significant resources exist, SCS will take appropriate action to avoid adverse effects on them.

The Texas Agricultural Experiment Station

Comment: The Station stated they appreciate the cooperative work with SCS and other agricultural agencies. They stated this is a fine example of a productive relationship between public agencies that can serve the needs of the people of Texas and they are pleased to be a part of that cooperative endeavor. The Station had no further comments on the draft plan.

Response: Noted.

Texas Agricultural Extension Service, Joe Pope, County Extension Agent

Comment: Mr. Pope stated he supported the plan and this endeavor will improve our water quality.

Response: Noted.

City of Stephenville, Bob Self, Water Pollution Control Officer

Comment: Mr. Self stated he has extensive experience with water quality problems in the Bosque River and the residents of the City will benefit from implementation of this program.

Response: Noted.

Comment: Mr. Self stated that according to the project map in Appendix E of the draft, 42 dairies eligible for project treatment are located above the City of Stephenville.

Response: The Project Map, Appendix E, identifies all dairies eligible for participation in the project. Only 31 dairies identified on the Project Map will be funded for technical and financial assistance through this project. Other dairies will be treated with assistance from the Agricultural Conservation Program and Great Plains Conservation Program.

Comment: Mr. Self stated the City is nearing the completion of the planning phase for doubling the capacity of the Municipal wastewater treatment plant and replacing undersized collection and outfall lines which is expected to be accomplished within the next 18 to 20 months. He stated that this work will provide guarantees of water quality for the people in Hico, Meridian and on down to Waco, but it will not do anything to improve the quality of water in Stephenville city limits. He stated that only through a project such as is proposed by this plan will there be some direct benefit to the citizens of Stephenville.

Response: Noted.

Comment: Mr. Self stated he has tremendous respect for the agencies and individuals involved in this effort to assist the dairymen in the installation of appropriate waste management and land treatment systems and he applauds the efforts and sincerely hopes the funding is granted for this project.

Response: Noted.

<u>Texas Association of Dairymen</u>

Comment: The Association stated that the Texas Association of Dairymen applaud the efforts to correct the problems and improve the watershed by 70 percent as stated in the draft plan. They stated that the dairymen are concerned about water quality and the cost many dairymen have spent to improve conditions indicates their willingness to cooperate.

Response: Noted. The goal of the project is to reduce animal waste loadings in watershed runoff by 70 percent.

Comment: The Association stated that the report was the most degrading public report against the dairy industry ever seen and that the true focus should be turned to those who were in positions of authority to regulate and report on the quality of water, land and air. They stated that changes need to be made, but the dairy industry should not be blamed for the problems of our environment.

Response: The assessment is a factual report of interdisciplinary studies by geologists, biologists, engineers, hydrologists, conservationists, water quality specialists, sociologists, economists, and cultural resource specialists. Studies were made by local, state, and federal agencies, including a Congressional hearing. All studies address the problem of untreated animal waste polluting the stream system in and below the watershed. This project is formulated to treat the problem by assisting the dairymen to design and implement animal waste management systems. In order to justify federal funding, a problem must be established and alternatives to correct the problem developed. The solution must be cost effective and/or environmentally beneficial. Non-agricultural related pollution problems in the watershed are recognized. Problems relating to Stephenville's sewage treatment plant and failed on-site sewage treatment systems (septic tanks and filter fields) were acknowledged. These problems are addressed in the Upper North Bosque HUP or through Stephenville's plans to construct an enlarged sewage treatment plant.

Comment: The Association stated the dairymen have been uninformed, unregulated, and undermined.

Response: The purpose of this project is to improve water quality in and below the watershed. The goal will be accomplished by providing information and financial assistance to the dairymen on alternatives to deal with the animal wastes generated by their operations.

Comment: The Association encouraged the SCS to assist more than 31 dairies as described in the plan.

Response: This project will be supplemented by the Agricultural Conservation Program and Great Plains Conservation Program to address the needs of an additional number of dairies in the watershed.

Cross Timbers Concerned Citizens

Comment: The Organization stated they are a chartered, non-profit organization that was formed three years ago in response to dairy-related pollution problems in Erath County. They stated they have worked diligently with numerous state and federal agencies in an effort to curb dairy pollution.

Response: Noted.

Comment: The Organization stated that they fully support efforts proposed in the Upper North Bosque River Watershed Plan and other similar efforts put forth by the SCS in recent years. They stated that one of the major ways dairy pollution will be brought under control is by providing cost-sharing and technical assistance to help dairies install the waste management facilities they need.

Response: Noted.

Comment: The Organization stated that they see the need for better state regulations governing these operations and the need for effective enforcement of rules through a fair system of routine dairy inspections.

Response: Noted.

Comment: The Organization questions the statement in the plan that the Trinity Aquifer does not have a recharge area in the watershed but is subject to contamination through improperly installed well heads. They stated that several studies, including one by Baylor University, have determined that the Trinity does have recharge in the watershed. They request that the SCS conduct further research.

Response: The "deeper Trinity Aquifer" is in reference to the aquifer in the Twin Mountains Formation below the Glen Rose Formation.

The Glen Rose Formation is the lowest formation in the geologic column cropping out in the watershed as shown on page 7, Geologic Strata Cropping Out in the Watershed, in Appendix B, Figure B3 and Geologic Atlas of Texas, Brownwood Sheet). The Glen Rose Formation lithology overlying the Twin Mountains Formation is mostly hard, thin bedded limestone interbedded with marl and claystone. Total thickness of the Glen Rose Formation within the watershed is estimated to be in excess of 100 feet. The lithology and thickness of the formation effectively restrict vertical movement of groundwater.

The Twin Mountains Formation does not cropout in the Upper North Bosque Watershed because of its position below the Glen Rose Formation. The Glen Rose intercepts downward movement of groundwater before it reaches the Twin Mountains Formation. Therefore, there isn't a natural surface recharge area in the watershed to the "deeper Trinity Aquifer"; and potential contamination from the watershed entering the aquifer will be through wells with substandard well heads.

Comment: The Organization also questions using the 25-year, 24-hour rainfall event as the standard for lagoon requirements. They state that the heavy rains the past few years and the chronic rains that are endemic to this area have pretty much proven the 25-year, 24-hour standard to be inadequate.

Response: The 25-year, 24-hour rainfall event is the requirement set by the Texas Water Commission (Texas Register 321.35) to control runoff from open lots and associated areas and process generated wastewater. Designs are based on SCS practice standards and comply with the TWC requirements.

Comment: The Organization stated they fully support the plan and would like to see it expanded and accelerated.

Response: Noted.

List of Preparers

The draft watershed plan and environmental assessment was reviewed and concurred in by state staff specialists having responsibility for engineering, soils, agronomy, biology, and geology. This review was followed by review of the document and supporting data by the Technical Services Center.

LIST OF PREPARERS

NAME AND PRESENT TITLE	EDUCATION Degree(s)	EXPERIENCE Title & Years of Experience	OTHER Licenses, etc
Gary A. Batte Area Conservationist	B.S., Agriculture Education	Area Cons...17 Dist Cons... 8 Soil Cons... 3	Soil and Water Cons.Society of America
Max D. Bircket Geologist	B.S., Geology	Geologist . 25	Licensed Professional Geologist
F. Charles Baird Water Management Engineer	B.S., Agricultural Engineering	Water Mgt. Spec..... 3 Civil Eg....15 Agri. Eng...10	Registered Professional Engineer
Nancy J. Cole Archaeologist	B.S.& M.A., Archeology	Archeologist.16	
Stanley L. Ellison Area Resource Conservationist	B.S., Agriculture Business M.S., Range Science	Area Resource Cons..... 1 Area Range Cons..... 16 DC..... 2.5 RC..... 2.5	Society for Range Mgt.
James L. Hailey Planning Staff Leader Leader	B.S. & M.S. Agricultural Engineering	Planning Staff Leader.... 1 Hyd. Eng.... 11 Civ.Eng..... 6 Ag. Eng..... 5	Registered Professional Engineer
James Henson Biologist/ Environmental Spec.	B.S., Wildlife Science	Biologist .. 32	Certified Biologist

NAME AND PRESENT TITLE	EDUCATION Degree(s)	EXPERIENCE Title & Years of Experience	OTHER Licenses, etc.
Matthew R. Judy Biologist	B.S., Forest Game Mgt.	Biologist .. 3 Soil Cons... 2 Forester ... 3 Soil Cons... 1	Wildlife Society American Fish.Society
Jerry W. Kazda Agricultural Economist	B.S., Agricultural Economics	Agricultural Economist. 27	
Gerald H. Ledyard Cartographer	4 Yrs of University Level Study	Supervisory Cartographer 14 Cartographer 7 Carto. Tech Supervisor 4 PhotoLab.Tech 9	American Soc Photo- grammetry, Assn. of Professional Soil Scient.
William H. Lewis, Jr. Dist. Conservationist	B.S., Education	Dist. Cons.. 15 Soil Cons.... 9	Soil & Water Cons.Society of America
Kenneth W. Schrank Dist. Conservationist	B.S., Agriculture	Dist. Cons...16 Soil Cons.... 9	Soil & Water Cons.Society of America
Jerry E. Stanford Civil Engineer	B.S. & M.S. Agricultural Engineering	Civ. Eng.. 14.5 Ag. Eng.... 2.5	Registered Professional Engineer
David L. Strakos Civil Engineering Tech	High School Diploma	Civ.Eng.Tech. 5 Survey. Tech. 9	
Gail T. Chandler Public Affairs Spec.	B.S., Equine Science	Soil Cons.... 1 Dist. Cons... 2 Soil Cons.. 8.5	Soil & Water Cons.Society of America
Lisa K Moulder Civil Engineer	B.S., Agricultural Engineering	Civil Eng.... 3 Agri. Eng.... 7	Registered Professional Engineer
Larry J. Wachel Civil Engineering Technician	B.S., Biology	CET..... 9 SCT..... 3	
Jack L. White Dist. Conservationist	B.S., Animal Science	Dist. Cons.. 14 Soil Cons...3.5 Survey.Tech..5	

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APPENDIX A

LETTERS OF COMMENT

DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P. O. BOX 17300
FORT WORTH, TEXAS 76102-0300

REPLY TO
ATTENTION OF

July 13, 1992

Planning Division

PDM 11-5

Mr. Harry W. Oneth
State Conservationist
Soil Conservation Service
101 South Main Street
Temple, Texas 76501-7682

Dear Mr. Oneth:

Thank you for the opportunity to review your Draft Watershed Plan and Environmental Assessment for the Upper North Bosque River Watershed. We concur that this project will improve surface water and ground water quality in and below the watershed by assisting in a program to reduce the pollutant load.

The Permits and Compliance Section on page 56 states that "no federal permits are required for project action." Practices described on page 46 for Alternative 2, the recommended plan, include waste storage ponds, diversion terraces, grassed waterways, fencing, and pond sealing and lining. Any of these practices could require a permit in accordance with Section 404 of the Clean Water Act. Under Section 404, the U.S. Army Corps of Engineers regulates the discharge of dredged and fill material into waters of the United States, including wetlands. We advise you to address the need for any Section 404 permits on a case by case basis.

Thank you for your interest in our nation's water resources and the opportunity to review your document. Please continue to check with us prior to initiating construction in or affecting waters of the United States.

Sincerely,

Paul M. Hathorn

Paul M. Hathorn
Chief, Environmental Resources Branch

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VI
1445 ROSS AVENUE, SUITE 1200
DALLAS, TEXAS 75202

6 E-F

Mr. Harry W. Oneth
State Conservationist
SCS, 101 South Main
Temple, Texas 76501-7682

FDR 11-5

Dear Mr. Oneth:

In complying with Section 309 of the Clean Air Act, we have completed our review of your agency's Draft Watershed Plan and Environmental Aesessment (Plan-EA) of the Upper North Bosque River Watershed in Erath and Hamilton Courties, Texas.

The EA proposes to install animal waste management systems and associated land treatment practices on 31 dairy farms to improve surface and ground water quality in and below the watershed. Implementation of the plan will be accomplished through the local soil and water conservation districts. This project will be supplemented by the Agriculture Conservation Program and Great Plains Conservation Program in the watershed. The plan will be applied during a ten year period.

We offer the following information for your consideration:

> Confined animal feeding operations may be subject to NPDES permitting requirements (see 40 CFR 122.23). EPA Region 6 is currently working on a general permit for these operations and expects the Federal Register notice to be published shortly. If you need further assistance on these requirements, contact Ms. Paulette Johnsey at (214) 655-7175.

Based on the expected benefits of this proposal in reducing the pollutant load within the North Bosque Watershed, EPA has no objections to the proposed action.

We thank you for your coordination and the opportunity to comment on the Plan-EA. If you have any questions, or if I may be of further assistance in this matter, please do not hesitate to contact me or Mr. Carl Townsend of my staff at (214) 655-2260.

Sincerely yours,

for William L. Cox

Norm Thomas
Chief
Federal Activities Branch (6E-F)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Stadium Centre Building
711 Stadium Drive East, Suite 252
Arlington, Texas 76011

June 17, 1992

IN REPLY REFER TO:

PDM 11-5

Harry W. Oneth, State Conservationist
Soil Conservation Service
101 South Main Street
Temple, Texas 76501-7682

Dear Mr. Oneth:

This responds to your request of May 22, 1992, for comments on the Draft Plan and Environmental Assessment for Upper North Bosque River Watershed in Erath and Hamilton Counties, Texas. The U.S. Fish and Wildlife Service (Service) is supportive of the plan which will improve water quality by providing funding and technical assistance for wastewater control and treatment structures for pollution abatement from numerous dairies that are concentrated in this watershed.

Identification and evaluation of concerns (page 27) listed fish and wildlife, wetlands, and endangered species as 'low' for degree of significance to decisionmaking. Wildlife is reportedly scarce in the vicinity of the dairies. While we agree that the focus of the plan should be on land management and improvement of water quality, cooperating dairies should be encouraged to allow areas of natural cover to develop with diverse vegetation, and to provide wildlife habitat whenever possible. County and watershed management plans should include the optimization of wildlife habitat such as riparian corridors, forested bottomlands, and wetlands. Emergent wetlands should be developed as a part of the waste management systems, as they have been shown to be excellent nutrient assimilators.

Studies are needed to evaluate possible contaminant buildup (nutrients, trace elements, i.e. selenium, zinc) in wastewater lagoons, sediments, and in soils to which manure is applied. Bird use of wastewater lagoons or created wetlands should be monitored. The presence and effects of other potential feed additives or veterinary supplies such as prophylactic drugs, antibiotics, cattle wormers, and hormones should be investigated. A long term commitment to monitor the effectiveness of the plan is necessary.

In summary, the concentration of dairies locating in the Upper North Bosque River watershed requires development of an area wide management plan. Waste treatment designs that address cumulative as well as individual impacts are appropriate for long range planning to protect surface and ground water resources from contamination. Strategic plans for the watershed should include provisions for wildlife habitat, especially providing riparian corridors for wildlife by maintaining existing bottomlands, and protecting, expanding, and enhancing wetlands.

The Service appreciates the opportunity to review and comment on the Upper North Bosque River Watershed Plan. We applaud the initiative of the Soil Conservation Service in providing leadership and resources to address the needs of this industry, while also helping to bring cooperating dairies into compliance with regulations.

Sincerely,

Robert M. Short

Robert M. Short
Field Supervisor

North Central Texas Council of Governments

P. O. Drawer COG Arlington, Texas 76005-5888

PDM 14-5

June 23, 1992

Harry W. Oneth
State Conservationist
Soil Conservation Service
101 South Main Street
Temple, TX 76501-7682

RE: Draft Plan and Environmental Assessment for Upper North Bosque River Watershed
SAI# TX-R-92-06-28-0009-50-04

Dear Mr. Oneth:

This is to inform you that the North Central Texas Council of Governments has completed review and comment on the above referenced application as required by the Texas Review and Comment System (TRACS). Individuals and organizations listed below have been copied; however, you may also use this memo to inform appropriate agencies of our action and to document your compliance with areawide procedures as required by TRACS.

Your application was reviewed for appropriate areawide concerns. This normally includes consideration by one of NCTCOG's technical review committees as well as review by the Government Applications Review Committee and by the Executive Board. On the basis of this review process, the Executive Board, at its June 18, 1992 meeting adopted the following areawide position:

> The NCTCOG regional review process has determined that this project meets the review criteria specified in the rules of the Texas Review and Comment System. Favorable consideration of the project is recommended.

We sincerely thank you for your cooperation in this matter. If we can be of further service or assistance, please feel free to call Jody Buchanan or Mary Ann Hartsell in the Executive Director's Office, at 817/640-3300 (metro).

Sincerely,

William J. Pitstick
Executive Director

WJP:mah

cc: Robert E. Layton, Jr., Regional Administrator, Region 6, EPA
T. C. Adams, Governor's Office of Budget and Planning, Austin

1091

TEXAS STATE SOIL AND WATER CONSERVATION BOARD

311 North 5th
P.O. Box 658
Temple, Texas 76503
(817) 773-2250

PDM 11-5

June 11, 1992

Harry W. Oneth, State Conservationist
Soil Conservation Service
101 South Main
Temple, TX 76501

Dear Wes:

We received, for our review and comment a copy of the Draft Plan and Environmental Assessment for the Upper North Bosque River Watershed in Erath and Hamilton Counties, Texas.

This agency received and approved the application for assistance on this project and assigned it a priority on September 20, 1989.

Our involvement with the sponsors and your staff working on this project leads us to believe that the objectives of the sponsors can be satisfied by implementation of this watershed plan and that the selected alternative is the best practicable solution to the agriculturally related water quality problems in the watershed. We urge all associated with this project to seek expeditious implementation of this plan.

Sincerely yours,

Robert G. Buckley
Executive Director

vd

CURTIS TUNNELL
EXECUTIVE DIRECTOR

TEXAS HISTORICAL COMMISSION
P.O. BOX 12276 AUSTIN, TEXAS 78711 (512)463-6100

Department of Antiquities Protection

June 25, 1992

Mr. Harry W. Oneth
State Conservationist
United States Department of Agriculture
Soil Conservation Service
101 South Main Street
Temple, TX 76501-7682

Re: Cultural Resources Assessment, SAI/EIS# TX-R-92-05-28-0009-50-00, Draft Plan and Environmental Assessment for Upper North Bosque River Watershed, Erath and Hamilton Counties, Texas (SCS, A5, B4)

Dear Sir:

Thank you for the opportunity to review the above referenced project. Based on the information in the Draft Plan and Environmental Assessment, we concur with your recommendations that cultural resources investigations should be undertaken prior to any ground-disturbing activities related to this project. We will continue to review the project upon receipt of an archeological survey report. If we can be of any assistance, please contact Dan Prikryl of my staff at (512) 463-6096.

Sincerely,

Timothy K. Perttula, Ph.D.
Assistant Director for Antiquities Review

James E. Bruseth, Ph.D.
Deputy State Historic Preservation Officer

DP/TP/JB

cc:Phyllis O'Neill, Governor's Office of Budget and Planning

1119

THE TEXAS AGRICULTURAL EXPERIMENT STATION
THE TEXAS A&M UNIVERSITY SYSTEM
College Station, Texas 77843-2147

Office of the Director

(409) 845-8484

June 1, 1992

PDM 11-5

Mr. Harry W. Oneth, State Conservationist
USDA/Soil Conservation Service
101 South Main Street
Temple, Texas 76501-7682

Dear Mr. Oneth:

Thank you for the copy of the Draft Plan and Environmental Assessment for the Upper North Bosque Watershed in Erath and Hamilton Counties.

I am passing this document on to our staff for review and comment. We appreciate the cooperative work with Soil Conservation Service in our agricultural agencies. This is a fine example of a productive relationship between public agencies that can serve the needs of the people of Texas. We are very pleased to be a part of that cooperative endeavor.

Thank you for the opportunity to review this document.

Sincerely,

J. Charles Lee
Interim Director

JCL/sf

Texas Agricultural Extension Service
The Texas A&M University System
Courthouse Annex
Stephenville, Texas 76401

June 2, 1992

Cross Timbers Soil & Water Conservation District
239 S. Virginia
Stephenville, Texas 76401

To Whom It May Concern:

I am writing in support of the Upper North Bosque River Watershed Plan and Environmental Assessment that was mentioned in Kenneth Lesley's letter dated May 26. After reviewing the information in the preliminary project plan, I see this is another avenue to improve our water quality. As I understand this project, funds would be available for dairies which are expanding in size and for dairies in operation for less than five years. These are two critical areas which I see could benefit from this proposal which are presently exempt from some of the existing programs. With participation in this program, I do believe we can improve our surface and ground water quality by reducing the nutrient load from dairies.

I regret that I will not be able to attend the meeting on Thursday, June 4, as I will be out of town. I did want to make comments in support of the project, however.

Sincerely,

Joe Pope

Joe Pope
County Extension Agent
Agriculture

JP:ws

City of Stephenville

354 NORTH BELKNAP STEPHENVILLE, TEXAS 76401 817-965-7887

MR. KENNETH LESLEY
CHAIRMAN, CROSS TIMBERS SWCD
239 SOUTH VIRGINIA
STEPHENVILLE, TX 76401

DEAR MR. LESLEY:

I APPRECIATE THE OPPORTUNITY TO MAKE A FEW COMMENTS ABOUT THE DRAFT WATERSHED PLAN AND ENVIRONMENTAL ASSESSMENT BEING CONSIDERED TODAY.

IN THE PAST 7 YEARS, I HAVE HAD THE OPPORTUNITY TO SERVE ON A CITIZENS ADVISORY COMMITTEE TO THE TWC'S CRITICAL AREA STUDY, THE ADVISORY COMMITTEE TO THE HYDROLOGIC UNIT PROJECT, AND THE BRAZOS RIVER AUTHORITY'S BRAZOS BASIN STEERING COMMITTEE, ALL DEALING SPECIFICALLY WITH OUR AREA'S UNDERGROUND AND SURFACE WATER. THE THRUST OF EACH OF THESE EFFORTS HAS BEEN TO DETERMINE WHAT ACTIONS ARE GOOD AND NECESSARY TO PRESERVE AND PROTECT OUR NATURAL RESOURCES.

AS A MEMBER OF THE STEPHENVILLE CITY COUNCIL FROM 1985 TO 1991, I PARTICIPATED IN PLANNING WHICH WOULD RESULT IN IMPROVEMENTS TO THE QUALITY OF THE BOSQUE RIVER. AS A MEMBER OF THE STEPHENVILLE CHAMBER OF COMMERCE, I HAVE ASSISTED IN PLANNING AND EXECUTING SEVERAL WORKDAYS BY VOLUNTEERS TO "CLEAN UP" THE DEBRIS ALONG THE BANKS OF THE BOSQUE RIVER, ESPECIALLY IN THE AREA OF THE CITY PARK.

THE RESIDENTS OF THE CITY OF STEPHENVILLE WILL BENEFIT FROM THE IMPLEMENTATION OF THIS PROGRAM THROUGH IMPROVEMENT IN THE QUALITY OF THE WATER FLOWING THROUGH TOWN. ACCORDING TO THE PROJECT MAP IN APPENDIX E OF THE DRAFT, I COUNTED 42 DAIRIES ELIGIBLE FOR PROJECT TREATMENT LOCATED ON OR NEAR TRIBUTARIES TO THE BOSQUE RIVER ABOVE THE CITY. IF THIS PROJECT IS IMPLEMENTED IN CONJUNCTION WITH THE OTHER SCS AND ASCS PROGRAMS, MANY OF THE POTENTIAL SOURCES OF POLLUTION WILL BE ADDRESSED APPROPRIATELY.

THE CITY OF STEPHENVILLE IS NEARING THE COMPLETION OF THE PLANNING PHASE FOR DOUBLING THE CAPACITY OF THE MUNICIPAL WASTEWATER TREATMENT PLANT AND REPLACING UNDERSIZED COLLECTION AND OUTFALL LINES. THIS PROJECT (APPROXIMATELY $7 MILLION) WILL BE ACCOMPLISHED WITHIN THE NEXT 18 TO 20 MONTHS. THIS WILL PROVIDE GUARANTEES OF WATER QUALITY FOR THE PEOPLE IN NICO, MERIDIAN AND ON DOWN TO WACO, BUT IT WILL NOT DO ANYTHING TO IMPROVE THE QUALITY OF THE WATER RIGHT HERE IN OUR CITY LIMITS. ONLY THROUGH A PROJECT SUCH AS IS PROPOSED BY THIS DRAFT WILL THERE BE SOME DIRECT BENEFIT TO THE CITIZENS OF STEPHENVILLE.

I HAVE A TREMENDOUS RESPECT FOR THE AGENCIES AND THE INDIVIDUALS INVOLVED IN THIS EFFORT TO ASSIST THE DAIRYMEN IN THE INSTALLATION OF APPROPRIATE WASTE MANAGEMENT AND LAND TREATMENT SYSTEMS. I APPLAUDE YOUR EFFORTS AND SINCERELY HOPE THE FUNDING IS GRANTED FOR THIS PROJECT.

IF THERE IS ANY WAY AT ALL THAT I CAN BE OF FURTHER ASSISTANCE, PLEASE, CALL ME.

SINCERELY,

Bob Self

BOB SELF
WATER POLLUTION CONTROL OFFICER

TEXAS ASSOCIATION OF DAIRYMI

P.O. Box 1115, Stephenville, Texas 76401
(817) 968-5180

June 22. 1992

Mr. Kenneth Schrank
239 E. Virginia
Stephenville, TX 76401

Dear Mr. Schrank.

The Texas Association of Dairymen applaud your efforts to correct the problems and improve the watershed by 70% as stated in your Draft of the Upper North Bosque River Watershed Plan and Environmental Assessment for Erath and Hamilton Counties. Dairymen, too are concerned about the nitrate and coliform contamination in surface water. It was clear in your survey report that dairymen as well as citizens prioritized water quality, land management, groundwater quality and air quality as some of their top concerns. We strongly believe the dairy industry does not want to pollute our waters, our air or our land. They have concerns much the same as the public. The cost many dairymen have spent to improve conditions indicate their willingness to cooperate.

Your report states that only fourteen of the 110 dairies in the watershed have adequate waste water management facilities. Your assessment of immense quantities of untreated animal waste degrading the water quality leaves the reader frightened to say the least. Frankly, the report was the most degrading public report against the dairy industry ever seen. The photographs visually topped off the material submitted. The true focus should be turned to those who were in positions of authority to regulate and report on the quality of water, land and air. Changes will need to be made, but the dairy industry should not be blamed for the problems of our environment. Dairymen face the frustrations of managing a competitive business while trying to comply with numerous rules and regulations. They have been uninformed, unregulated and undermined.

We encourage your help in improving the Upper North Bosque River Watershed water quality by 70%. The monies generated to help do this should be used wisely and efficiently. We would encourage you to consider including more than 31 dairies. We feel that more dairies could be helped with the amount of money received. We encourage your office to look into the most efficient methods and uses of both our natural resources and our funds.

Sincerely,

Robin Brister

Robin Brister

Cross Timbers Concerned Citizens

Travis Brown, President

P.O. Box 1694
Stephenville, Texas 76401
(817) 764-4160

David Williams, Vice P

June 16, 1992

Kenneth W. Schrank
District Conservationist
Soil Conservation Service
239 S. Virginia
Stephenville, TX 76401

Dear Mr. Schrank:

On behalf of Cross Timbers Concerned Citizens, I'd like to offer a few comments on the proposed Upper North Bosque River Watershed Plan and Environmental Assessment.

As you know, Cross Timbers Concerned Citizens is a chartered, non-profit organization that was formed three years ago in response to dairy-related pollution problems in Erath County. Since then, our group has worked diligently with numerous state and federal agencies in an effort to curb dairy pollution.

Our group fully supports efforts proposed in the Upper North Bosque River Watershed Plan and other similar efforts put forth by the Soil Conservation Service in recent years. It's clear to us that one of the major ways dairy pollution will be brought under control is by providing cost-sharing and technical assistance to help dairies install the waste management facilities they need.

We are particularly in favor of providing such assistance to smaller dairymen, who face much more restrictive budget restraints than larger operations.

At the same time, we also see the need for better state regulations governing these operations and the need for effective enforcement of rules through a fair system of routine dairy inspections. Waste management systems don't do much good if they aren't efficiently managed.

There are a few specific points I'd like to make concerning your report.

On page 23, the report states, "The deeper Trinity Aquifer does not have a recharge area in the watershed but is subject to contamination through improperly installed well heads."

We question this statement and request you conduct further research. We understand that several studies, including one by Baylor University, have determined that the Trinity does have

recharge in the watershed. In fact, Dr. John Sweeten, in his report included in the rear portion of your report, states, "Since the Trinity Group Aquifer outcrops in this area and certain soil types have porous subsoils, application of excessive amounts of manure and wastewater could result in introduction of contaminants into the aquifer."

We also question using the 24-hour, 25-year rainfall event as the standard for lagoon requirements. Heavy rains the past few years and chronic rains that are endemic to this area have pretty much proven the 24-hour, 25-year standard to be inadequate, we feel.

Again, we fully support the plan, and would like to see it expanded and accelerated.

Also, we appreciate the Soil Conservation Service's willingness to document and publish this environmental assessment. I expect you will receive significant pressure from certain segments of the dairy industry to change or soften the conclusions in your report. We have confidence, however, that you will stand by the facts.

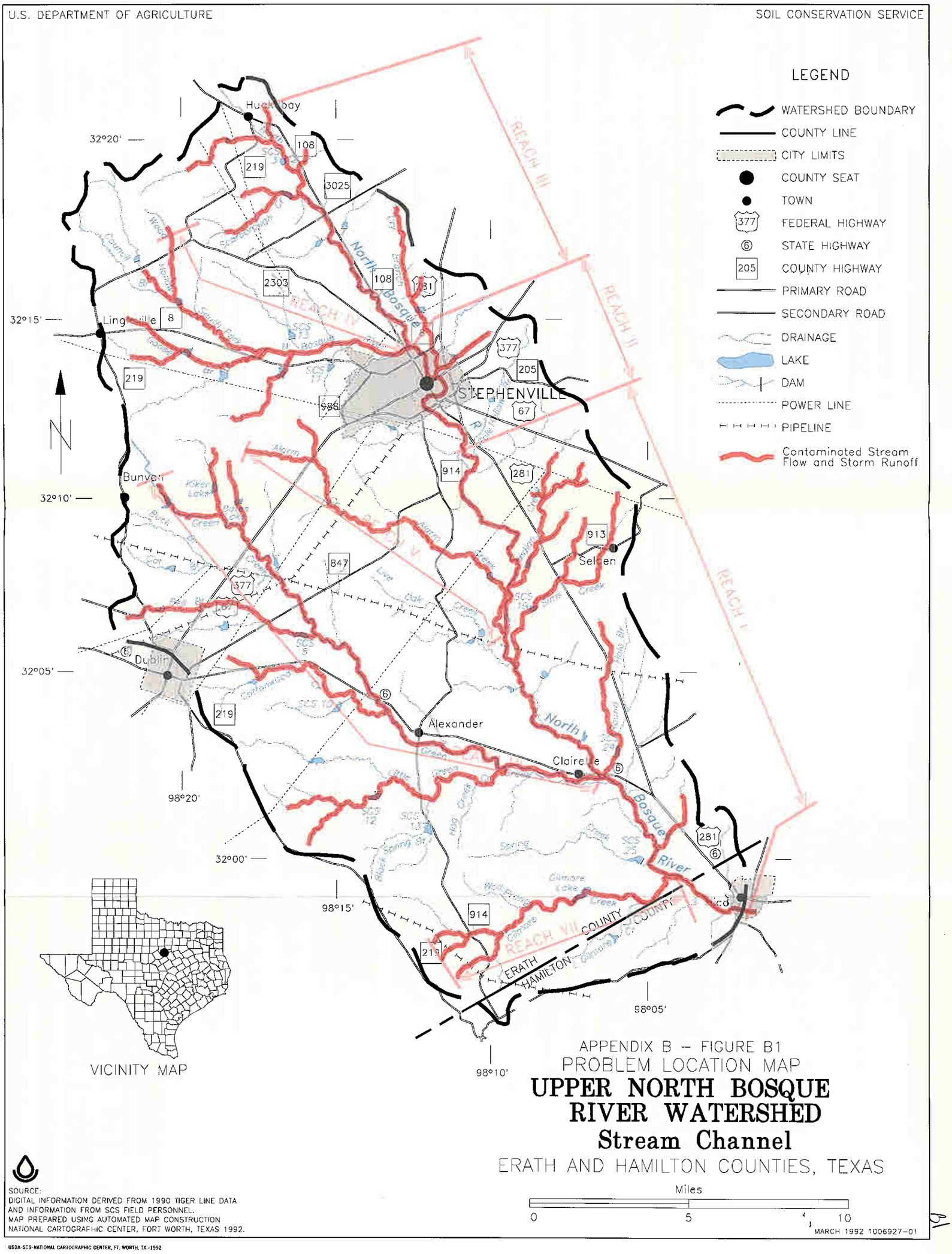
Sincerely,

Travis Brown

Travis Brown
President
Cross Timbers Concerned Citizens

APPENDIX B

SUPPORTING MAPS



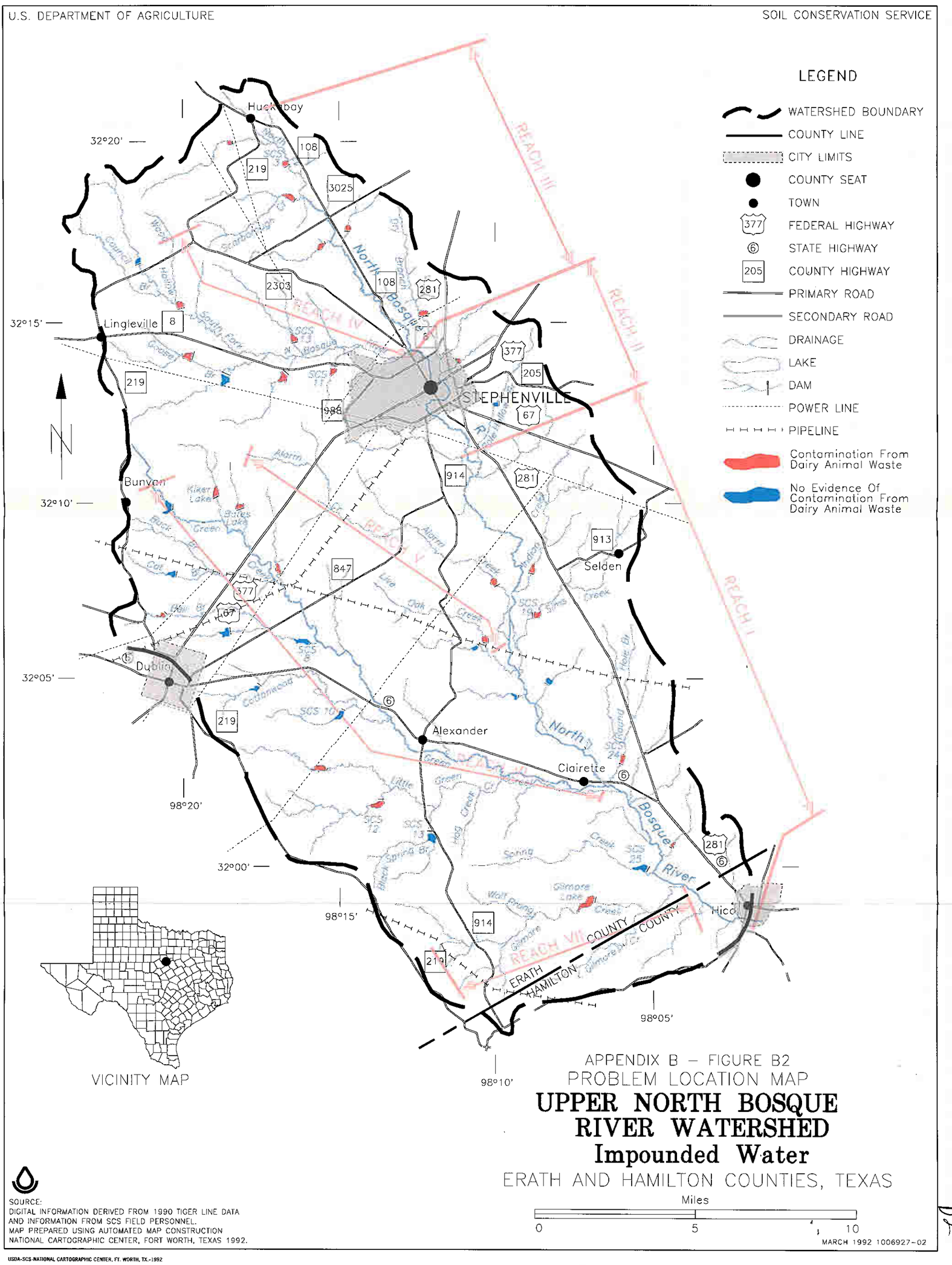
APPENDIX B – FIGURE B1

PROBLEM LOCATION MAP

UPPER NORTH BOSQUE RIVER WATERSHED

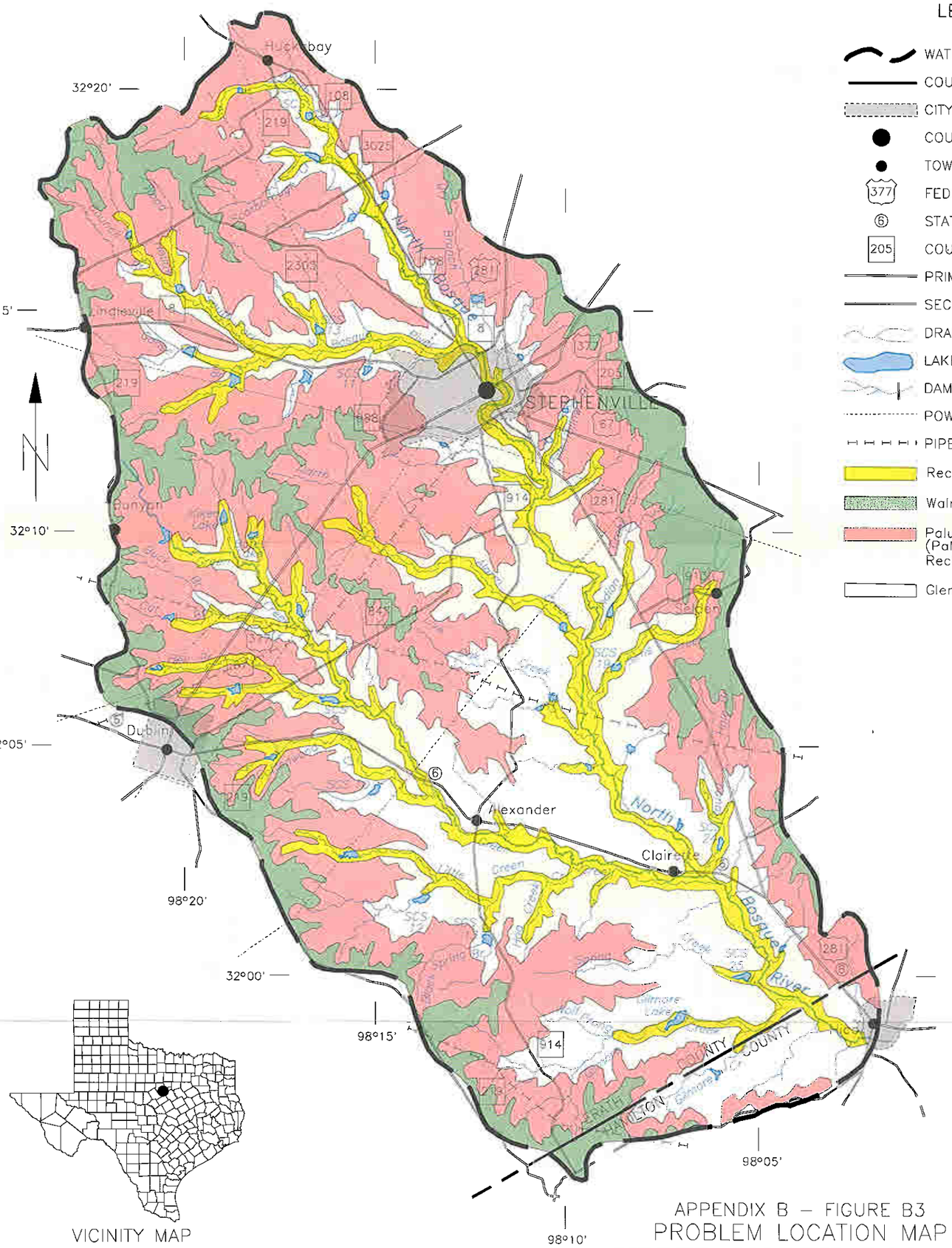
Stream Channel

ERATH AND HAMILTON COUNTIES, TEXAS


U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
LEGEND
WATERSHED BOUNDARY
COUNTY LINE
CITY LIMITS
COUNTY SEAT
TOWN
FEDERAL HIGHWAY
STATE HIGHWAY
COUNTY HIGHWAY
PRIMARY ROAD
SECONDARY ROAD
DRAINAGE
LAKE
DAM
POWER LINE
PIPELINE
Contamination From Dairy Animal Waste
No Evidence Of Contamination From Dairy Animal Waste
REACH I
REACH II
REACH III
REACH IV
REACH V
REACH VI
REACH VII
STEPHENVILLE
Lingleville
Bunyan
Dublin
Alexander
Clairette
Selden
Hico
North Bosque River
Bosque River
COUNTY
ERATH
HAMILTON
32°20'
32°15'
32°10'
32°05'
32°00'
98°20'
98°15'
98°10'
98°05'
VICINITY MAP
APPENDIX B – FIGURE B2
PROBLEM LOCATION MAP
UPPER NORTH BOSQUE RIVER WATERSHED
Impounded Water
ERATH AND HAMILTON COUNTIES, TEXAS
Miles
0
5
10
SOURCE:
DIGITAL INFORMATION DERIVED FROM 1990 TIGER LINE DATA AND INFORMATION FROM SCS FIELD PERSONNEL.
MAP PREPARED USING AUTOMATED MAP CONSTRUCTION NATIONAL CARTOGRAPHIC CENTER, FORT WORTH, TEXAS 1992.
MARCH 1992 1006927-02
USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX.-1992

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



VICINITY MAP

APPENDIX B – FIGURE B3

PROBLEM LOCATION MAP

UPPER NORTH BOSQUE RIVER WATERSHED

Groundwater

ERATH AND HAMILTON COUNTIES, TEXAS

Miles

0 5 10

MARCH 1992 1006927-03

SOURCE:
DIGITAL INFORMATION DERIVED FROM 1990 TIGER LINE DATA AND INFORMATION FROM SCS FIELD PERSONNEL.
MAP PREPARED USING AUTOMATED MAP CONSTRUCTION NATIONAL CARTOGRAPHIC CENTER, FORT WORTH, TEXAS 1992.

USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX.-1992

APPENDIX C

INVESTIGATION AND ANALYSIS REPORT

INVESTIGATION AND ANALYSIS REPORT

Project Formulation

The project was developed as a result of public and private concern for the disposition of huge amounts of dairy animal waste. Statements and testimony offered during public meetings, hearings, and media interviews were instrumental in formulating a plan that will be compatible with other water quality projects.

Also considered during planning were the desires and capabilities of each dairy operator, present and projected water quality problems, economic feasibility and on-site physical conditions. Potential with-project and without-project impacts on biologic, historic, and archaeologic resources were investigated. Likewise, sociological implications were examined.

On-site Dairy Information

Data was compiled for each dairy operation in the watershed by local Field Office soil conservationists and technicians. The data was used in projecting water quality conditions, estimating installation costs of various treatment alternatives, and assessing environmental impacts.

Each dairy will need a plan and related specifications to meet state animal waste management requirements. The plans and specifications will be prepared during the project installation period. Size of dairy herd and acreage available for operations influence the on-site hydrology and subsequent engineering of a waste management system. Factors such as location, landscape, geologic strata, soils, proximity to stream channels and water impoundments, and other enterprises or neighborhoods must be considered.

Water Quality

Literature dealing with watershed and North Bosque River water quality was researched and consulted. Texas Water Commission publications, storm runoff monitoring data, and Texas Department of Health information was utilized. This data was used in determining current water quality conditions by comparing those conditions to State standards.

Animal waste loadings in dairy runoff per watershed reach were estimated for present and projected future conditions. Included were computations for concentrations of total solids, volatile solids, total nitrogen, phosphate, potassium, and sodium. This

was accomplished using the previously mentioned computer data base and research data compiled and published by Dr. John M. Sweeten and Dr. Mary L. Wolfe from Texas A&M University.

Observations of local individuals were also utilized in determining existing and potential water contamination problems in runoff and impounded water.

Most of the dairies are located on the Paluxy Aquifer recharge area and/or they contribute runoff to the recharge area. Examination of Texas Water Development Board publications and maps and Geologic Atlas of Texas maps indicate strong potential for significant aquifer contamination.

Economics

The economic analyses were made following procedures as set forth in the "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies", March 10, 1983.

The general level of prices for outputs and inputs prevailing during or immediately preceding the period of planning was used for the entire period of analysis.

Discounting was used to convert future monetary values to present values. The current discount rate for the formulation and economic evaluation of plans for water and related land resources is 8.5 percent interest. The period of analysis used for economic evaluations was 35 years.

The benefits for this project were derived from offsite sources. Offsite benefits accrued from improved and expanded recreation visitor days. The value of a visitor day was determined using the point rating method for general recreation (Principles and Guidelines, Table VIII-3-2, p. 85). The point value was determined for both without and with project conditions. The gross value of the impairment was calculated to be $1.05 per visitor day. The value of impairment was adjusted to account for probability of occurrence. Based upon historic climatic parameters a probability was assigned for each month. The probability ranged from .25 for winter and wet months to .80 for the dry, hot summer months. The net value of the impairment, after weighting for probability, was $.58 per visitor day.

The increased use due to development of water based activities was estimated to be 9000 visitor days. The value of the visitor day was calculated to be $5.02.

No on-site benefits were calculated from the utilization of animal waste. Benefits will occur from the application of animal waste on pastureland and cropland. The nutrients in the animal waste

will result in increased yields. No measurement was made of project induced use of the animal waste.

Biology

Consultation and coordination with U.S. Fish & Wildlife Service and Texas Parks & Wildlife Department was conducted to gain their input into planning objectives. SCS Biologists made on site evaluations of present conditions of habitat and projected future impacts. Because most of the planned treatment will be to dairy holding pens and adjacent areas, no major impacts on wildlife habitat is expected. Aquatic habitat was investigated during the evaluation process.

Sociology

In order to obtain social information for the Upper North Bosque River Watershed, representatives of common interest groups were interviewed by SCS personnel in Stephenville on August 7,1991. Other types of sociological data, including census data and survey data, are incorporated as Appendix D-1. This data provides a broad perspective on the social status of the Upper North Bosque Watershed, the social effects of poor water quality, and the potential social benefits of the proposed project.

APPENDIX D

SUPPORTING INFORMATION

APPENDIX D - 1

SOCIAL ASSESSMENT

SOCIAL ASSESSMENT

I. Historical Background

The 229,760 acre Upper North Bosque Watershed is located in Erath and Hamilton Counties in north-central Texas. The City of Stephenville is the largest community with a population of 14,627. Other communities within the watershed are Dublin (pop. 3,005) and Hico (pop. 1,342).

Erath County was created in 1856 from Bosque and Coryell Counties and named for George B. Erath, an early frontiersman and Indian fighter. Hamilton County was originally created in 1842. In 1858, Hamilton County was re-created from Bosque, Comanche, and Lampasas counties. It was named for South Carolinian Governor James Hamilton who aided the Texas Revolution and Republic.

Stephenville used to be known as a retirement town. Population consisted of retired farmers and young college students. Middle aged residents were conspicuously absent from the population. Now the population is more equally distributed among the different age groups.

Erath County is predominantly church oriented, with Baptist being the main denomination. Tarleton State University and Texas A&M Research and Extension Center are located in Stephenville. Transportation within the watershed includes 17.3 miles of railroads and 449 miles of roads.

II. Population Characteristics

A. Population Trends

Population in Erath County has grown from 18,900 in 1977 to 26,600 in 1989. Approximately 49 percent (13,100) of the population is male and 51 percent (13,500) is female. The City of Stephenville's population has increased from 11,881 in 1980 to 13,502 in 1990.

Increased population is due in part to installation of a nuclear energy plant in Glen rose. Many of the plant's employees commute from Stephenville to Glen Rose.

B. Industrial Characteristics

In 1980, Erath County was the "state's second leading county in milk production." Today, it leads the state in milk production and is second in the number of dairy cattle present. In 1987, the county had 45,433 dairy cattle on 241 farms compared to 30,987 dairy cattle in 1982.

Beef cattle are also important to Erath County. The number of farms with beef cattle decreased from 1,029 in 1982 to 973 in 1987. However, the number of beef cattle in the county increased from 28,597 in 1982 to 28,906 in 1987.

Another significant industry is horticulture. The industry is expanding in Erath County, especially tree growing and green houses.

Crops produced in Erath County include small grains, fruit, and sorghums. Peanuts are the major cash crop. There is some irrigation in the county, mostly on peanuts.

The Stephenville Chamber of Commerce is aggressive in its efforts to bring industry into the city. Industries located in Stephenville include three small sewing factories, and an abrasive manufacturer. Industrial fluid control and electric equipment are other industries located in the city. A cheese processing plant is also located in Stephenville and has plans to expand in the future. Other dairy related businesses include suppliers of dairy equipment, feed, and veterinary services.

C. Agricultural Characteristics

Farms in Erath County numbered 1,599 on 562,030 acres in 1987 compared to 1,564 farms on 553,935 acres in 1982. Average farm size is 351 acres. The following tabulation shows the number of farms in 1982 and 1987 by value of sales of agricultural products.

NUMBER OF FARMS BY VALUE OF SALES

Sales Value	1982 No. Farms	1987 No. Farms
<$2,500	489	453
$2,500 - $4,999	269	286
$5,000 - $9,999	248	240
$10,000 - $24,999	208	227
$25,000 - $49,000	98	112
$50,000 - $99,999	59	61
> or = $100,000	192	220
Total Farms	1,564	1,599

Source: 1987 Census of Agriculture

Average value of farmland and its buildings has changed from $704 per acre in 1982 to $824 per acre in 1987, an increase of 17 percent. Farm production expenses averaged $52,413 per farm in 1987.

In 1987, total market value of agricultural products sold totaled approximately $112,428,000, with an average of $70,311 per farm. Market value of crops, greenhouses, and nurseries was approximately $7,008,000. Livestock, poultry, and other products had an estimated market value of $105,420,000. Dairy products sold for an estimated $78,966,000 from approximately 208 farms. In 1982, dairy products sold for $50,153,000 from 221 farms.

Approximately 1,122 operators (70 percent) are sole owners of their farms. Part owners account for 340 operators (21 percent) and 137 operators (9 percent) are tenants. An estimated 45 percent operators (725) reported farming as their principal occupation in 1987 and compared to 44 percent (695) of the operators in 1982. Fifty five percent of the operators in 1987 stated farming was not their principal occupation. In 1982, this figure was 56 percent (869).

D. Income Distribution

County wide, employment is approximately 95.3 percent. Per capita income is $13,391 with an average weekly wage of $281.43. Estimated local tax base is $1,174,853,546.00.

With an unemployment rate of 4.70 percent, Erath County spends $5,706,277 on welfare. Population percentage under poverty level is 16.90 percent.

E. Attitudes and Perceptions

The community is very much aware of the water quality problem. Newspaper articles and letters to the editor concerning the problem appear in local and area newspapers regularly. Numerous public meetings have been held concerning the water quality problem.

Agencies, institutes, and others are also aware of Erath County's water quality problem. The Extension Service is currently monitoring animal waste discharge on dairies in Erath County. Studies are also being conducted by Tarleton State University and Institute for Applied Research with grants from EPA. As the water quality in Erath County will also affect water quality

in Lake Waco and the future Lake Bosque, the Brazos River Authority and the City of Waco are also monitoring this project. These two lakes supply drinking water to an estimated population of 136,000.

F. History and Concern for Water Quality

Newspaper reports provide a history of insight into the publics awareness and concern of the water quality in the Upper North Bosque River. Numerous public meetings have also been held. Minutes of these meetings are available at the SCS State Office. Following is a summary of articles printed in local, regional, and state-wide newspapers:

DATE	NEWSPAPER	COMMENTS
?	Stephenville Empire-Tribune	Article about a dairy family. "Strict quidelines dealing with wastewater discharges from dairies have cost the Beltman family plenty in terms of fines, lawyer's fees and even future plans."
?	Texas Agriculture	"Research institute tackles dairy problems." Headline.
?	?	Announced plans for dairy waste management demonstration project in Erath County.
?	Stephenville Empire-Tribune	SCS Chief tours Erath County to assess dairy waste management problems.
10-2-88	Stephenville Empire-Tribune	"Quality groundwater vital to economy."
6-7-89	Stephenville Empire-Tribune	"...the worst thing is the contamination and pollution that is being done to the surface waters of the area that replenishes the underground water." Letter to Editor.
6-18-89	Fort Worth Star-Telegram	"As dairies move into Erath County, manure washes into ponds and streams teaching neighbors about Milk's Dark Side." Headline.
6-24-89	Fort Worth Star-Telegram	U.S. House Agriculture Committee to hold meetings in Stephenville to study the dairy pollution problem.
6-25-89	Fort Worth Star-Telegram	"Texas Water Commission officials yesterday announced a stepped-up assault on Erath County dairy pollution, saying staggering increases in public complaints and growing publicity had made the problem its top priority."

6-29-89	Dublin Progress	Cross Timbers Concerned Citizens organized and Congressman Charles Stenholm scheduled to address pollution problem in Stephenville.
6-29-89	Waco Tribune-herald	"The problem (animal waste that must be disposed of) takes on added significance because the Bosque River, which runs through Erath County, flows into Lake Waco. State water officials say the pollution is not a Lake Waco problem - yet."
6-29-89	Stephenville Empire-Tribune	Subcommittee of U.S. House of Representatives to hold hearing to review livestock waste management systems and methods of preventing water contamination at Tarleton State University.
6-29-89	Fort Worth Star-Telegram	Congressional hearing to be held in Stephenville. "...officials say the unusual hearing at Tarleton State University will focus further attention on a problem that experts say could threaten Central Texas water supplies."
6-30-89	Stephenville Empire-Tribune	Dallas television news story on water pollution in Erath County caused by dairy waste portrays dairy farmer in negative light.
7-2-89	Stephenville Empire-Tribune	"She said polluted water regularly runs across her property from _____ dairy and that some days 'the stench is so bad you can't go outside without retching.'"
7-2-89	Stephenville Empire-Tribune	Dairyman tells his side of the story.
7-2-89	Stephenville Empire-Tribune	"...noticeable increase in water pollution attributable to dairy waste has not become visible until the last two years."

7-5-89	Waco Tribune-Herald	"Keep dairy runoff out of Lake Waco.""Dairy farms are the lifeblood of Erath County, but the Bosque River is the lifeblood of Lake Waco." Editorial.
8-13-89	Stephenville Empire-Tribune	Open forum held for dairymen and state agencies in Stephenville.
9-19-89	Fort Worth Star-Telegram	Nine dairies may face stiff fines by TWC.
9-19-89	Stephenville Empire-Tribune	Nine dairies may face stiff fines by TWC.
9-20-89	Stephenville Empire-Tribune	Erath County dairies fined a total of $342,160 by TWC.
9-20-89	Stephenville Empire-Tribune	Editorial on how heavy fines on local dairies are out of line.
9-28-89	Stephenville Empire-Tribune	Dairyman says they need help not threats in Letter to the Editor.
10-4-89	Stephenville Empire-Tribune	Sen. Glasgow pledges support in getting Erath County dairymen to comply with TWC regulations.
10-24-89	Stephenville Empire-Tribune	"... the Texas State Soil and Water Conservation Board has identified runoff from these dairy operations in the Upper North Bosque River watershed as the highest priority agricultural related nonpoint source water quality problem in the state of Texas."
11-1-89	Fort Worth Star-Telegram	Dairies hire lawyer to argue their case before TWC.
11-2-89	Fort Worth Star-Telegram	Editorial on water quality problem in Erath County.
11-8-89	Stephenville Empire-Tribune	Editorial discusses results of geologist's report on water quality in Erath County.

11-8-89	Stephenville Empire-Tribune	Geologist reports that the Trinity Sands Aquifer, which supplies drinking water for 56 counties, is in real danger of being contaminated.
12-17-89	Stephenville Empire-Tribune	"In many cases, law enforcement agencies, to gain recognition and public votes, are tuning against those who farm and are passing legislation which makes it virtually impossible for those engaged in agribusiness to operate." Quote.
12-21-89	Dublin Progress	TWC officials speak at Cross Timbers Concerned Citizens meeting in Dublin.
2-1-90	Fort Worth Star-Telegram	"Pay the fines or else, dairy farms are told." Headline.
2-22-90	Dublin Progress	Six Erath County dairies fined by TWC.
2-25-90	Stephenville Empire-Tribune	"I think there's some potential for contamination,...,that's reason for concern." TWC
2-25-90	Stephenville Empire-Tribune	The main thrust of the organization (Dublin Concerned Citizens) is concern for elderly being adversely affected by contaminated run-off.
3-1-90	The J-TAC	Tarleton receives water resource grant to study and evaluate water quality in Erath County.
3-12-90	Stephenville Empire-Tribune	"Symposium to touch water resources." Headline.
4-8-90	Stephenville Empire-Tribune	Tarleton Institution for Research created to conduct research and initiate planning to resolve problems associated with dairy pollution, water quality, and economic development in Stephenville area.

APPENDIX D - 2

ANIMAL WASTE LOADINGS IN WATERSHED RUNOFF

File: AWLR

UPPER NORTH BOSQUE RIVER WATERSHED - PL-566 WATERSHED PROTECTION (WATER QUALITY) PROJECT

ANIMAL WASTE IN WATERSHED AVERAGE ANNUAL RUNOFF

PRESENT CONDITIONS - (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows	Animal Waste (wet)	total solids	volatile solids	TKN	P2O5 total	K2O total	Na	Downstream Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	total solids lbs.	volatile solids lbs.	TKN lbs.	P2O5 total lbs.	K2O total lbs.	Na lbs.
	(No.)	(lbs./yr.)	%	%	%	%	%	%												
I	2,580	134,474,160	40.70	10.60	0.54	0.26	0.45	0.078	0.250	0.005	0.005	0.004	0.030	0.070	13,682,810	71,270	3,630	1,400	10,150	1,150
II	630	32,836,868	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	3,341,150	11,400	890	340	4,430	1,750
III	2,320	120,923,040	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	12,303,920	64,090	3,260	1,260	16,320	6,430
IV	4,310	224,645,920	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	22,857,710	119,060	6,070	2,340	30,330	11,950
V	900	46,909,800	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	4,773,070	24,860	1,270	490	6,330	2,500
VI	10,290	536,335,380	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	54,572,120	284,260	14,480	5,580	72,410	28,530
VII	490	25,539,780	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	2,598,670	13,540	690	270	3,450	1,360
Total	21,520	1,121,665,448													114,129,450	594,480	30,290	11,680	151,420	59,670

FUTURE WITHOUT PL-566, GPCP, AND SPECIAL ACP COST-SHARE - (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows	Animal Waste (wet) *	total solids	volatile solids	TKN	P2O5 total	K2O total	Na	Downstream Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	PERCENT INCREASE OVER PRESENT CONDITIONS: total solids % increase	volatile solids % increase	TKN % increase	P2O5 total % increase	K2O total % increase	Na % increase
	(No.)	(lbs./yr.)	%	%	%	%	%	%												
I	4,550	237,155,100	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	16	78	76	16	76	77
II	910	47,431,020	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	44	44	44	44	44	44
III	4,710	245,621,940	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	106	106	106	106	106	106
IV	5,480	285,628,560	40.10	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	27	27	27	27	21	21
V	2,300	119,880,600	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	156	156	156	156	156	155
VI	13,350	695,828,100	40.70	10.60	0.54	0.26	0.45	0.078	0.250	0.005	0.005	0.004	0.030	0.070	30	30	30	30	30	30
VII	920	47,952,240	40.70	10.60	0.54	0.26	0.45	0.078	0.250	0.005	0.005	0.004	0.030	0.070	88	88	87	85	88	88
Total	32,290	1,682,498,160													58	58	58	58	58	58

FUTURE WITH PL-566, GPCP, AND SPECIAL ACP COST-SHARE [116 + 31 PL-566 + 50 GPCP and SPECIAL ACP] + 95 DAIRIES WITH ADEQUATE MANAGEMENT, 15 WITHOUT ADEQUATE MANAGEMENT

Reach	#Cows	Animal Waste (wet)	total solids	volatile solids	TKN	P2O5 total	K2O total	Na	Downstream Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	PERCENT REDUCTION FROM FUTURE-WITHOUT-PROJECT: total solids % reduct.	volatile solids % reduct.	TKN % reduct.	P2O5 total % reduct.	K2O total % reduct.	Na % reduct.
	(No.)	(lbs./yr.)	%	%	%	%	%	%												
I	110	31,006,620	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	94	94	84	85	84	84
II	140	7,297,080	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	85	85	84	84	85	85
III	750	39,091,500	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	94	94	84	84	84	84
IV	860	44,824,920	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	94	94	84	84	84	84
V	360	18,763,920	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	94	94	84	84	84	84
VI	2,090	108,934,980	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	94	94	84	84	84	84
VII	140	7,297,080	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	85	85	84	84	85	85
Total	5,050	263,216,100													94	94	84	84	84	84

* Cows producing inadequately managed waste

File: MLR

UPPER NORTH BOSQUE RIVER WATERSHED : PL-566 WATERSHED PROTECTION (WATER QUALITY) PROJECT

ANIMAL WASTE IN WATERSHED AVERAGE ANNUAL RUNOFF

PRESENT CONDITIONS (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows	Animal Waste (wet)	total solids	volatile solids	TKN	P2O5 total	K2O total	Na	DOWNSTREAM Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	total solids	volatile solids	TKN	P2O5 total	K2O total	Na
	(No.)	(lbs./yr.)	%	%	%	%	%	%							lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
IV	4,310	224,645,820	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	22,857,710	119,060	6,070	2,340	30,330	11,950
III	2,320	120,923,040	40.10	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	12,303,920	64,090	3,260	1,260	16,320	6,430
	6,630	345,568,860													35,161,630	183,150	9,330	3,600	46,650	18,380
II	630	32,836,860	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	3,341,150	17,400	890	340	4,430	1,750
Total	7,260	378,405,720													38,502,780	200,550	10,220	3,940	51,080	20,130
V	900	46,909,800	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	4,773,070	24,860	1,270	490	6,330	2,500
VI	10,290	536,335,380	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	54,572,120	284,260	14,480	5,590	72,410	28,530
VII	490	25,539,180	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	2,598,670	13,540	690	270	3,450	1,360
	18,940	987,190,680													100,446,640	523,210	26,660	10,280	133,270	52,520
I	2,580	134,474,760	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	13,682,810	71,270	3,630	1,400	18,150	7,150
Total	21,520	1,121,665,440													114,129,450	594,480	30,290	11,680	151,420	59,670

FUTURE WITHOUT PL-566, EQIP, AND SPECIAL ACP COST-SHARE (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows	Animal Waste (wet)	total solids	volatile solids	TKN	P2O5 total	K2O total	Na	DOWNSTREAM Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	total solids	volatile solids	TKN	P2O5 total	K2O total	Na
	(No.)	(lbs./yr.)	%	%	%	%	%	%							lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
IV	5,480	285,628,560	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	29,062,710	151,380	7,710	2,970	38,560	15,200
III	4,770	248,621,940	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	25,297,280	131,770	6,710	2,590	33,560	13,230
	10,250	534,250,500													54,359,990	283,150	14,420	5,560	72,120	28,430
II	910	47,431,020	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	4,826,110	25,140	1,280	490	6,400	2,520
Total	11,160	581,681,520													59,186,100	308,290	15,700	6,050	78,520	30,950
V	2,300	119,880,600	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	12,197,650	63,540	3,240	1,250	16,180	6,380
VI	13,350	695,828,700	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	70,800,570	368,790	18,790	7,240	93,940	37,020
VII	920	47,952,240	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	4,879,140	25,410	1,290	500	6,470	2,550
	27,730	1,445,343,060													147,063,660	766,030	39,020	15,040	195,110	76,900
I	4,550	237,155,100	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	24,130,530	125,690	6,400	2,470	32,020	12,620
Total	32,280	1,682,498,160													171,194,190	891,720	45,420	17,510	227,130	89,520

Cows producing inadequately managed waste

UPPER NORTH BOSQUE RIVER WATERSHED : PL-566 WATERSHED PROTECTION (WATER QUALITY) PROJECT

ANIMAL WASTE IN WATERSHED AVERAGE ANNUAL RUNOFF

PRESENT CONDITIONS (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows (No.)	Animal Waste (wet) lbs./yr.	total solids %	volatile solids %	TKN %	P2O5 total %	K2O total %	Na %	ON-SITE Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	total solids lbs.	volatile solids lbs.	TKN lbs.	P2O5 total lbs.	K2O total lbs.	Na lbs.
I*	4,310	224,645,820	40.70	10.60	0.54	0.26	0.45	0.074	1.00	1.00	1.00	1.00	1.00	1.00	91,430,850	23,812,460	1,213,090	584,080	1,010,910	170,730
III	2,320	120,923,040	40.70	10.60	0.54	0.26	0.45	0.074	1.00	1.00	1.00	1.00	1.00	1.00	49,215,480	12,817,840	652,980	314,400	544,150	91,980
	6,630	345,568,860													140,646,330	36,630,300	1,866,070	898,480	1,555,060	262,630
II	630	32,836,860	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	13,364,600	3,480,710	177,320	85,380	147,770	24,960
total	7,260	378,405,720													154,011,130	40,111,010	2,043,390	983,860	1,702,830	287,590
V	900	46,909,800	40.70	10.60	0.54	0.26	0.45	0.074	1.00	1.00	1.00	1.00	1.00	1.00	19,092,290	4,972,440	253,310	121,970	211,090	35,650
VI	10,290	536,335,380	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	218,280,580	56,851,580	2,896,210	1,394,470	2,413,510	407,610
VII	490	25,539,780	40.70	10.60	0.54	0.26	0.45	0.074	1.00	1.00	1.00	1.00	1.00	1.00	10,394,690	2,707,220	137,910	66,460	114,930	19,410
	18,940	987,190,480													401,786,610	104,642,220	5,330,820	2,566,780	4,442,360	750,240
1	2,580	134,474,760	40.70	10.60	0.54	0.26	0.45	0.014	1.00	1.00	1.00	1.00	1.00	1.00	54,731,230	14,254,320	726,160	349,630	605,140	102,200
total	21,520	1,121,665,440													456,517,840	118,896,540	6,056,980	2,916,230	5,047,500	852,440

FUTURE WITHOUT PL-566, GPCP, AND SPECIAL ACP COST-SHARE (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows (No.)	Animal Waste (wet) lbs./yr.	total solids %	volatile solids %	TKN %	P2O5 total %	K2O total %	Na %	ON-SITE Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	total solids lbs.	volatile solids lbs.	TKN lbs.	P2O5 total lbs.	K2O total lbs.	Na lbs.
I*	5,480	285,628,560	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	116,280,820	30,276,630	1,542,390	742,630	1,285,330	217,090
III	4,770	248,621,940	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	101,189,130	26,353,930	1,342,560	646,420	1,118,800	188,950
	10,250	534,250,500													217,470,950	56,630,560	2,884,950	1,389,050	2,404,130	406,030
II	910	47,431,020	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	19,304,430	5,027,490	256,130	123,320	213,440	36,080
total	11,160	581,681,520													236,744,380	61,658,050	3,141,080	1,512,370	2,617,570	442,080
V	2,300	119,880,600	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	48,791,400	12,707,340	647,360	311,690	539,460	91,110
VI	13,350	695,828,700	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	283,202,280	73,757,840	3,757,470	1,809,150	3,131,230	528,830
VII	920	47,952,240	40.70	10.60	0.54	0.26	0.45	0.074	1.00	1.00	1.00	1.00	1.00	1.00	19,516,560	5,082,940	258,940	124,680	215,790	36,440
	27,730	1,445,343,060													588,254,620	153,206,370	7,804,950	3,757,890	6,504,050	1,098,460
I	4,550	237,155,100	40.10	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	96,522,130	25,138,440	1,280,640	616,600	1,067,200	180,240
total	32,280	1,682,498,160													684,776,750	178,344,810	9,085,590	4,374,490	7,571,250	1,278,700

* Cows producing inadequately managed waste

ANIMAL WASTE LOADINGS IN WATERSHED AVERAGE ANNUAL RUNOFF

ABOVE FLOOD PREVENTION STRUCTURES

File: AWLR

UPPER NORTH BOSQUE RIVER WATERSHED : PL-566 WATERSHED PROTECTION (WATER QUALITY) PROJECT

ANIMAL WASTE IN WATERSHED AVERAGE ANNUAL RUNOFF ABOVE FLOOD PREVENTION STRUCTURES

PRESENT CONDITIONS (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows	Animal Waste Unit lbs./yr.	total solids %	volatile solids %	TKN %	P2O5 total %	K2O total %	Na %	DOWNSTREAM Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	total solids lbs.	volatile solids lbs.	TKN lbs.	P2O5 total lbs.	K2O total lbs.	Na lbs.
IV	3,550	185,033,100	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	18,827,120	98,070	5,800	1,920	24,900	9,840
III	1,720	89,649,840	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	9,121,870	47,510	2,420	930	12,100	4,770
	5,270	274,682,940													27,948,990	145,580	7,420	2,850	37,000	14,610
II	260	13,551,720	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	1,378,890	7,180	370	140	1,830	720
total	5,530	288,234,660													29,327,880	152,760	7,790	2,990	38,910	15,330
V	580	30,230,160	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	3,075,980	16,020	820	310	4,080	1,610
VI	5,310	276,767,820	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	28,161,130	146,690	7,470	2,880	37,360	14,720
VII	490	25,539,780	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	2,598,670	13,540	690	270	3,450	1,360
	11,910	620,773,020													63,163,660	329,010	16,770	6,450	83,800	33,020
I	1,650	86,001,300	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	8,750,630	45,580	2,320	890	11,610	4,590
total	13,560	706,774,320													71,914,290	374,590	19,090	7,340	95,410	37,610

FUTURE WITHOUT PL-566, EPCP, AND SPECIAL ACP COST-SHARE (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows	Animal Waste Unit lbs./yr.	total solids %	volatile solids %	TKN %	P2O5 total %	K2O total %	Na %	DOWNSTREAM Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	total solids lbs.	volatile solids lbs.	TKN lbs.	P2O5 total lbs.	K2O total lbs.	Na lbs.
IV	4,300	224,124,600	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	22,804,600	118,790	6,950	2,330	30,260	11,920
III	3,100	161,578,200	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	16,440,980	85,640	4,360	1,680	21,810	8,600
	1,400	385,702,800													39,245,260	204,430	10,410	4,010	52,070	20,520
II	510	26,582,220	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	2,704,740	14,090	720	280	3,590	1,410
total	7,910	412,285,020													41,950,000	218,520	11,130	4,290	55,660	21,930
V	900	46,909,800	40.70	10.60	4.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	4,773,070	24,860	1,270	490	6,330	2,500
VI	4,550	341,399,100	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	34,737,340	180,940	9,220	3,550	46,090	18,160
VII	920	47,952,240	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	4,879,140	25,410	1,290	500	6,470	2,550
	14,280	848,546,160													86,339,870	449,730	22,910	8,830	114,550	45,140
I	2,720	141,771,840	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	14,425,280	75,140	3,830	1,470	19,140	7,540
total	19,000	990,318,000													100,764,850	524,870	26,740	10,300	133,690	52,680

Cows producing inadequately managed waste

File: ANLRPS

UPPER NORTH BOSQUE RIVER WATERSHED : PL-566 WATERSHED PROTECTION WATER QUALITY! PROJECT

ANIMAL WASTE IN WATERSHED AVERAGE ANNUAL RUNOFF ABOVE FLOOD PREVENTION STRUCTURES

PRESENT CONDITIONS (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows [No.]	Animal Waste Iwet7 lbs./yr.7	total solids %	volatile solids %	TKN %	P205 total %	K20 total %	Na %	On-Site Delivery Ratio Factors: total solids	volatile solids	TKN	P205 total	K20 total	Na	total solids lbs.	volatile solids lbs.	TKN lbs.	P205 total lbs.	K20 total lbs.	Na lbs.
II	3,550	185,833,100	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	75,308,470	19,613,510	999,180	481,090	832,650	140,630
III	1,720	89,649,040	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	36,487,480	9,502,880	484,110	233,090	403,420	68,130
	5,210	274,682,940													111,795,950	29,116,390	1,483,290	714,180	1,236,070	208,160
II	260	13,551,720	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	5,515,550	1,436,480	73,180	35,230	60,980	10,300
total	5,530	288,234,660													117,311,500	30,552,870	1,556,470	749,410	1,297,050	219,060
V	580	30,230,760	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	12,303,920	3,204,460	163,250	78,600	136,040	22,960
VI	5,310	216,161,820	60.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	112,644,500	29,337,390	1,494,550	719,600	1,245,460	210,340
VII	490	25,539,780	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	10,394,690	2,707,220	137,910	66,400	114,930	19,410
	11,910	620,773,020													252,654,610	65,801,940	3,352,180	1,614,010	2,793,490	471,790
I	1,650	86,001,300	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	35,002,530	9,116,140	464,410	223,600	387,010	65,360
total	13,560	706,774,320													287,657,140	74,918,080	3,816,590	1,837,610	3,180,490	537,150

FUTURE WITHOUT PL-566, RPCP, AND SPECIAL ACP COST-SHARE (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT 7

Reach	#Cows [No.]	Animal Waste Iwell lbs./yr.1	total solids %	volatile solids %	TKN %	P205 total %	K20 total %	Na %	On-Site Delivery Ratio Factors: total solids	volatile solids	TKN	P205 total	K20 total	Na	total solids lbs.	volatile solids lbs.	TKN lbs.	P205 total lbs.	K20 total lbs.	Na lbs.
IV	4,300	224,124,600	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	91,218,710	23,757,210	1,210,270	582,720	1,008,560	170,330
III	3,100	161,578,200	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	65,762,330	17,127,270	872,520	420,100	727,100	122,800
	7,400	385,702,800													156,981,040	40,884,800	2,082,790	1,002,820	1,735,660	293,130
II	510	26,582,220	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	10,818,960	2,817,720	143,540	69,110	119,620	20,200
total	7,910	412,285,020													167,800,000	43,702,220	2,226,330	1,071,930	1,855,280	313,330
V	900	46,909,800	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	19,092,290	4,972,440	253,310	121,970	211,090	35,650
VI	6,550	341,399,100	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	138,949,430	36,180,300	1,843,560	887,640	1,536,380	259,460
VII	920	47,952,240	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	19,516,560	5,082,940	258,940	124,680	215,790	36,440
	16,280	848,546,160													345,308,280	89,945,900	4,582,140	2,206,220	3,818,460	644,880
I	2,120	141,771,840	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	57,781,140	15,027,820	765,570	368,610	637,970	107,750
total	19,000	990,318,000													403,089,420	104,973,720	5,347,710	2,574,830	4,456,430	752,630

d Cows producing inadequately managed waste

UPPER NORTH BOSQUE RIVER WATERSHED : PL-566 WATERSHED PROTECTION (WATER QUALITY) PROJECT

ANIMAL WASTE IN WATERSHED AVERAGE ANNUAL RUNOFF ABOVE FLOOD PREVENTION STRUCTURES

PRESENT CONDITIONS (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows	Animal Waste (wet)	total solids	volatile solids	TKN	P2O5 total	K2O total	Na	DOWNSTREAM Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	total solids	volatile solids	TKN	P2O5 total	K2O total	Na
	(No.)	(lbs./yr.)	%	%	%	%	%	%							lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
I	1,650	86,001,300	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	8,750,630	45,500	2,320	890	11,610	4,500
II	260	13,551,120	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	1,378,890	7,180	370	140	1,830	720
III	1,720	89,649,840	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	9,121,870	47,510	2,420	930	12,100	4,770
IV	3,550	185,033,100	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	18,827,120	98,070	5,000	1,920	24,980	9,840
V	580	30,230,160	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	3,075,980	16,020	820	310	4,080	1,610
VI	5,310	274,747,620	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	28,161,130	146,690	7,470	2,880	37,360	14,720
VII	490	25,539,780	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	2,598,670	13,540	690	270	3,450	1,360
Total	13,560	706,774,320													71,914,290	374,890	19,090	7,340	95,410	37,600

FUTURE WITHOUT PL-566, GPCP, AND SPECIAL ACP COST-SHARE (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows	Animal Waste (wet)	total solids	volatile solids	TKN	P2O5 total	K2O total	Na	DOWNSTREAM Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	PERCENT INCREASE OVER PRESENT CONDITIONS: total solids	volatile solids	TKN	P2O5 total	K2O total	Na
	(No.)	(lbs./yr.)	%	%	%	%	%	%							% increase	% increase	% increase	% increase	% increase	% increase
I	2,720	141,771,840	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	65	65	65	65	65	65
II	510	26,582,220	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	96	96	95	100	96	96
III	3,100	161,578,200	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	80	80	80	81	80	80
IV	4,300	224,124,600	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	21	21	21	21	21	21
V	900	46,909,800	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	55	55	55	56	55	55
VI	6,560	341,399,100	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	23	23	23	23	23	23
VII	920	47,952,240	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	88	88	87	86	88	88
Total	19,000	990,318,000													46	46	46	45	46	46

FUTURE WITH PL-566, GPCP, AND SPECIAL ACP COST-SHARE (114 + 31 PL-566 + 80 GPCP and SPECIAL ACP) + 95 DAIRIES WITH ADEQUATE MANAGEMENT, 15 WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows	Animal Waste (wet)	total solids	volatile solids	TKN	P2O5 total	K2O total	Na	DOWNSTREAM Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	PERCENT REDUCTION FROM FUTURE-WITHOUT-PROJECT: total solids	volatile solids	TKN	P2O5 total	K2O total	Na
	(No.)	(lbs./yr.)	%	%	%	%	%	%							% reduct.	% reduct.	% reduct.	% reduct.	% reduct.	% reduct.
I	410	21,370,020	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	85	85	85	85	85	85
II	80	4,169,760	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	84	84	85	86	84	84
III	400	20,846,800	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	87	87	87	87	87	87
IV	560	29,188,320	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	87	87	87	87	87	87
V	140	1,297,080	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	84	84	84	84	84	84
VI	1,050	54,728,100	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	84	84	84	84	84	84
VII	140	7,297,080	40.10	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	85	85	84	84	85	85
Total	2,780	144,899,160													85	85	85	85	85	85

* Cows producing inadequately managed waste

ANIMAL WASTE LOADINGS IN WATERSHED AVERAGE ANNUAL RUNOFF

BELOW FLOOD PREVENTION STRUCTURES

File : ANLRBFPS

UPPER NORTH BOSQUE RIVER WATERSHED : PL-566 WATERSHED PROTECTION (WATER QUALITY) PROJECT

ANIMAL WASTE IN WATERSHED AVERAGE ANNUAL RUNOFF BELOW FLOOD PREVENTION STRUCTURES

PRESENT CONDITIONS (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows (No.)	Animal Waste (wet) (lbs./yr.)	total solids %	volatile solids %	TKN %	P2O5 total %	K2O total %	Na %	ON-SITE Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	total solids lbs.	volatile solids lbs.	TKN lbs.	P2O5 total lbs.	K2O total lbs.	Na lbs.
IV	760	39,612,720	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	16,122,380	4,198,950	213,910	102,990	178,260	30,110
III	600	31,273,200	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	12,728,190	3,314,960	168,880	81,310	140,730	23,170
	1,360	70,885,920													28,850,570	7,513,910	382,790	184,300	318,990	53,280
II	370	19,285,740	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	7,849,050	2,044,220	104,140	50,140	86,780	14,660
total	1,730	90,171,060													36,699,620	9,558,130	486,930	234,440	405,770	68,540
V	320	16,679,040	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	6,788,370	1,767,980	90,070	43,310	15,060	12,680
VI	6,980	259,567,560	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	105,644,000	27,516,160	1,401,660	674,880	1,169,050	197,210
VII	0	0	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	0
	7,030	366,617,660													149,131,990	38,840,270	1,978,660	952,690	1,648,880	278,190
I	930	48,473,460	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	19,728,700	5,138,190	261,760	126,030	218,130	36,840
total	7,960	414,891,720													168,860,690	43,978,460	2,240,420	1,078,720	1,867,010	315,330

FUTURE WITHOUT PL-566, GPCP, AND SPECIAL ACP COST-SHARE (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows (No.)	Animal Waste (wet) (lbs./yr.)	total solids %	volatile solids %	TKN %	P2O5 total %	K2O total %	Na %	ON-SITE Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	total solids lbs.	volatile solids lbs.	TKN lbs.	P2O5 total lbs.	K2O total lbs.	Na lbs.
IV	1,180	61,503,960	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	25,032,110	6,519,420	332,120	159,910	276,770	46,740
III	1,670	87,043,740	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	35,426,800	9,226,640	470,040	226,310	391,700	66,150
	2,850	148,547,700													60,458,910	15,746,060	802,160	386,220	668,470	112,890
II	400	20,848,800	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	8,485,460	2,209,970	112,580	54,210	93,820	15,850
total	3,250	169,396,500													68,944,370	17,956,030	914,740	440,430	762,290	128,740
V	1,400	72,970,800	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	29,699,120	7,734,900	394,040	189,720	328,370	55,460
VI	6,800	354,429,600	40.70	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	144,252,850	37,569,540	1,913,920	921,520	1,594,930	269,370
VII	0	0	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	0
	17,450	596,796,900													242,896,340	63,260,470	3,222,700	1,551,670	2,685,590	453,570
I	1,830	95,383,260	40.10	10.60	0.54	0.26	0.45	0.076	1.00	1.00	1.00	1.00	1.00	1.00	38,820,990	10,110,630	515,070	248,000	429,220	72,490
total	13,280	692,780,160													281,717,330	73,371,700	3,737,770	1,799,670	3,114,810	526,060

Cows producing inadequately managed waste

File: AWLR

UPPER NORTH BOSQUE RIVER WATERSHED : PL-566 WATERSHED PROTECTION (WATER QUALITY) PROJECT

ANIMAL WASTE IN WATERSHED AVERAGE ANNUAL RUNOFF BELOW FLOOD PREVENTION STRUCTURES

PRESENT CONDITIONS (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows	Animal Waste (wet)	total solids	volatile solids	TKN	P2O5 total	K2O total	Na	DOWNSTREAM Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5	K2O	Na	total solids	volatile solids	TKN	P2O5 total	K2O total	Na
	[No.]	(lbs./yr.)	%	%	%	%	%	%				total	total		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
IV	760	39,612,720	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	4,030,590	20,990	1,070	410	5,350	2,110
III	600	31,273,200	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	3,182,050	16,570	840	330	4,220	1,660
	1,360	70,885,920																		
II	370	19,285,140	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	7,212,640	37,560	1,910	740	9,570	3,770
total	1,730	90,171,060													1,962,260	10,220	520	200	2,600	1,030
															9,174,900	47,780	2,430	940	12,170	4,800
V	320	16,679,040	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	1,697,090	8,840	450	170	2,250	890
VI	4,980	259,567,560	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	26,411,000	137,570	7,010	2,700	35,040	13,810
VII	0	0	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	0
	7,030	366,417,660																		
I	930	48,473,460	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	37,282,990	194,190	9,890	3,810	49,460	19,500
total	7,960	414,891,120													4,932,170	25,690	1,310	500	6,540	2,580
															42,215,160	219,880	11,200	4,310	56,000	22,080

FUTURE WITHOUT PL-566, GPCP, AND SPECIAL ACP COST-SHARE (14 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows	Animal Waste (wet)	total solids	volatile solids	TKN	P2O5 total	K2O total	Na	DOWNSTREAM Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5	K2O	Na	total solids	volatile solids	TKN	P2O5 total	K2O total	Na
	[No.]	(lbs./yr.)	%	%	%	%	%	%				total	total		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
IV	1,180	61,503,960	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	6,258,030	32,600	1,660	640	8,300	3,270
III	1,670	87,043,740	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	8,856,700	46,130	2,350	910	11,750	4,630
	2,850	148,547,700																		
II	400	20,848,800	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	15,114,730	78,730	4,010	1,550	20,050	7,900
total	3,250	169,396,500													2,121,370	11,050	560	220	2,810	1,110
															17,236,100	89,780	4,570	1,770	22,860	9,010
V	1,400	72,970,800	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	7,424,780	38,670	1,970	760	9,850	3,880
VI	6,800	354,429,600	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	36,063,210	187,850	9,570	3,690	47,850	18,860
VII	0	0	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	0
	11,450	596,796,900																		
I	1,830	95,383,260	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	60,724,090	316,300	16,110	6,220	80,560	31,750
total	13,280	692,180,160													9,705,250	50,550	2,580	990	12,880	5,070
															70,429,340	366,850	18,690	7,210	93,440	36,820

d Cows producing inadequately managed waste

File : NWLRBFPS

UPPER NORTH BOSQUE RIVER WATERSHED : PL-566 WATERSHED PROTECTION (WATER QUALITY) PROJECT

ANIMAL WASTE IN WATERSHED AVERAGE ANNUAL RUNOFF BELOW FLOOD PREVENTION STRUCTURES

PRESENT CONDITIONS (64 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows	Animal Waste (wet) (lbs./yr.)	total solids %	volatile solids %	TKN %	P2O5 total %	K2O total %	Na %	DOWNSTREAM Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	total solids lbs.	volatile solids lbs.	TKN lbs.	P2O5 total lbs.	K2O total lbs.	Na lbs.
I	930	48,473,460	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	4,932,170	25,690	1,310	500	6,540	2,580
It	370	19,285,140	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	1,962,260	10,220	520	200	2,600	1,030
III	600	31,273,200	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	3,182,050	16,570	840	330	4,220	1,660
IV	760	39,612,720	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	4,030,590	20,990	1,070	410	5,350	2,110
V	320	16,679,040	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	1,697,090	8,840	450	170	2,250	890
VI	4,980	259,567,560	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	26,411,000	137,570	7,010	2,700	35,040	13,810
VII	0	0	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	0
Total	7,960	414,891,120													42,215,160	219,890	11,200	4,310	56,000	22,080

FUTURE WITHOUT PL-566, GPCP, AND SPECIAL ACP COST-SHARE (64 DAIRIES WITH ADEQUATE MANAGEMENT, 96 DAIRIES WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows	Animal Waste (wet) (lbs./yr.)	total solids %	volatile solids %	TKN %	P2O5 total %	K2O total %	Na %	DOWNSTREAM Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	PERCENT INCREASE OVER PRESENT CONDITIONS: total solids % Increase	volatile solids % Increase	TKN % Increase	P2O5 total % Increase	K2O total % Increase	Na % Increase
I	1,830	95,383,260	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	97	97	97	98	97	97
II	400	20,848,800	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	8	8	8	10	8	8
III	1,670	87,043,740	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	178	178	180	176	178	179
IV	1,180	61,503,960	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	55	55	55	56	55	55
V	1,400	72,910,800	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	338	337	338	347	338	336
VI	6,800	354,429,600	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	37	37	37	37	37	37
VII	0	0	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	0
Total	13,280	692,180,160													95	95	95	96	95	95

FUTURE WITH PL-566, GPCP, AND SPECIAL ACP COST-SHARE (114 x 31 PL-566 x 50 GPCP and SPECIAL ACP1 x 95 DAIRIES WITH ADEQUATE MANAGEMENT, 15 WITHOUT ADEQUATE MANAGEMENT)

Reach	#Cows	Animal Waste (wet) (lbs./yr.)	total solids %	volatile solids %	TKN %	P2O5 total %	K2O total %	Na %	DOWNSTREAM Delivery Ratio Factors: total solids	volatile solids	TKN	P2O5 total	K2O total	Na	PERCENT REDUCTION FROM FUTURE-WITHOUT-PROJECT: total solids % reduct.	volatile solids % reduct.	TKN % reduct.	P2O5 total % reduct.	K2O total % reduct.	Na % reduct.
I	270	14,072,940	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	85	85	86	86	85	85
II	60	3,127,320	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	85	85	86	86	85	85
III	220	11,466,840	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	87	87	87	87	87	87
IV	150	7,818,300	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	87	87	87	88	87	87
V	220	11,466,840	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	84	84	84	84	84	84
VI	1,090	56,812,980	40.70	10.60	0.54	0.26	0.45	0.076	0.250	0.005	0.005	0.004	0.030	0.070	84	84	84	84	84	84
VII	0	0	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	0
Total	2,010	104,765,220													85	85	85	85	85	85

APPENDIX D - 3

CASE STUDY OF ANIMAL WASTE MANAGEMENT SYSTEMS

This is an original presentation by Mary Leigh Wolfe, Assistant Professor, and John M. Sweeten, Extension Agricultural Engineer, Department of Agricultural Engineering, Texas A&M University, College Station, Texas. The report was written for presentation by the authors at the 1990 Sixth International Symposium on Agricultural and Food Processing Wastes in December 1990, sponsored by The American Society of Agricultural Engineers.

RUNOFF AND WASTEWATER MANAGEMENT SYSTEMS FOR OPEN LOT DAIRIES

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Major expansion of the dairy industry has occurred in the last 10 years in Erath County, Texas. For several decades, this area has been the location of a limited number of small dairy operations with sufficient land to maintain low animal densities on pastures except during milking operations. Today, however, new dairy operations are typically much larger (1,000 or more head) and maintain high animal concentrations in confined lots or corrals on small acreages relative to the number of cows, in a manner that is similar to practices in the desert Southwest. Typical animal spacings in open lots are 56 m^2 (600 square feet) per cow. Large amounts of water are used for manure removal and milk sanitation. Average annual precipitation is 760 mm (30 inches). In addition, high intensity rainfall typical of thunderstorms in Central Texas causes runoff which contacts animal wastes on corral surfaces. The 25 year frequency, 24 hour duration design storm in Erath County averages 185 mm (7.3 inches), producing a predicted 155 mm (6.1 inches) of runoff based on SCS-USDA Soil Cover Complex Number 90.

Combined solid manure, liquid manure and contaminated runoff are normally routed to one or more treatment lagoons or holding ponds where the effluent and solids are collected for limited primary and secondary treatment while awaiting disposal by land application. Many dairies also use settling basins or static screens for coarse solids removal and nutrient recovery ahead of lagoons or holding ponds.

Dairy operations are considered by the Texas Water Commission (TWC) as potential point sources of pollution, and land application of manure creates potential nonpoint sources (NPS). The TWC must approve engineering applications and issue permits to manage and dispose of animal manure and wastewater for dairies with over 250 head in the milking herd (TWC, 1987). All dairy operations must register with the TWC and install and operate systems in a manner consistent with the stated "no-discharge" policy (TWC, 1987; 1990). This means that wastes and wastewater must be collected and disposed of by land application. A construction permit from the Texas Air Control Board is required for dairies that will exceed 1,000 head in confinement, including non-lactating animals.

Ground water can be polluted by leachate from the holding ponds, by infiltration beneath the open lots, or by improper land disposal of wastewater and solid manure at rates that exceed plant nutrient requirements. Since the Trinity Group Aquifer outcrops in this area and certain soil types have porous subsoils, application of excessive amounts of manure and wastewater could result in introduction of contaminants into the aquifer. Heavy rains transport manure constituents directly into

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Prepared for Proceedings of the Sixth International Symposium on Agricultural and Food Processing Wastes, Chitago, Illinois, December 17-18, 1990.

surface streams and aquifer recharge areas, thereby impairing surface water quality unless adequate systems are installed.

The Upper North Bosque River, which flows through the center of Erath County and eventually enters a water supply reservoir, has been characterized as the state's major agricultural nonpoint source water quality problem pursuant to Section 319 of the Federal Clean Water Act. The project described in this paper is continuing as a major component of the Upper North Bosque River Hydrologic Unit Project[1] funded under the USDA Water Quality Initiative, which has the purpose of achieving voluntary adoption of Best Management Practices (BMPs) for nonpoint source water pollution abatement by farmers and ranchers.

OBJECTIVES AND PURPOSE

The primary objective of this research, demonstration and education project is to evaluate and improve design criteria for wastewater and runoff management systems for open lot dairies in Central Texas. The purposes of this paper are to characterize the quality of dairy wastewater and runoff from typical dairies and to quantify fresh water usage that could become wastewater.

METHODS AND EQUIPMENT

Description of Dairy Facilities

Data presented in this paper were collected at three dairy farms in Erath County in North Central Texas from 1988 to 1990. The dairies range in size from 286 to 1,900 cows (Holsteins) in the milking herd. The primary sources of wastewater at these three dairies are: milking parlor, milking equipment, milk storage tank, open-sided cattle holding shed, open lots or corrals, traffic lanes, feeding lanes or bunks, and working alleys or chutes. Shades are provided in the dairy corrals. In each case, liquid manure and wastewater from the milking facility are collected in holding ponds and lagoons, and irrigation systems are utilized for disposal. Runoff from open lots is collected either in separate detention ponds or in the wastewater treatment/storage lagoons, and two of these farms utilize concrete settling basins for partial removal of settleable solids. In all three dairies, solid manure is collected by tractor-mounted scrapers and spread on pasture or cropland either on-site or off-site without stockpiling at the dairies.

The experimental equipment and procedures for each dairy are described individually in the following section. Two of the farms (Dairies M and B) have permits from the TWC, and the other farm (Dairy A) has obtained engineering assistance from the Soil Conservation Service--USDA and has filed for a TWC permit to be issued in 1990.

Dairy M: A wastewater settling basin study was conducted in 1988 at Dairy M, which has 1,900 cows that are kept in open corrals and fed in head-lock feeding aprons along paved alleys. The cattle are milked three times per day in two double 16 herringbone milking parlors following rinsing in a drip shed using sprinkler cow washers. During feeding, the cattle stand on

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[1] Cooperating agencies include the Texas Agricultural Extension Service, Texas Water Resources Institute, Texas Agricultural Experiment Station, Soil Conservation Service-USDA, Texas State Soil and Water Conservation Board, Texas Water Development Board, and the Bosque and Upper Leon Soil and Water Conservation Districts.

a 3 m (10 feet) wide concrete apron behind the head-lock stanchions. This apron is tractor scraped daily, with semi-solid manure hauled to nearby pasture land along with solid manure from the corrals, which is collected on a weekly basis. The open lot portion of the dairy occupies approximately 10 ha (25 acres). The milking parlor floor is flushed using a mixture of fresh water and recycled rinsate from the milking equipment and bulk tank.

All wastewater from the milking parlor and drip shed, as well as any rainfall runoff, is channeled into the 0.9 m (3 feet) deep, 24 m (80 feet) long settling basin. The basin has two compartments operated in parallel, each with 330 m^3 (11,700 cubic feet) capacity. Settled solids are removed with a wheel loader. Overflow from the settling basin enters the anaerobic treatment/storage lagoon from which it is irrigated with a big-gun sprinkler onto pasture land. The study at this dairy involved sampling inflow and outflow from the concrete settling basin and the storage/treatment lagoon on four occasions. Flowrates were not measured.

Dairy A: A study involving a two-stage anaerobic lagoon and open lot runoff was established at Dairy A which milks an average of 286 cows in a double 8 herringbone milking parlor twice daily in 4 groups. Each group of cattle is pre-washed using a sprinkler cow-washer system in the holding shed. Inside the milking parlor, cow udders, grates, floors, and walls are manually washed by pressure hoses. Final cleanup is effected by flushing once per day using two 1900 L (500 gallon) flush tanks. Longitudinal slopes of the milking parlor and holding shed floors are 0.5 and 2.0 percent, respectively. All dairy wastewater from the cow pre-wash sprinklers, milking parlor, milk storage tank and equipment is routed through a 0.46 m (1.5 foot) type-H flume into a 1900 L (500 gallon) conical-bottom sump and drained by gravity through a 20 cm (8 inch) x 125 m (410 feet) long PVC pipeline into primary and secondary lagoons with capacities of approximately 4,250 and 2,830 m^3 (150,000 and 100,000 cubic feet), respectively.

The milking cattle are fed in open lots with a total of 260 m (850 feet) of fence line feed bunk space. Watersheds for monitoring runoff were established in the two largest open lots, which included all the fence line bunk space. An upper watershed was delineated that has an area of approximately 1 ha (2.5 acres) that drain into a 0.46 m (1.5 feet) depth type-H flume equipped with an ISCO Model 2910 discrete sampler. Cattle also have access to pasture outside the drainage area that is diverted into the flume. Average watershed slope is 2.5 percent from the milking parlor to the flume 310 m (1020 feet) away. The lower watershed consists entirely of a dairy corral and has a net drainage area of 1.6 ha (4 acres) diverted into a 0.61 m (2.0 feet) flume, equipped with a stage recorder and Model 2910 ISCO sampler. Average watershed slope is 3.2 percent over a distance of 384 m (1260 feet) from the milking parlor. A new runoff holding pond has been designed for construction this year, together with installation of an irrigation system, subject to issuance of a TWC permit. In-line water meters have been installed to measure water usage for the milking parlor including the flush system, for the sprinkler cow-washer system, and the cattle drinking water.

Dairy B: This 950 cow open lot dairy was built in 1987 on 65 ha (160 acres) and consists of a double-16 herringbone milking parlor in which cows are manually washed following pre-rinsing with a sprinkler cow-washer system in the holding shed. Cows are milked 3 times per day. Wastewater from a plate cooler, vacuum pump, and milking equipment is collected in a sump and is recycled through the cow pre-wash and the flush system. Water is provided by 2 wells that are 125 to 150 m (410 to 490 feet) deep. Cows are fed in head-lock stanchions four times per day along concrete feeding

alleys that were formerly flushed but are presently tractor-scraped, as a water conservation measure and to preserve lagoon capacity.

This dairy has 650 to 700 cows in the milking herd and the remainder are dry cows. All 950 head are kept on dry lots that cover 6.5 ha (16 acres) including feeding and cattle alleys and shade structures. Runoff flows into a large primary lagoon/holding pond with a capacity of 24,800 m^3 (876,000 cubic feet), and any overflow enters a second stage holding pond (Figure 1). Runoff from 5 of the 8 feed pens passes through concrete settling basins prior to entering the primary lagoon. Runoff is monitored through two 0.9 m (3 feet) depth type-H flumes set at the northwest and southwest corners of the open lots. These were labeled "North" and "South" flumes, respectively.

Liquid manure and wastewater from the milking parlor enters a collection sump and is routed through a 25 cm (10 inch) diameter pipeline into a 0.45 m (1.5 feet) depth type-H flume, prior to discharge into a dual-chambered settling basin. The settling basin's chambers are 0.67 m (2.2 feet) deep and have lateral dimensions as follows: East Chamber, 5.5 m x 14.6 m (18 feet by 48 feet); West Chamber, 9.1 m x 18.2 m (30 feet by 60 feet), exclusive of 10:1 ramps on each end. The two chambers of the settling basin are decanted through a slotted plank inlet and a perforated 20 cm (8 inch) diameter corrugated plastic riser into the primary lagoon/holding pond. Semi-solids are removed by articulated wheel loader and stored in earthen bunkers prior to loading into trucks for off-site disposal on neighboring pasture land. This wastewater flow has been monitored using a float-activated stage recorder. Currently, a bubbler stage recorder is used for this purpose. Wastewater and runoff collected in the two lagoons are irrigated onto 48 ha (120 acres) of coastal bermudagrass pasture on a sandy loam soil.

Analytical Procedures

Manure and wastewater samples were collected in the field and either stored in a frozen condition prior to shipment or transported within 2 days of collection to Texas A&M University, 110 km (180 miles) away, where samples were stored in a freezer. Prior to analysis, samples were thawed, mixed, composited, divided into split samples and analyzed by two laboratories for the following parameters:

a. Water and Wastewater Laboratory, Agricultural Engineering Department--solids (total, fixed, and volatile), chemical oxygen demand (COD), and total Kjeldahl nitrogen (ammonia and organic). Most of the wastewater samples were also partitioned into filterable and non-filterable solids including fixed and volatile fractions of each. Also, solid or semi-solid manure samples were analyzed for moisture, ash, and total Kjeldahl nitrogen. These analyses were performed according to Standard Methods for Examination of Water and Wastewater (APHA, 1980).

b. Extension Soil and Water Testing Laboratory--nitrate, nitrite, phosphorus (total), potassium, iron, sulfate, manganese, pH, sodium, calcium, magnesium, chloride, carbonate, bicarbonate, and conductivity. Also, sodium absorption ratio (SAR) and soluble sodium percentage (SSP) were calculated.

The values from individual samples were averaged for each sampling date, and mean values were calculated across sampling dates. Comparisons were made between means at sampling locations to determine the effectiveness of the treatment systems.

RESULTS

Dairy M--Settling Basin and Lagoons

The settling basin provided excellent removal of solids-related parameters from liquid dairy manure (Table 1) in that 44.8 percent of the volatile solids, 59 percent of the volatile suspended solids, and 46.5 percent of the COD were removed. The volatile solids removal efficiency (Figure 2) would indicate that treatment volume of lagoons might be reduced following properly-designed and operated settling basin. Nutrient removal was erratic, however, with an average of 14.4 percent N reduction and essentially no removal of phosphorus. Moisture, ash and total nitrogen content of the settled solids were 86.0, 21.5 and 1.76 percent, respectively.

Effluent from the anaerobic lagoon that followed the settling basin was sampled from an irrigation pipeline riser outlet. The lagoon effluent being pumped at Dairy M contained an average of 152 mg/l N, 28 mg/l P, and 180 mg/l K. The anaerobic lagoon provided much less reduction of most parameters than was expected, with VS and COD reductions of only 12.4 and 14.4 percent, respectively, and with no apparent loss of nutrients (Table 1). This may have been caused by removal of readily settleable and digestible solids in the settling basin before lagoon treatment. However, reductions of suspended (non-filterable) volatile solids (VSS) were appreciable in the lagoon, averaging 30 percent. Lagoon sampling dates were in March, and higher treatment efficiencies might be obtained in warmer weather. Since entering flowrates were not measured, the hydraulic retention time of neither the settling basins nor the lagoon was determined.

Dairy A: Measurements of water use were made by weekly water meter readings from November 1989 to August 1990. Measured fresh water usage at Dairy A for manure removal was determined to be an average of 204 L (53.9 gallons) per cow per day. Of this amount, 43.1 ± 6.4 L (11.4 ± 1.7 gallons) per cow per day was used in the milking parlor (including the flushing operation) and for milk handling system cleanup. The cow washers added 161 ± 12.5 L (42.5 ± 3.3 gallons) per cow per day to the water use. Essentially all this water entered the wastewater stream and the two-stage lagoons.

Concentrations of constituents in the combined wastewater stream from the milking parlor and holding shed are shown in Tables 2 and 3. For comparison, concentrations of effluent from both the primary anaerobic lagoon and the second-stage anaerobic lagoon are also shown. The average concentrations of selected parameters are shown in Figures 3 and 4. As shown in Table 2, the primary anaerobic lagoon produced very large reductions in concentrations of total solids (72.8 percent), volatile solids (82.4 percent) and chemical oxygen demand (91.1 percent). The second stage lagoon was less effective than the primary lagoon in this regard. Overall concentration reductions for effluent from both lagoons as compared to the raw wastewater, were as follows: total solids (75.4 percent), volatile solids (85.6 percent), and COD (94.3 percent). The ratio of COD to total solids (TS) decreased from 1.39 in raw wastewater to 0.45 and 0.33 in primary and second stage lagoon effluent, respectively. The digestion of volatile solids (VS) was evident in the decreased VS/TS ratio of 0.65 in raw wastewater to only 0.42 and 0.40 in primary and second stage lagoon effluent. Nutrient reductions were appreciable, with N, P and K losses averaging 62.9 percent, 56.3 percent, and 26.9 percent, respectively, through the system. Total nitrogen losses in the primary lagoon were 39 percent. Most of the nitrogen was in the ammonium form.

Conductivities were moderace to high. However, these values were attributed in large part to the presence of divelent anions and cations. There did not appear to be a sodium hazard with this lagoon effluent.

Runoff from both the upper and lower watersheds in dairy open lots contained 8,446 and 4,345 mg/l totel solids, respectively (Table 4). However, this material was mostly fixed solids, as the volatile solids represented just 24 to 29 percent of total solids. While COD was high at 3,979 and 2,377 mg/l for upper and lower watersheds, the COD/TS ratio averaged only 0.51. Nutrient concentrations were appreciable, especielly in terms of potassium, as the runoff samples averaged 88 mg/l total N, 37 mg/l total P, and 390 mg/l K. Selinity does not appear to be a major problem with land applicetion of this collected runoff due to low values of sodium absorption ratio (SAR) of 1.6 to 2.5.

Dairy B: Raw wastewater concentrations from the milking parlor, supernatant from primary and secondary lagoons/holding ponds, and open lot runoff are summarizad in Table 5. The settling basin was constructed late in 1989 and settling basin outflow data were not available.

Milking centar wastewatet contained an average of 8,014 mg/l total solids, of which 68.5 percent was volatile solids and the remaindar was fixed solids. Suspended (non-filtereble) solids represented 55.8 percent of the total solids and was mostly (83.5 percent) volatile material. The COD concentration evereged 9,932 mg/l, and the COD/TS ratio avereged 1.24. Totel nutrient content in the rew dairy wastewater averaged 4D7 mg/l total N, 74 mg/l P, and 496 mg/l K. The EC values exceedad 5,260 µmhos/cm but were strongly influenced by the high sulfate and bicerbonate values.

Primary lagoon supernatant samples showed veriable concentrations of solids parameters possibly related to sampling difficulties, as indicated by large standard deviations. Although the sampled total solids concentrations averaged 8,651 mg/l, it was clear that reduction of volatile solids and COD was occurring, eepecially the dissolved (filtarable) volatile solids fraction. Nitrogen reduction evereged only 16 percent, which may have been due in part to the hydraulic retention time that existed at the pariod of these samples. The legoon effluant that was applied frequently to pastures contained an averege of 343 mg/l total N which was 89 percent in the ammonium form. Totel P and K concentrations were 109 and 365 mg/l, respectively. Sodium adsorption ratio (SAR) was only 1.6 indicating that the lagoon effluent would not represent a sodium hazard, especially in view of the sandy loam soil texture.

The secondary lagoon received only direct rainfall and drainage from one of the runoff debris basins. Overflow from the primary legoon did not occur. Consequently, solids and nutrient contents were relatively low. This structure wes operated almost independently of the primary lagoon and a seperete irrigation pump wes used for de-watering it.

Runoff in 1989 was monitored in the north flume on 5 occasions and on one occasion from the south flume. Runoff concentrations in the north flume averaged 6,539 mg/l total solids, which were mostly fixed solids (60.2 percent). Also, volatile suspended solids were less than 10 percent of the total solids in direct contrast with the milking parlor westewater. The COD/TS ratio was 0.50. These data indicata that most of the solids transported in runoff was soil rather than manure particles.

Nitrogen concentration of the open lot runoff (87 mg/l) was much lower than in the milking parlor wasteweter. However, K, sodium chloride, SAR and SSP levels were much higher in the open lot runoff, possibly reflecting an accumulation of soluble salts on the lot surface that wera flushed into the lagoon by runoff events.

Water use for sanitation and manure removal at Dairy B was metered starting in November, 1989, near the end of collecting the wastewater data reported in this paper. For this period, fresh water use averaged 247 L (65.3 gallons) per cow per day. Since then, however, water use has been reduced by more than 50% by using tractor scraping of feed alleys and recycling of water used for milk cooling equipment operation. These results will be reported in a later paper along with effects on wastewater concentrations and lagoon operation.

SUMMARY AND CONCLUSIONS

This project involved determining the effectiveness of dairy manure and wastewater treatment systems in reducing pollutant concentrations and enabling the harvest and utilization of nutrients. Practices being studied are (a) solids settling basins, (b) lagoon systems (primary and/or secondary), and (c) runoff retention ponds. At one dairy with 1,900 cows, periodic grab sampling was used to determine the treatment efficiency of a shallow concrete settling basin. Subsequently, two other dairies with 286 and 950 head have been selected and instrumented to monitor quantity and quality of wastewater from the milking parlor and holding shed and from open lots. At both these dairies, inflow vs. outflow samples are being taken to determine efficiency of settling basins (at the 950 cow dairy) and lagoons and the effluent quality for land disposal to evaluate design criteria for BMPs. Concentration reductions of 45 percent volatile solids and 14 percent total nitrogen have been measured in settling basins, and two-stage lagoon systems have produced up to 63 percent nitrogen reduction, 85 percent VS reduction and 94 percent COD reduction. Effluent characteristics have been determined and studies of land application of lagoon effluent have been initiated. Ranges of average nutrient concentrations in runoff and lagoon effluent were as follows: total N--61 to 343 mg/l; total phosphorus 25 to 109 mg/l; and potassium--143 to 462 mg/l.

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1. APHA. 1980. Standard Methods for the Examination of Water and Wastewater. 15th Edition. American Public Health Association, Washington, D.C. 1134 p.

2. TWC. 1987. Control of Certain Activities by Rule. Chapter 321, Subchapter B, Part IX, 31 TAC 321.31-321.41. Texas Water Commission, Austin, Texas. Texas Register, March 17, 1987. pp. 905-909.

3. TWC, 1990. Control of Certain Activities by Rule. Subchapter B. Livestock and Poultry Production Operations, 31 TAC 321.42-321.46. Texas Water Commission, Austin, Texas. Texas Register, April 27 (pp. 2420-2421) and June 22 (pp. 3639-3640).

Table 1. Effect of Settling Basin and Anaerobic Lagoon at Dairy M on Concentrations of Solids, Nutrients, Salinity and Chemical Oxygen Demand

Constituent	Settling basin			Anaerobic lagoon		
	Average inflow, mg/l	Average outflow, mg/l	Reduction, percent	Average pumped effluent, mg/l	Reduction percent	Combination settling basin lagoon, percent
Total Solids, TS	2985	2007	32.8	1884	6.1	36.9
Volatile Solids, VS	2028	1119	44.8	980	12.4	51.7
Volatile Suspended Solids, VSS	1401	574	59.0	403	29.8	71.2
Chemical Oxygen Demand, COD	4269	2283	46.5	1955	14.4	54.2
Total Nitrogen, N	170	146	14.4	152	(-) 4.1	10.6
Phosphorus, P	23.7	23.3	1.4	27.6	(-) 18.5	(-) 16.5
Potassium, K	170	151	10.8	180	(-) 19.2	(-) 5.9
Conductance, EC, μmhos/cm	2021	2038	(-) 0.8	2009	1.4	0.6
SAR	1.64	1.69	(-) 2.7	1.83	(-) 8.5	(-) 12.3

* Data are averages of 4 subsamples on 4 sampling dates.

Table 2. Wastewater and Lagoon Effluent Characteriatics, Dairy A, January 18 - September 29, 1989

Constituent	Units	Milking parlor wastewater Average (N=15)	Std. dev.	Primary lagoon effluent Average (N=10)	Std. dev.	Secondary lagoon effluent Average (N=11)	Std. dev.
Total solids	mg/l	6187	2911	1684	270	1459	178
Fixed solids	mg/l	2178	806	979	168	882	94
Volatile solids	mg/l	4006	2232	706	125	577	119
COD	mg/l	8571	5217	762	87	489	91
Nitrogen, total	mg/l	275	198	168	13	102	18
*Nitrate	mg/l	1.0	1.1	0.3	0.2	0.2	0.1
*Ammonium	mg/l	249	191	162	14	98	18
*Organic total	mg/l	25	17	6	2	4	2
Phosphorus	mg/l	59	32	34	14	26	2
Potassium	mg/l	281	131	188	35	205	15
Calcium	mg/l	210	95	110	42	100	9
Magnesium	mg/l	81	24	59	23	66	5
Sodium	mg/l	124	54	81	32	95	8
Manganese	mg/l	1.4	0.6	0.4	0.1	0.3	0.2
Boron	mg/l	24	59	0.2		0.2	
Carbonate	mg/l	33	20				
Bi-carbonate	mg/l	1457	543	1575	302	1220	160
Sulfate	mg/l	498	351	39	6	31	9
Chloride	mg/l	479	295	201	76	223	62
Iron	mg/l	15.1	21.6	2.1	3.0	1.2	2.0
Total salts	mg/l	2793	1028	2318	393	1938	177
EC, conductance	µmhos/cm	3584	1518	2647	387	2261	340
pH		7.1	.4	7.5	0.1	7.8	0.3
SAR		1.85	.79	1.63	0.15	1.8	0.13
SSP	%	18.3	4.8	19.3	1.3	20.9	1.0

Table 3. Wastewater and Lagoon Effluent Charecteristics, Dairy A, October 12 to December 29, 1989

Constituent	Units	Milking parlor wastewater		Primary lagoon effluent		Secondery lagoon effluent	
		Average (N=6)	Std. dev.	Average (N=5)	Std. dev.	Average (N=5)	Std. dev.
Total solids	mg/l	4469	1735	2190	344	1767	67
Fixed solids	mg/l	1445	532	1162	119	1083	60
Volatile solids	mg/l	3025	1223	1028	250	684	123
Filt. solids	mg/l	1942	554	1456	251	1262	86
* Fixed	mg/l	993	362	934	107	885	67
* Volatile	mg/l	940	231	518	214	377	78
Total susp. solids	mg/l	2528	1235	738	207	505	117
* Fixed	mg/l	433	252	228	153	198	92
* Volatile	mg/l	2085	1009	510	82	307	163
COD	mg/l	4869	3309	2367	1902	722	167
Nitrogen	mg/l	204	131	189	28	145	17
* Nitrate	mg/l	0.45	0.27	0.44	0.29	0.23	0.12
* Ammonium	mg/l	182	128	176	22	136	16
* Organic	mg/l	21	6	13	5	9	2
Phosphorus	mg/l	54	17	38	5	29	6
Potassium	mg/l	169	107	213	4	214	13
Calcium	mg/l	133	22	117	20	110	12
Magnesium	mg/l	69	16	69	7	71	3
Sodium	mg/l	140	39	105	6	102	6
Manganese	mg/l	0.7	0.3	0.38	0.22	0.3	0.1
Bi-carbonate	mg/l	1217	704	1472	312	1107	296
Sulfate	mg/l	481	626	179	103	50	13
Chloride	mg/l	198	101	202	67	176	14
Iron	mg/l	3	2	5	7	4	6
Total salts	mg/l	2301	1689	2147	426	1938	202
EC, elec. cond.	µmhos/cm	2869	1305	2762	235	2476	189
pH		2.40	0.5	7.5	0.6	7.8	0.3
SAR		27.0	0.56	1.89	0.27	1.83	0.09
SSP	%	26.4	6.3	21.3	2.5	20.8	3.1

Table 4. Runoff Characteristics From Open Lots, Dairy A, February 16 to November 3, 1989

Constituent	Unit	Upper watershed Average (N-5)	Upper watershed Std. dev.	Lower watershed Average (N-3)	Lower watershed Std. dev.
Total solids	mg/l	8446	4959	4345	2183
Fixed solids	mg/l	6385	4708	3073	1800
Volatile solids	mg/l	2061	925	1271	382
COD	mg/l	3979	1227	2377	4
Nitrogen, total	mg/l	80.8	56.3	95.8	58.7
* Nitrate	mg/l	0.17	0.9	0.3	0.1
* Ammonium	mg/l	63.3	57.2	81.6	62.3
* Organic total	mg/l	17.0	6.3	13.9	3.8
Phosphorus	mg/l	44	16	29	9
Potassium	mg/l	362	162	418	248
Calcium	mg/l	202	62	112	46
Magnesium	mg/l	69	14	65	19
Sodium	mg/l	105	42	142	68
Manganese	mg/l	2.1	0.9	0.7	0.4
Bi-carbonate	mg/l	858	288	1036	280
Sulfate	mg/l	110	112	219	192
Chlotide	mg/l	293	153	374	296
Iron	mg/l	38	45	16	22
Total Salts	mg/l	1939	680	2366	925
EC, elect. cond.	µmhos/cm	2207	612	2862	835
pH		7.4	0.4	7.5	0.3
SAR		1.6	0.65	2.5	1.0
SSP	%	15.5	4.1	21.8	3.5

Table 5. Wastewater Characteristics from Dairy B, June 30 to December 8, 1989

Constituent	Units	Milking parlor wastewater (N-10)		Primary lagoon effluent (N-8)		Secondary lagoon effluent (N-5)		Runoff, north flume (N-5)		Runoff South flume (N-1)
		Average	Std. dev.	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.	
Total solids	mg/l	8014	3502	8651	10179	1994	1124	6539	3123	9360
Fixed solids	mg/l	2528	1335	4319	4787	773	375	3984	2249	5310
Volatile solids	mg/l	5487	2231	4332	5434	1221	766	2555	946	4050
Filt. solids	mg/l	3765	1898	1849	162	1341	768	3476	1165	7570
* Filt. fixed solids	mg/l	1862	1117	1140	153	687	337	1929	563	4400
* Filt. vol. solids	mg/l	1902	810	709	199	654	453	1549	638	3170
Total susp. solids	mg/l	4474	2140	6801	10087	653	418	3063	3530	1790
* Susp. fixed solids	mg/l	734	406	3178	4801	86	64	2057	2478	910
* Susp. vol. solids	mg/l	3737	1762	3622	5312	567	380	1006	1055	880
COD	mg/l	9932	4513	9264	13227	1767	1386	3184	1190	5823
Nitrogen	mg/l	407	303	343	161	69	87	87	27	155
* Nitrate	mg/l	5.0	12.0	0.2	0.2	0.7	0.8	0.3	0.3	0.2
* Ammonium	mg/l	371	288	305	144	55	83	61	18	114
* Organic	mg/l	31	15	37	45	14	4	25	10	40
Phosphorus	mg/l	74	36	109	176	15	18	27	8	33
Potassium	mg/l	496	342	365	132	143	108	610	196	1383
Calcium	mg/l	293	93	621	1050	72	53	208	137	76
Magnesium	mg/l	128	52	129	119	39	31	107	52	158
Sodium	mg/l	186	113	128	20	103	52	233	54	492
Manganese	mg/l	1.2	0.6	4.3	9.0	0.7	0.2	0.5	0.3	0.4
Bi-carbonate	mg/l	2391	1291	1915	368	594	604	1520	471	2379
Sulfate	mg/l	817	366	156	181	202	279	465	345	755
Chloride	mg/l	698	842	242	173	272	203	505	300	1500
Iron	mg/l	8.3	4.8	74.8	181	5.6	1.7	11	10	4.2
Total salts	mg/l	4982	2719	3567	1479	1425	1110	3647	823	6743
EC, elec. cond.	µmhos/cm	5262	2898	3652	711	1739	1119	3821	1178	7260
pH		7.3	0.4	7.6	0.3	7.4	0.4	7.4	0.0	7.30
SAR		2.40	1.7	1.6	0.5	2.3	1.2	3.6	1.4	6.9
SSP	%	17.6	5.0	15.4	5.7	32.6	10.2	24.0	4.4	29.1

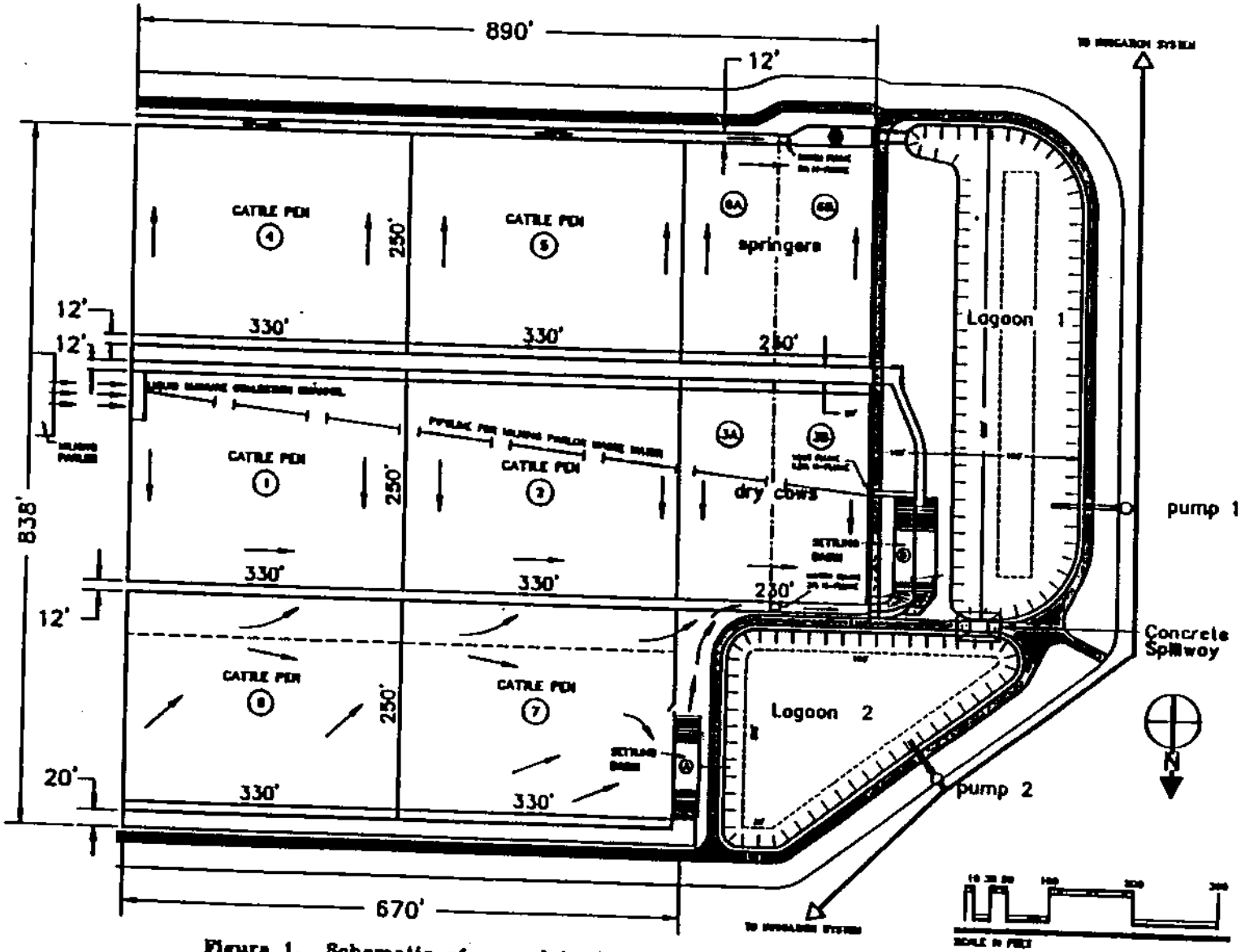


Figure 1. Schematic of open lots, lagoons, and sampling stations at Dairy B

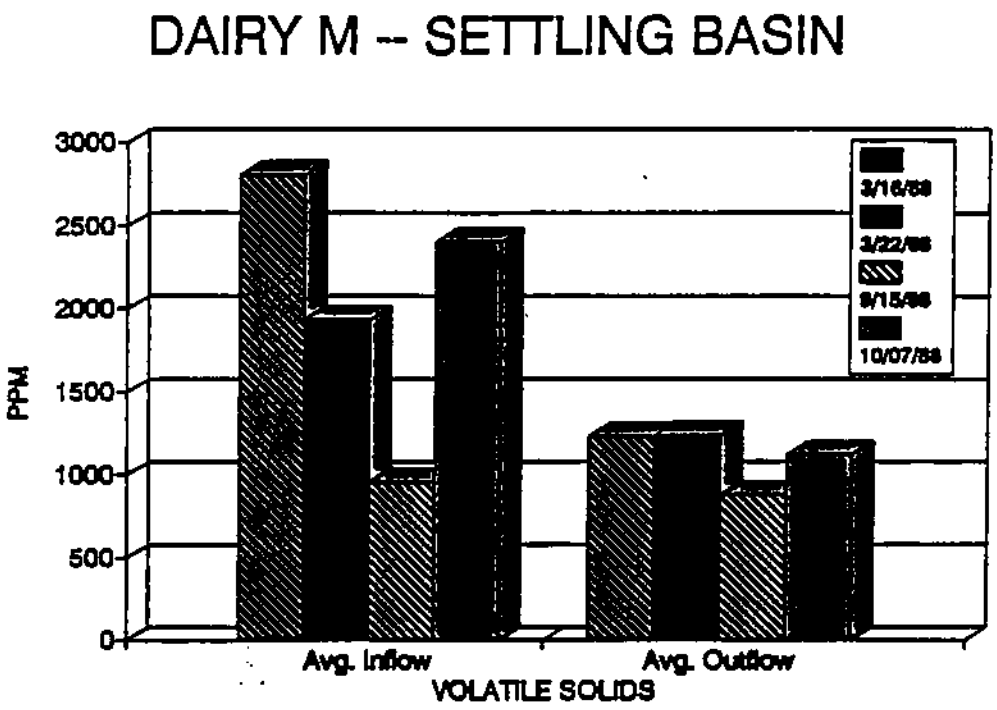


Figure 2. Reduction in volatile solids concentration in milking parlor wastewater using concrete settling basin, Dairy M, Erath County, Texas.

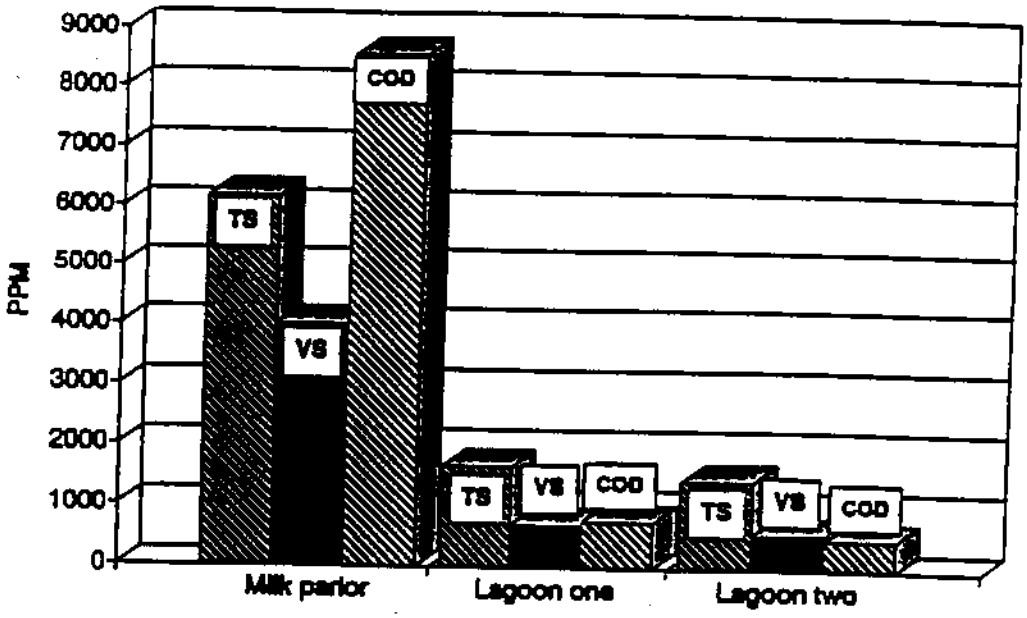


Figure 3. Concentrations of Total Solids, Volatile Solids, and Chemical Oxygen Demand in milking parlor wastewater and effluent from primary and secondary anaerobic lagoons. Dairy A, 1989.

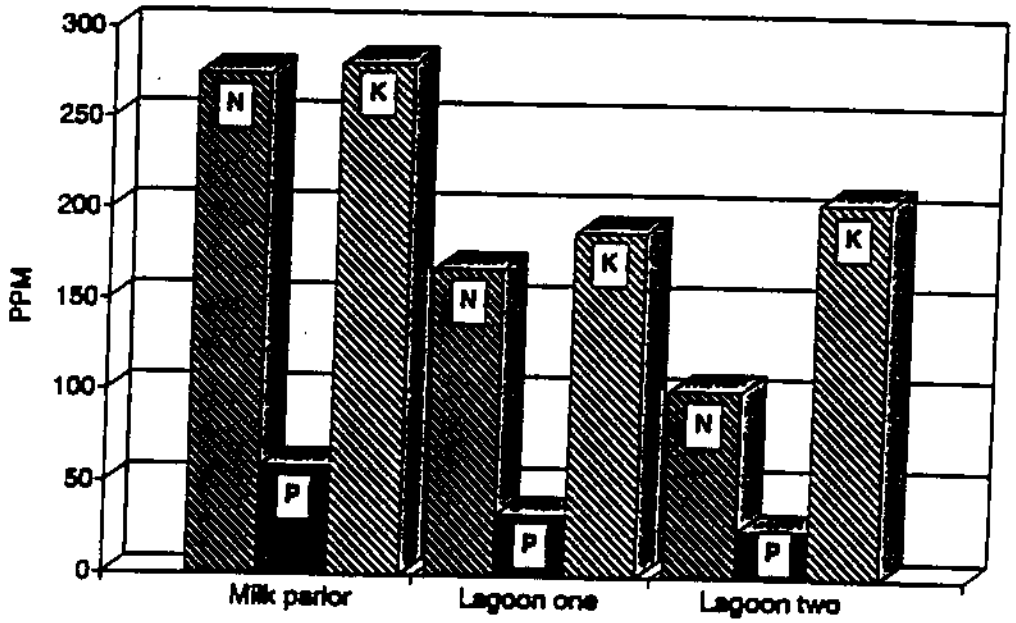


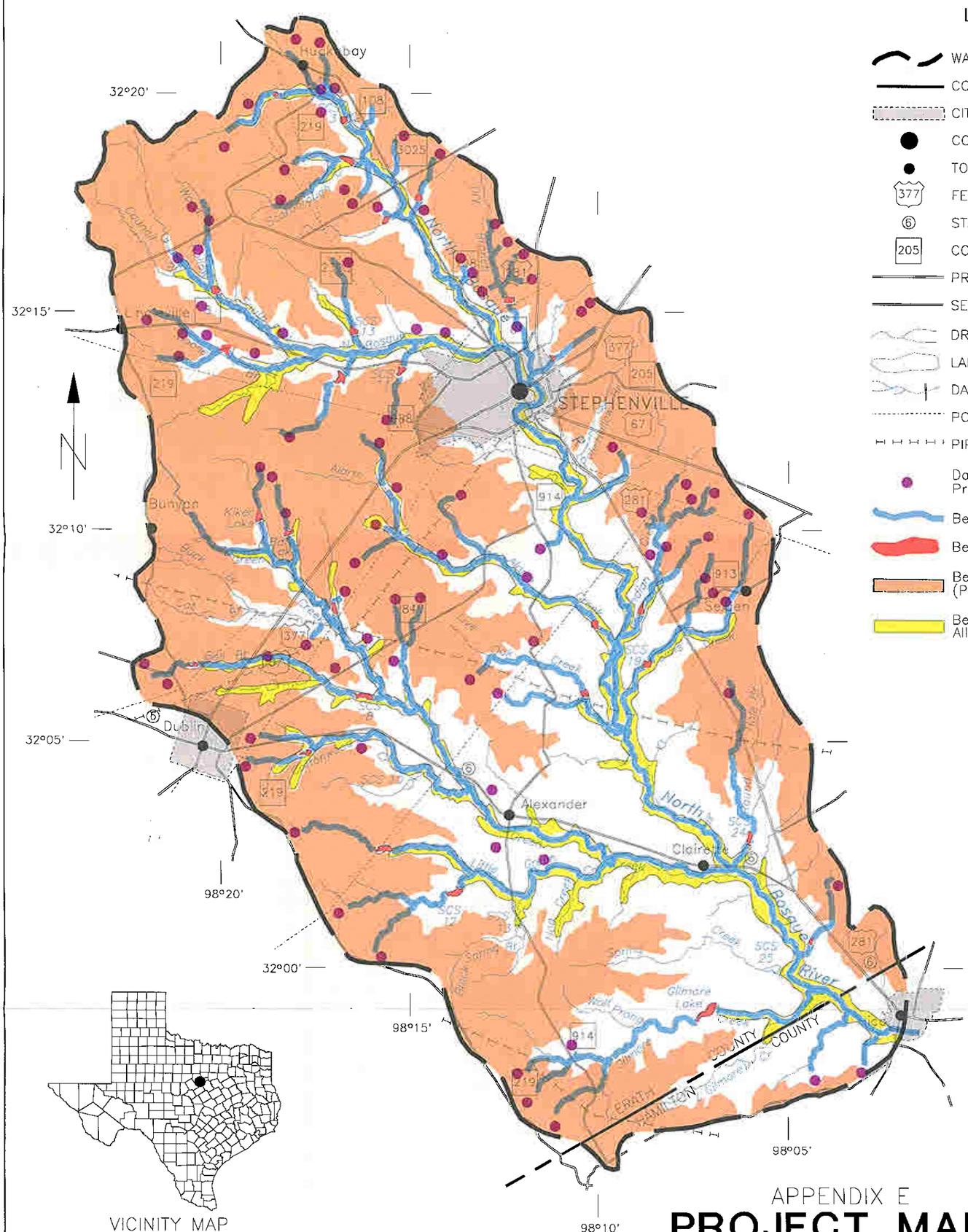
Figure 4. Concentrations of macronutrients in milking parlor wastewater and effluent from primary and secondary anaerobic lagoons. Dairy A, 1989.

APPENDIX E

PROJECT MAP

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



LEGEND

- WATERSHED BOUNDARY
- COUNTY LINE
- CITY LIMITS
- COUNTY SEAT
- TOWN
- 377 FEDERAL HIGHWAY
- ⑥ STATE HIGHWAY
- 205 COUNTY HIGHWAY
- PRIMARY ROAD
- SECONDARY ROAD
- DRAINAGE
- LAKE
- DAM
- POWER LINE
- PIPELINE
- Dairies Eligible for Project Treatment
- Benefited Stream
- Benefited Impoundment
- Benefited Aquifer (Paluxy Aquifer)
- Benefited Perched Alluvial Aquifer

VICINITY MAP

APPENDIX E

PROJECT MAP

UPPER NORTH BOSQUE RIVER WATERSHED

ERATH AND HAMILTON COUNTIES, TEXAS

SOURCE:
DIGITAL INFORMATION DERIVED FROM 1990 TIGER LINE DATA AND INFORMATION FROM SCS FIELD PERSONNEL.
MAP PREPARED USING AUTOMATED MAP CONSTRUCTION NATIONAL CARTOGRAPHIC CENTER, FORT WORTH, TEXAS 1992.

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USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX.-1992

LIST OF ACRONYMS

ACP	Agricultural Conservation Program
ASCS	Agricultural Stabilization and Conservation Service
BRA	Brazos River Authority
CO	Conservation Operation Program
COE	Corps of Engineers
EPA	U.S. Environmental Protection Agency
EPIC	Erosion-Productivity Impact Calculator
FmHA	Farmers Home Administration
GPCP	Great Plains Conservation Program
GRASS	Geographic Resource Analysis Support System
HUP	Hydrologic Unit Project
O&M	Operation and Maintenance
PL-566	Watershed Protection and Flood Prevention Act
RC&D	Rural Conservation and Development Program
SCS	Soil Conservation Service
SWRRB	Simulator for Water Resources in Rural Basins
TACB	Texas Air Control Board
TAES	Texas Agricultural Experiment Station
TAEX	Texas Agricultural Extension Service
TDH	Texas Department of Health
TPWD	Texas Parks and Wildlife Department
TSSWCB	Texas State Soil and Water Conservation Board
TWC	Texas Water Commission
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WQ	Water Quality