Appendix A: List of Acronyms

7Q2	Minimum 7-Day, 2-Year Discharge
AVMA	American Veterinary Medical Association
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CAFO	Concentrated Animal Feeding Operation
cfu	Colony Forming Units
CI	Confidence Interval
CRP	Clean Rivers Program
CWA	Clean Water Act
EDAP	Economically Distressed Area Program
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESRI	Environmental Systems Research Institute
ETJ	Extraterritorial Jurisdiction
GBRA	Guadalupe-Blanco River Authority
GIS	Geographic Information System
LDC	Load Duration Curve
LO	Lockhart Region Subwatershed Designation
LU	Luling Region Subwatershed Designation
MGD	Million Gallons per Day
MS4	Municipal Separate Storm Sewer System
NAIP	National Agriculture Imagery Program
NEMO	Nonpoint Source Education for Municipal Officials
NH_3	Ammonia
NOAA	National Oceanic and Atmospheric Administration
NPS	Nonpoint Source Pollution
NRCS	National Resources Conservation Service
OSSF	On-Site Sewage Facility
RRC	The Railroad Commission of Texas
SAFE	Sports Athletic Field Education

SCADA	Supervisory Control and Data Acquisition
SELECT	Spatially Explicit Load Enrichment Calculation Tool
SEP	Supplemental Environmental Project
SRF	State Revolving Fund
SWAT	Soil and Water Assessment Tool
SWCD	Soil and Water Conservation District
TACAA	Texas Association of Community Action Agencies
TAG	Technical Advisory Group
TAMU	Texas A&M University
TCEQ	Texas Commission on Environmental Quality
TDA	Texas Department of Agriculture
TFB	Texas Farm Bureau
TMDL	Total Maximum Daily Load
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TSS	Total Suspended Solids
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
TWDMS	Texas Wildlife Damage Management Service
TxDOT	Texas Department of Transportation
UGRA	Upper Guadalupe River Authority
UH	Uhland Region Subwatershed Designation
USDA	United States Department of Agriculture
USGS	Unites States Geological Survey
UV	Ultraviolet
WCSC	Watershed Coordination Steering Committee
WQMP	Water Quality Management Plan
WWTF	Wastewater Treatment Facility

Appendix B: Elements of Successful Watershed Plans

A. Identification of Causes and Sources of Impairment

An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in the watershed-based plan (and to achieve any other watershed goals identified in the watershed protection plan). Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed. Information can be based on a watershed inventory, extrapolated from a subwatershed inventory, aerial photos, GIS data, and other sources.

B. Expected Load Reductions

An estimate of the load reductions expected for the management measures proposed as part of the watershed plan. Percent reductions can be used in conjunction with a current or known load.

C. Proposed Management Measures

A description of the management measures that will need to be implemented to achieve the estimated load reductions and an identification (using a map or description) of the critical areas in which those measures will be needed to implement the plan. These are defined as including BMPs and measures needed to institutionalize changes. A critical area should be determined for each combination of source and BMP.

D. Technical and Financial Assistance Needs

An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan. Authorities include the specific state or local legislation which allows, prohibits, or requires an activity.

E. Information, Education, and Public Participation Component

An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the appropriate NPS management measures.

F. Schedule

A schedule for implementing the NPS management measures identified in the plan that is reasonably expeditious. Specific dates are generally not required.

G. Milestones

A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented. Milestones should be tied to the progress of the plan to determine if it is moving in the right direction.

H. Load Reduction Evaluation Criteria

A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the watershed-based plan needs to be revised. The criteria for loading reductions do not have to be based on analytical water quality monitoring results. Rather, indicators of overall water quality from other programs can be used. The criteria for the plan needing revision should be based on the milestones and water quality changes.

I. Monitoring Component

A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the evaluation criteria. The monitoring component should include required project-specific needs, the evaluation criteria, and local monitoring efforts. It should also be tied to the state water quality monitoring efforts.

Appendix C: Partnership Ground Rules

The following are the Ground Rules for the Plum Creek Watershed Partnership agreed to and signed by the members of the Plum Creek Watershed Partnership Steering Committee (hereafter referred to as the Steering Committee) in an effort to develop and implement a watershed protection plan.

The signatories to these Ground Rules agree as follows:

GOALS

The goal of the Partnership is to develop and implement a Watershed Protection Plan to improve and protect the water quality of Plum Creek (Segment 1810). According to the draft *2004 Texas Water Quality Inventory and 303(d) List*, Plum Creek exhibits elevated nutrient levels and is impaired by elevated bacteria concentrations making it unsuitable for contact recreation use.

The Steering Committee will consider and attempt to incorporate the following into the development and implementation of the watershed protection plan:

- Economic feasibility, affordability and growth;
- Unique environmental resources of the watershed;
- Regional water planning efforts; and
- Regional cooperation.

POWERS

The Steering Committee is the decision making body for the Partnership. As such, the Steering Committee will formulate recommendations to be used in drafting the watershed protection plan and will guide the implementation of the watershed protection plan to success. Formal Steering Committee recommendations will be identified as such in the planning documents and meeting summaries.

Although formation of the Steering Committee was facilitated by the Texas AgriLife Extension Service and the Texas State Soil and Water Conservation Board (TSSWCB), the Steering Committee is an independent group of watershed stakeholders and individuals with an interest in restoring and protecting the designated uses and the overall health of the Plum Creek Watershed.

The Steering Committee provides the method for public participation in the planning process and will be instrumental in obtaining local support for actions aimed at restoring surface water quality in Plum Creek.

TIME FRAME

Development of a Plum Creek Watershed Protection Plan will require at least a 15-month period. The Steering Committee will function under a June 2007 target date to complete the initial development of the watershed protection plan. Achieving water quality improvement in Plum Creek may require significant time as implementation is an iterative process of executing programs and practices followed by achievement of interim milestones and reassessment of strategies and recommendations. The Steering Committee will function throughout the 15-month initial development period and may continue to function thereafter as a recommendation of the watershed protection plan.

STEERING COMMITTEE MEMBERSHIP SELECTION

The Steering Committee is composed of stakeholders from the Plum Creek Watershed. Initial solicitation of members for equitable geographic and topical representation was conducted using three methods: 1) consultation with the County Extension Agents, Plum Creek Conservation District, Guadalupe-Blanco River Authority, Caldwell-Travis and Hays County Soil and Water Conservation Districts and local and regional governments, 2) meetings with the various stakeholder interest groups and individuals, and 3) self-nomination or requests by the various stakeholder groups or individuals.

Stakeholders are defined as either those who make and implement decisions or those who are affected by the decisions made or those who have the ability to assist with implementation of the decisions.

STEERING COMMITTEE

Members include both individuals and representatives of organizations and agencies. A variety of members serve on the Steering Committee to reflect the diversity of interests within the Plum Creek Watershed and to incorporate the viewpoints of those who will be affected by the watershed protection plan.

Size of the Steering Committee is not strictly limited by number but rather by practicality. To effectively function as a decision-making body, the membership shall achieve geographic and topical representation. If the Steering Committee becomes so large that it becomes impossible or impractical to function, the Committee will institute a consensus-based system for limiting membership.

Steering Committee members are expected to participate fully in Committee deliberations. Members will identify and present insights, suggestions, and concerns from a community, environmental, or public interest perspective. Committee members are expected to work constructively and collaboratively with other members toward reaching consensus.

Committee members will be expected to assist with the following:

- Identify the desired water quality conditions and measurable goals;
- Prioritization of programs and practices to achieve goals;
- Help develop a watershed protection plan document;
- Lead the effort to implement this plan at the local level; and
- Communicate implications of the watershed protection plan to other affected parties in the watershed.

Steering Committee members will be asked to sign the final watershed protection plan. The Steering Committee will not elect a chair, but rather remain a facilitated group. Extension and/or the TSSWCB will serve as the facilitator. In order to carry out its responsibilities, the Steering Committee has discretion to form standing and ad hoc work groups to carry out specific assignments from the Committee. Steering Committee members will serve on a work group and represent that work group at Steering Committee meetings to bring forth information and recommendations.

WORK GROUPS

Topical work groups formed by the Steering Committee will carry out specific assignments from the Steering Committee. Initially formed standing work groups are:

- Agricultural Nonpoint Source Work Group
- Outreach and Education Work Group
- Urban Stormwater and Nonpoint Source Work Group
- Waste Water and Industry Work Group
- Water Quality and Habitat Work Group

Each work group will be composed of a minimum of 5 Steering Committee members and any other members of the Partnership with a vested interest in that topic. There is no limit to the number of members on a work group. Each work group will elect a chair.

Tasks such as research or plan drafting will be better performed by these topical work groups. Work Group members will discuss specific issues and assist in developing that portion of the watershed protection plan, including implementation recommendations.

Work Groups and individual Work Group members are not authorized to make decisions or speak for the Steering Committee.

TECHNICAL ADVISORY GROUP

A Technical Advisory Group (TAG) consisting of state and federal agencies with water quality responsibilities will provide guidance to the Steering Committee and Work Groups. The TAG will assist the Steering Committee and Work Groups in watershed protection plan development by answering questions related to the jurisdiction of each TAG member. The TAG includes, but is not limited to, representatives from the following agencies:

- Texas Commission on Environmental Quality
- Texas AgriLife Extension Service
- Texas Department of Agriculture
- Texas Parks and Wildlife Department
- Texas Railroad Commission
- Texas State Soil and Water Conservation Board
- Texas Farm Bureau
- Texas Water Development Board
- U.S. Environmental Protection Agency
- U.S. Geological Survey
- USDA Natural Resources Conservation Service

Replacements and Additions

The Steering Committee may add new members if (1) a member is unable to continue serving and a vacancy is created or (2) important stakeholder interests are identified that are not represented by the existing membership. A new member must be approved by a majority of existing members. In either event, the Steering Committee will, when practical, accept additional members.

Alternates

Members unable to attend a Steering Committee meeting (an absentee) may send an alternate. An absentee should provide advance notification to the facilitator of the desire to send an alternate. An alternate attending with prior notification from an absentee will serve as a proxy for that absent Steering Committee member and will have voting privileges. An alternate attending without advance notification will not be able to participate in Steering Committee votes. Absentees may also provide input via another Committee member or send input via the facilitator. The facilitator will present such information to the Committee.

Absences

All Steering Committee members agree to make a good faith effort to attend all Steering Committee meetings, however, the members recognize that situations may arise necessitating the absence of a member. Three absences in a row of which the facilitator was not informed of beforehand or without designation of an alternate constitute a resignation from the Steering Committee.

Decision-Making Process

The Steering Committee will strive for consensus when making decisions and recommendations. Consensus is defined as everyone being able to live with the decisions made. Consensus inherently requires compromise and negotiation. If consensus cannot be achieved, the Steering Committee will make decisions by a simple majority vote. If members develop formal recommendations, they will do so by two-thirds majority vote. Steering Committee members may submit recommendations as individuals or on behalf of their affiliated organization.

QUORUM

In order to conduct business, the Steering Committee will have a quorum. Quorum is defined as at least 51% of the Steering Committee (and/or alternates) present and a representative of either Extension or the TSSWCB present.

FACILITATOR

The TSSWCB Regional Watershed Coordinator and the Extension Coordinator are independent positions, financed by the State of Texas through federal grant funds. Each has specific roles to perform in facilitating the Partnership and Steering Committee.

TSSWCB Regional Watershed Coordinator

The TSSWCB Regional Watershed Coordinator provides technical assistance to the stakeholders in developing the Plum Creek Watershed Protection Plan. The TSSWCB Regional Watershed Coordinator will 1) ensure the planning process culminates in a watershed protection plan for Plum Creek, 2) facilitate discussions in Steering Committee and Work Group meetings necessary to formulate the watershed protection plan, 3) draft text and prepare the watershed protection plan such that it incorporates Steering Committee recommendations, 4) collaborate with the Extension Coordinator to facilitate the development and implementation of the watershed protection plan through the Steering Committee and work groups, and 5) ensure the Plum Creek Watershed Protection Plan satisfies the 9 elements fundamental to a watershed protection plan as promulgated by the U.S. Environmental Protection Agency.

Extension Coordinator

The Extension Coordinator will serve as an educator and facilitator to help the Steering Committee organize its work, run meetings, coordinate educational trainings and draft notes and other materials if requested, and work with the TSSWCB to facilitate the development and implementation of the plan. The Extension Coordinator will co-lead the meetings and work with all of the members to ensure that the process runs smoothly. The role of the Extension Coordinator includes working with the Steering Committee to prepare meeting summaries, assisting in the location and/or preparation of background materials, distributing documents the Steering Committee develops, conducting public outreach, moderating public workshops, providing assistance to Steering Committee members regarding Committee business between meetings, and other functions as the Steering Committee requests.

MEETINGS

All meetings (Partnership, Steering Committee, and Work Group) are open and all interested stakeholders are encouraged and welcomed to participate.

Over the 15-month development period, regular meetings of either the Steering Committee or work groups will occur each month. The Steering Committee may determine the need for additional meetings. Steering Committee and work group meetings will be scheduled to accomplish specific milestones in the planning process.

Meetings will start and end on time. Meeting times will be set in an effort to accommodate the attendance of all Steering Committee members. The Extension Coordinator will notify members of the Partnership, Steering Committee, and work groups of respective meetings.

Open Discussion

Participants may express their views candidly, but without personal attacks. Time is shared because all participants are of equal importance.

Agenda

Extension and the TSSWCB, in consultation with Steering Committee members are charged with developing the agenda. The anticipated topics are determined at the previous meeting and through correspondence. A draft agenda will be sent to the Steering Committee with the notice of the meeting. Agendas will be posted on the project website. Agenda items may be added by members at the time that the draft agenda is provided. The Extension Coordinator will review the agenda at the start of each meeting and the agenda will be amended if needed and the Committee agrees. The Committee will then follow the approved agenda unless they agree to revise it.

Meeting Summaries

Extension will take notes during the meetings and may provide audio recording. Meeting summaries will be based on notes and/or the recording. Extension and the TSSWCB will draft meeting notes and distribute them to the committee for their review and approval. All meeting summaries will be posted on the project website.

Distribution of Materials

Extension and the TSSWCB will prepare and distribute the agenda and other needed items to members. Distribution will occur via email and websites, unless expressly asked to use U.S. Mail (i.e. member has no email access). To encourage equal sharing of information, materials will be made available to all. Those who wish to distribute materials to the Steering Committee or a Work Group may ask Extension or the TSSWCB to do so on their behalf.

Speaking in the Name of the Committee

Individuals do not speak for the Steering Committee as a whole unless authorized by the Committee to do so. Members do not speak for Extension or the TSSWCB and neither the Extension nor the TSSWCB speak for Steering Committee members. If Committee spokespersons are needed, they will be selected by the Steering Committee.

Development and Revision of Ground Rules

These ground rules were drafted by Extension and the TSSWCB and presented to the Steering Committee for their review, possible revision, and adoption. Once adopted, ground rules may be changed by two-thirds majority vote provided a quorum is present.

Appendix D: Land Use Classification Definitions

Developed Open Space

Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot, single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

Developed Low Intensity

Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49% of total cover. These areas most commonly include single-family housing units.

Developed Medium Intensity

Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79% of the total cover. These areas most commonly include single-family housing units.

Developed High Intensity

Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses, and commercial/industrial buildings. Impervious surfaces account for 80 to100% of the total cover.

Open Water

All areas of open water, generally with less than 25% cover of vegetation or soil.

Barren Land

Barren areas of bedrock, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.

Forested Land

Areas dominated by trees generally greater than 5 meters tall, and greater than 50% of total vegetation cover.

Near Riparian Forested Land

Areas dominated by trees generally greater than 5 meters tall, and greater than 50% of total vegetation cover. These areas are found following in near proximity to streams, creeks and/or rivers.

Mixed Forest

Areas dominated by trees generally greater than 5 meters tall, and greater than 20-50% of total vegetation cover.

Orchard

Orchards, vineyards, and other areas planted or maintained for the production of fruits, nuts, berries, or ornamentals.

Rangeland

Areas dominated by upland grasses and forbs. In rare cases, herbaceous cover is less than 25%, but exceeds the combined cover of the woody species present. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.

Pasture/Hay

Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.

Cultivated Crops

Areas used for the production of annual crops, such as corn, sorghum, wheat, and cotton. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.

Appendix E: Load Duration Curve Explanation

The load duration curve (LDC) is an initial tool that can be used to help identify potential pollutant sources in a watershed. As the first step in this process, a flow duration curve is developed. Flow duration curves are constructed using historical hydrograph data of actual observed streamflows at a given location. In Plum Creek, these flows are obtained from USGS Stations 08172400 (Plum Creek at Lockhart) and 08173000 north of Luling (Plum Creek upstream from confluence of West Fork). The streamflow data for the Uhland monitoring station was based on the nearest downstream USGS station (08172400). Observed streamflow data collected at the Uhland monitoring station were compared to USGS station data for the same dates. During high flows, the USGS station had much higher deviations from the observed streamflows at the Uhland site. However, at lower flows (possibly due to point source flows) the deviation was negligible. A systematic procedure was used to obtain the cutoff for streamflow beyond which the deviation between the USGS station and the GBRA station increased considerably. All USGS streamflow data above this threshold streamflow were adjusted using the land area contributing to this location, and USGS flows lower than the threshold were used without adjustment for the Uhland monitoring station.

For a given period of record, daily average flow data are ordered from highest to lowest and plotted to construct a flow duration curve line. Data are then separated into different flow ranges. Flow duration curves are commonly split into high flows, moist conditions, mid-range flows, dry conditions, and low flows based on observations as indicated in Figure E.1. Here, highest flows occur less than 10% of the time, and over 90% of the time, streamflow is greater than low flow conditions. Extreme low flow conditions, known as 7Q2 data (minimum 7-day flow conditions over a 2-year period) are not included in the analysis, as they are not included in TCEQ water quality assessments. For this reason, they are not utilized for load reduction calculations.

By examining flow conditions at different sampling locations, overall flow patterns within the watershed can be characterized. However, flow duration curves are not based on time and do not show when flows occur, only their frequency.

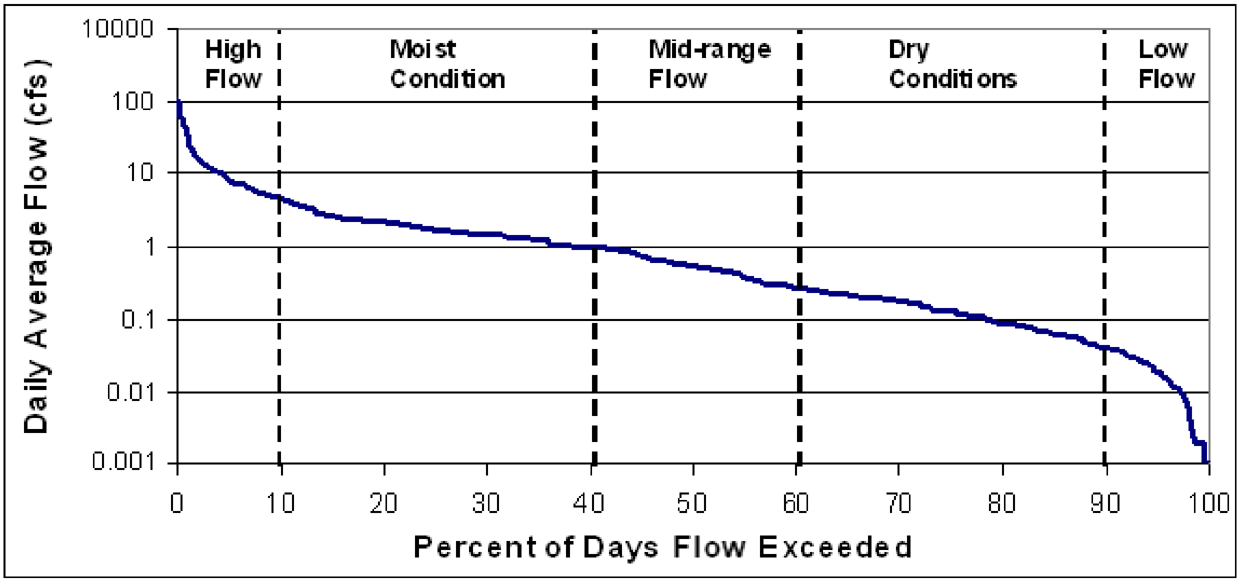

Figure E.1. Example flow duration curve. Vertical axis is flow rate and horizontal axis is percent exceedence. Curve shows percentage of time during a year, on average, a stream exhibits different flow conditions from very high flows during floods to low flow during summer or in long periods of time between rainfall events.

Next, it is necessary to determine if and under which flow conditions water quality standards are not met. The daily streamflow rate at all points along the flow duration curve is multiplied by a water quality criterion or target (EPA 2006). For example, to support contact recreation in Texas freshwater streams, the Texas Surface Water Quality Standard for *E. coli* is a geometric mean of 126 cfu/100 mL. By using the geometric mean rather than the single sample criterion of 394 cfu/ 100 mL, bacteria loads after implementation efforts, if successful, will be below both geometric mean and single sample criteria. If the single sample criterion were used as a water quality target, stream loads after reductions might still exceed the geometric mean.

In addition to a water quality criterion, a 10% margin of safety is typically included in load reduction calculations. The margin of safety allows for possible variability in streamflow and pollutant loads resulting from potential contributions from tributaries, variation in the effectiveness of control measures, and other sources of uncertainty over time and space. As a result, the target stream *E. coli* concentration for Plum Creek is 114 cfu/100 mL, which is the Texas Standard geometric mean of 126 cfu/100 mL minus the 10% margin of safety. Multiplying this value by streamflow at all points along the flow curve produces the maximum acceptable pollutant load (in this example *E. coli*), or the load duration curve (dark blue line in Figure E.2 and blue line in Figures E.3 and E.4) for that specific monitoring location on the stream. Actual monitored data for pollutants (pink boxes in Figure E.2) can then be evaluated based on how they compare to regulatory limits under different streamflow conditions. To do this, the total pollutant load for the stream at a given place and time is calculated by multiplying the measured streamflow by the measured pollutant concentration.

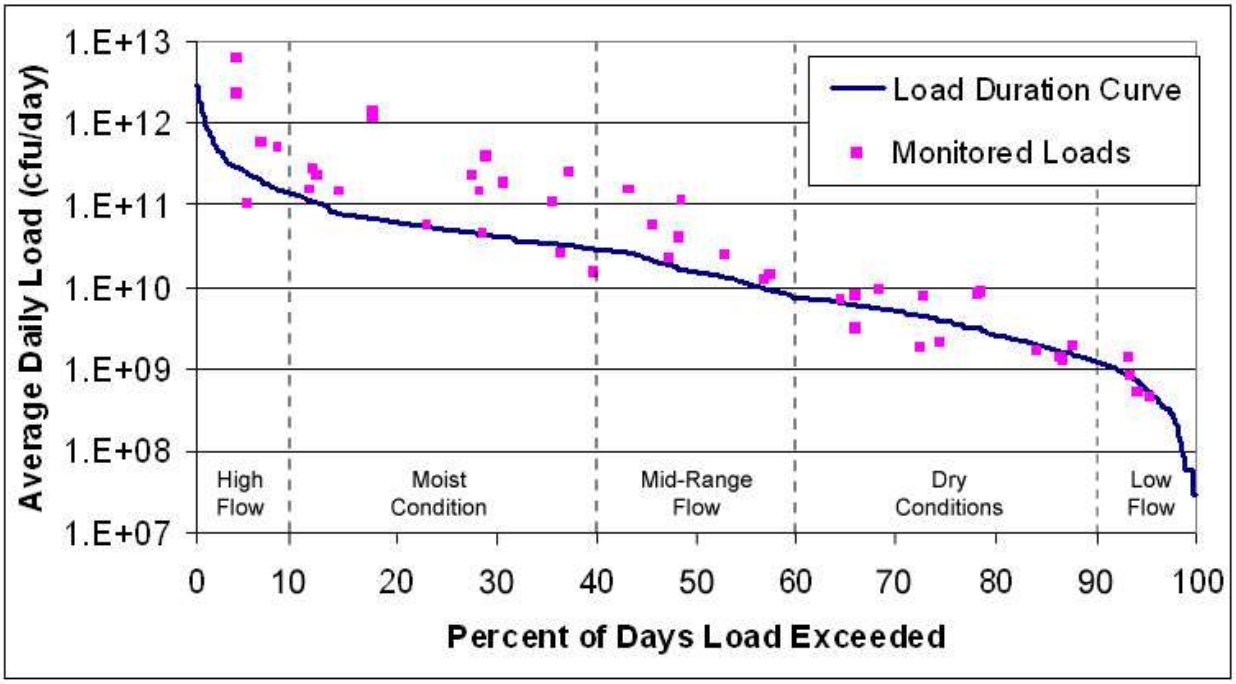

Figure E.2. Example load duration curve. Flow duration curve is multiplied by the *E. coli* bacteria criterion of 126cfu/100 mL to yield a maximum allowable bacterial load for a stream, varying with streamflow conditions.

Once individual monitoring station data points are plotted, patterns of observed exceedences provide basic information on the nature of pollutant sources. Exceedences on the left side of the curve, when flows are highest, typically indicate nonpoint sources. Moderate to high streamflows are correlated with significant rainfall events, which typically generate runoff. As it moves overland, runoff can transport various materials, including sediment, bacteria, and nutrients. Because many pollutants that would not otherwise reach the stream under drier conditions are moved to the stream by runoff, greater pollutant loads are generally observed at high flows.

In contrast, exceedences that occur during low flows in relatively dry conditions (on the right side of the curve) typically indicate point source contributions or discharges directly into the stream, since runoff is not occurring. These may include piped wastewater effluent, sewer bypasses and overflows, urban stormwater outlets, or industrial discharges, and also can be an indication of direct deposition by wildlife, non-domestic animals, and livestock. This separation of timing of exceedences is helpful in identifying both categories of potential pollutant sources and the processes that may be affecting how pollutants are entering the stream. However, load duration curves cannot separate individual sources (septic systems and urban runoff, for example) and cannot determine the exact points in time that all high pollutant levels occur.

Using the LDC and monitored data, it is then possible to calculate the load reduction that will be needed to meet water quality goals. To do this, a statistical regression analysis is performed using the actual monitored data for that location. The regression trendline, or load regression curve in Figures E.3 and E.4, is plotted on the graph and is compared to the load duration curve. The difference between the load estimated by the regression curve and the target load at the water quality criterion (with the 10% margin of safety) determines the percent reduction required for each flow condition. The highest load reduction percent for any one flow condition determines the necessary reduction for that site. For instance, the highest reduction at Uhland is the 64.7% under moist conditions. This value is used as the target load reduction for the site.

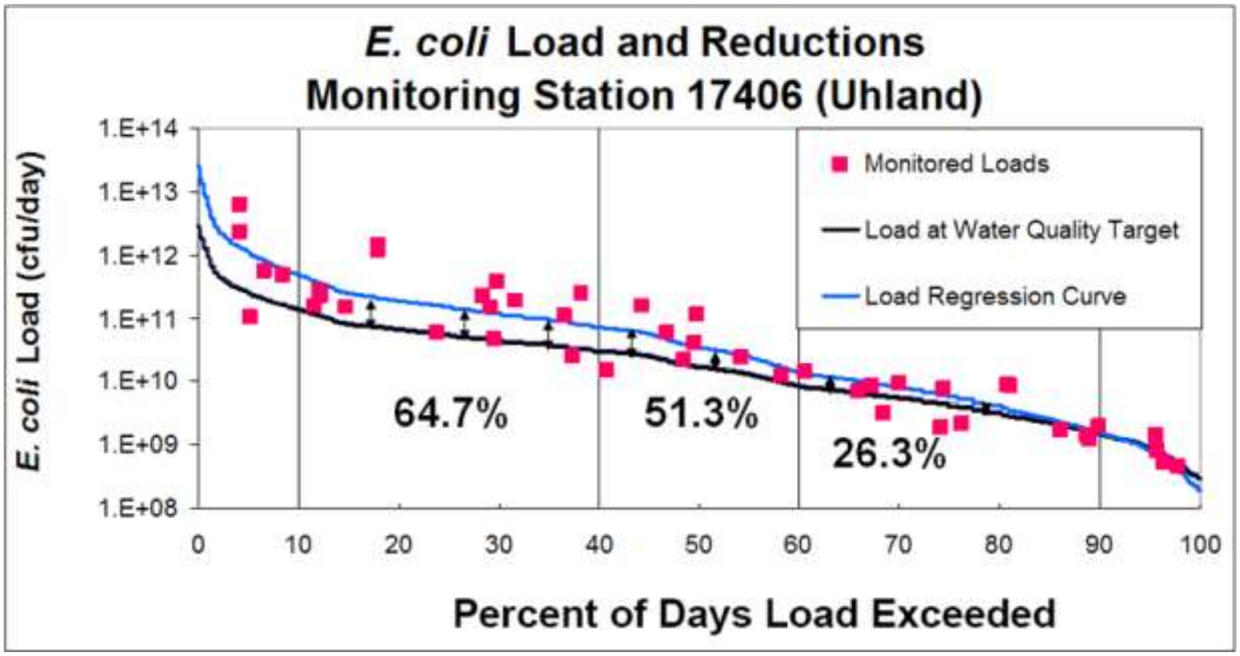

Figure E.3. Example load reduction determination for Uhland monitoring station.

In some situations, the highest load reduction occurs during low flow conditions. For instance, at Lockhart, the highest indicated load reduction is 15% during dry conditions (Figure E.4). Since this is the highest required reduction at the site (other flow conditions show no necessary load reductions), this value is used for the target load reduction at the Lockhart monitoring station.

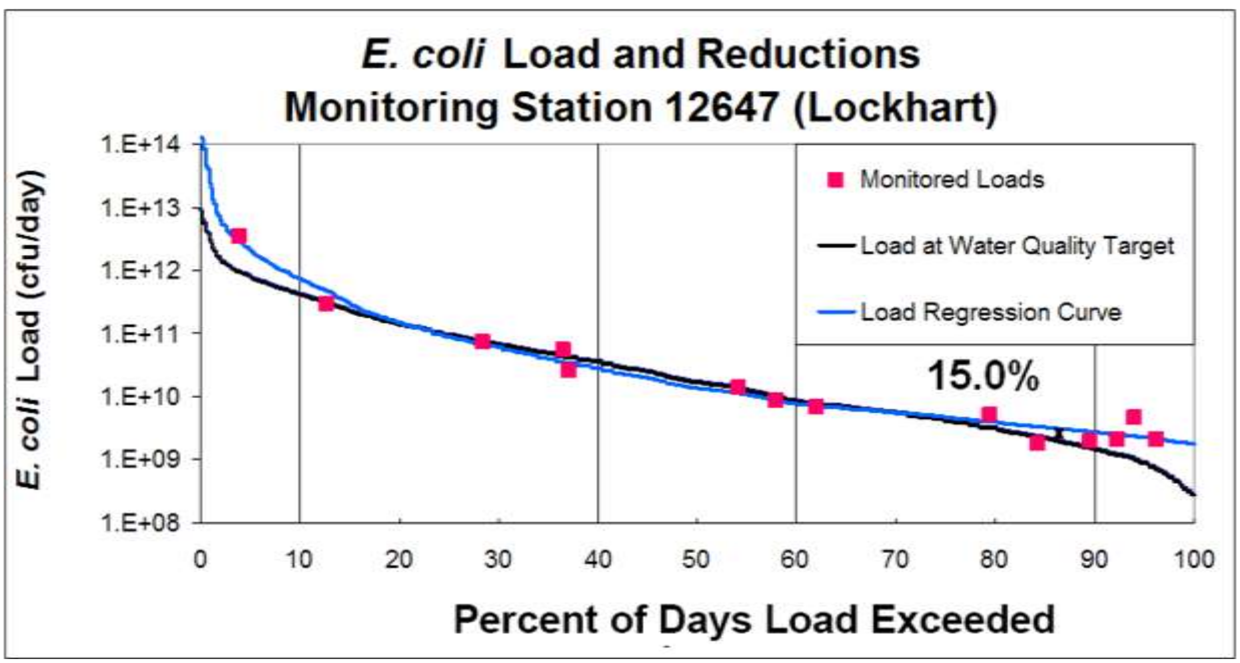

Figure E.4. Example load reduction for Lockhart monitoring station.

For each additional pollutant, the same approach of utilizing flow data, actual monitored water quality data, Texas standards or screening criteria, and margin of safety is used. In this way, estimated loads and load reductions can be determined for any particular pollutant of interest, and this information can serve as a starting point to guide selection of management strategies to achieve watershed planning goals.

Appendix F: SELECT Approach Explanation

The Spatially Explicit Load Enrichment Calculation Tool (SELECT) is an analytical approach for developing an inventory of potential bacterial sources, particularly nonpoint source contributors, and distributing their potential bacterial loads based on land use and geographical location. A thorough understanding of the watershed and potential contributors that exist is necessary to estimate and assess bacterial load inputs. Land use classification data and data from state agencies, municipal sources, and local stakeholders on the number and distribution of pollution sources are used as inputs in a Geographical Information Systems (GIS) software format. The watershed is divided into multiple smaller subwatersheds based on elevation changes along tributaries and the main segment of the water body. Pollutant sources in the landscape can then be identified and targeted where they are most likely to have significant effects on water quality, rather than looking at contributions on a whole-watershed basis. The SELECT approach was utilized by the Plum Creek Steering Committee as one of their decision-making tools.

Septic Systems

Using 2000 census block data from the U.S. Census Bureau, the number and location of households in the Plum Creek Watershed were determined. Homes within city limits were determined to be on city sewer facilities, and those outside cities were assumed to rely on septic systems. Using home and subdivision records obtained from the counties in the Plum Creek Watershed, the age of homes, and thus septic systems, was determined. Based on the findings of Reed, Stowe, and Yanke (2001), regulated septic systems installed since 1989 were conservatively estimated to have a 12% failure rate. Systems installed prior to 1989 regulation were assumed to be unregulated and have a 50% failure rate. The total potential daily *E. coli* bacteria load generated by septic systems in individual subwatersheds in the Plum Creek Watershed was estimated as:

$$Septic-Load = \#FailingSeptics * \frac{10^6 cfu}{100mL} * \frac{70gal}{person/day} * \frac{\#Persons}{Household} * \frac{3758.2mL}{gal} * 0.5$$

where #FailingSystems is the estimated number of failing septic systems within a subwatershed, 10^6 cfu is bacteria production, 70 gallons per person per day is assumed to be daily discharge, and #Persons is the average number of individuals within a household (EPA 2001).

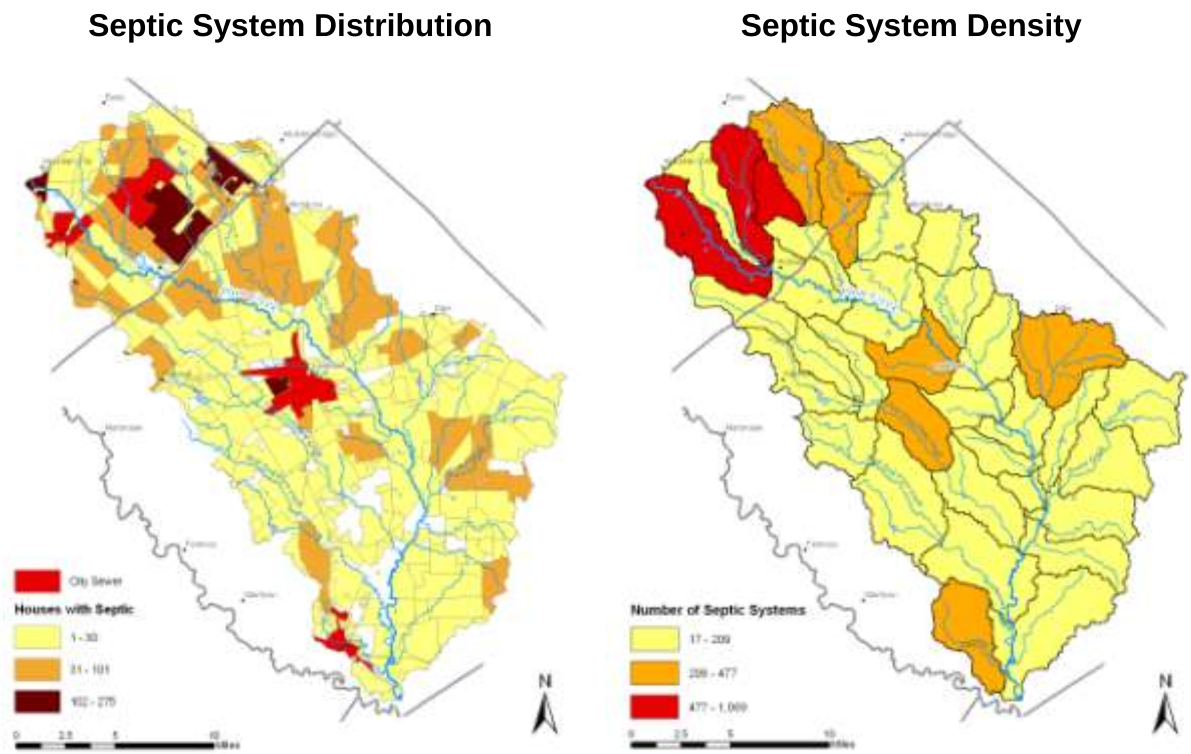

Figure F.1. Septic system distribution and relative density in the Plum Creek Watershed.

PETS

Using 2000 census block data from the U.S. Census Bureau, the number of households was determined for each subwatershed in the Plum Creek Watershed. Based on a survey by the AVMA (2002), the average Texas household has 0.8 dogs. By multiplying the average number of dogs by the number of households in each subwatershed, dog density can be estimated and total potential daily bacterial load approximated using:

$$Dog - Load = \# Households * \frac{0.8 dogs}{Household} * 5 * 10^{9} cfu / day * 0.5$$

where $5*10^9$ cfu/day*0.5 is the average daily *E. coli* bacteria production per dog (EPA 2001).

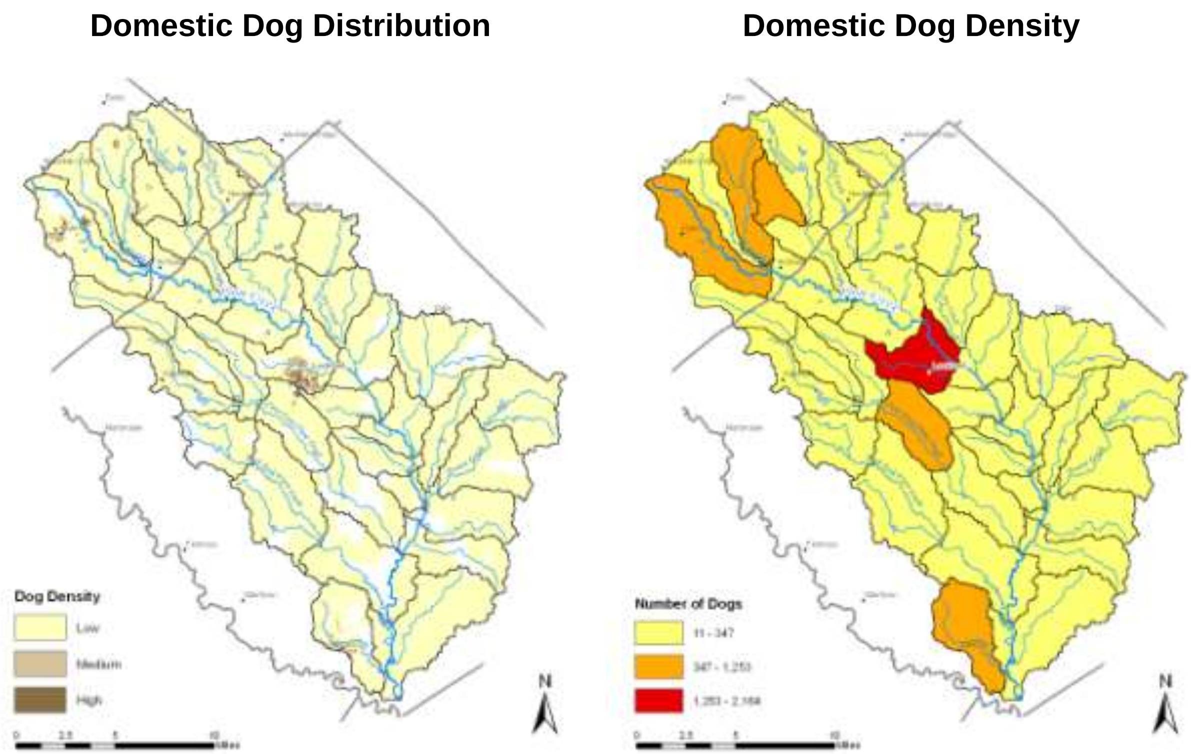

Figure F.2. Estimated dog distribution and relative density in the Plum Creek Watershed.

WILDLIFE

The potential bacteria contribution of white-tailed deer in the Plum Creek Watershed was estimated using deer census estimates from TPWD (Lockwood 2005). Average regional densities of white-tailed deer within resource management units were obtained for the SELECT analysis. Based on the average number of deer per square mile for each resource management unit, the number of deer was calculated within each resource management unit in the Plum Creek Watershed. Deer were then distributed across rangeland and forest land areas 20 acres or larger in size and the total number of white-tailed deer in each subwatershed calculated. The total potential daily bacteria load for each subwatershed was then estimated using the *E. coli* production rate of Zeckoski et al. (2005).

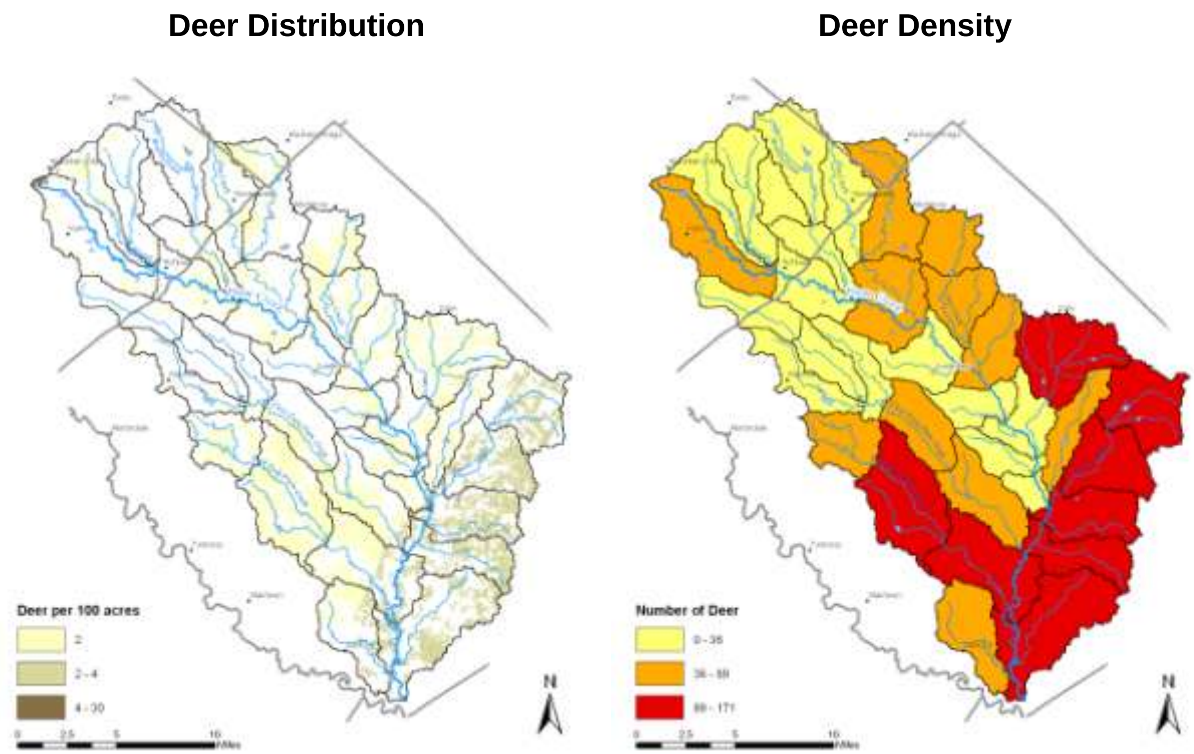

Figure F.3. Estimated white-tailed deer distribution and relative density in the Plum Creek Watershed.

Based on research information from Hellgren (1997), a population density of 12 animals/mile^2 was used to estimate the number of feral hogs in the Plum Creek Watershed. Habitat preferences and behavior characteristics reported by Hellgren (1997) also were used as the basis for distributing hogs to non-developed land use classes (forested land, near riparian forested land, mixed forest, rangeland, pasture/hay, and cultivated crops). In addition, for SELECT analysis, animals were restricted to areas within 100 m of perennial water sources, including ponds, flood control structures, and wastewater outfalls. Total potential daily *E. coli* loads from feral hogs were estimated using:

$$FeralHog\text{–}Load = \#Hogs * 8.9 * 10^9 \, cfu/day * 0.5$$

where $8.9*10^9$ cfu/day*0.5 is the average daily *E. coli* bacteria production per hog (EPA 2001).

*L*IVESTOCK

E. coli contributions from sheep and goats in the watershed were based on 2002 USDA census data for Caldwell, Hays, and Travis Counties. Using county totals for these animals, goats and sheep were distributed across rangeland and pasture land uses for the SELECT analysis. The average density of sheep and goats was determined for each county, and then the total population within the watershed was estimated by considering only the portions of these counties within the Plum Creek Watershed. Based on these numbers, the total potential daily *E. coli* load for sheep and goats was estimated using:

$$Sheep/Goat-Load = \#SheepGoats * 18*10^9 cfu/day * 0.5$$

Where $18*10^9$ cfu/day*0.5 is the average daily *E. coli* production per animal (EPA 2001).

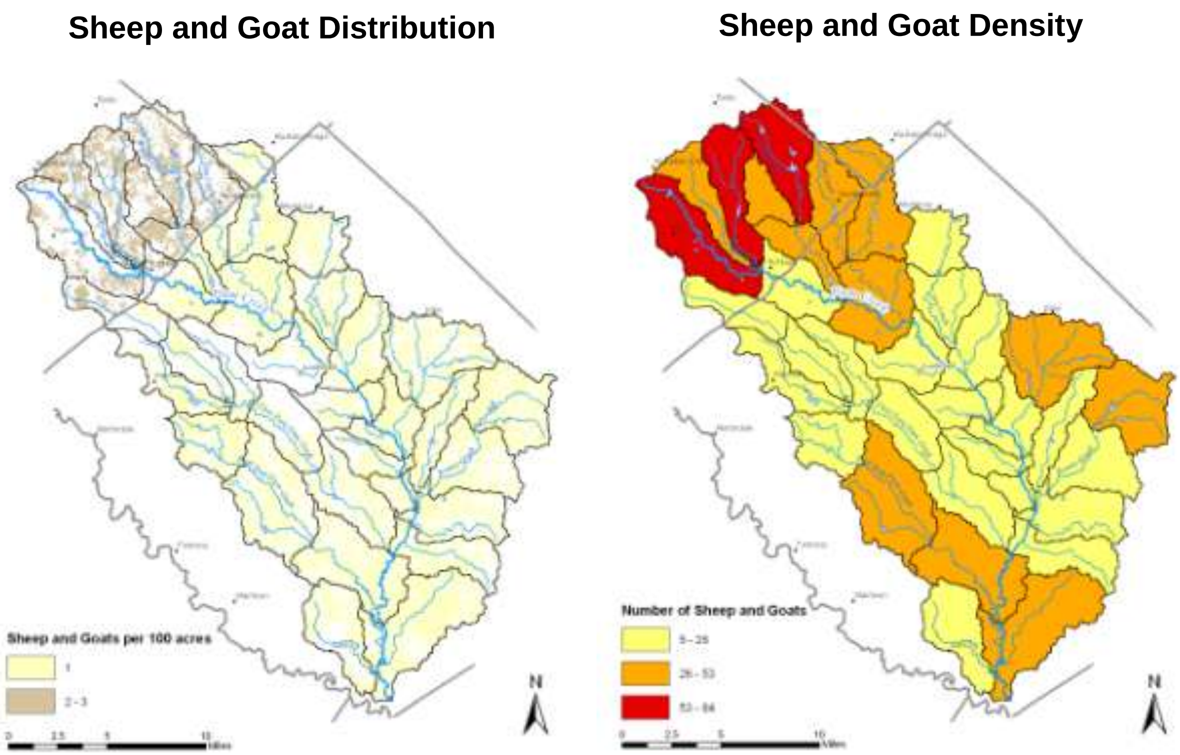

Figure F.4. Estimated sheep and goat distribution and relative density in the Plum Creek Watershed.

In the same way, bacteria load contributions from horses in the Plum Creek Watershed were estimated using 2002 USDA census totals for the counties that make up the watershed. Horses were distributed only across pasture/hay land uses in the watershed. An average density of horses was determined for each county, and the total population of horses within the watershed was estimated by summing the average density across the areas of Caldwell, Hays, and Travis Counties that lie within the Plum Creek Watershed. Based on the total population of horses in the watershed, the total potential daily *E. coli* load produced by horses was estimated using:

$$Horse-Load = \#Horses * 4.2*10^8 cfu/day * 0.5$$

where $4.2*10^8$ cfu/day*0.5 is the average daily *E. coli* production per horse (EPA 2001).

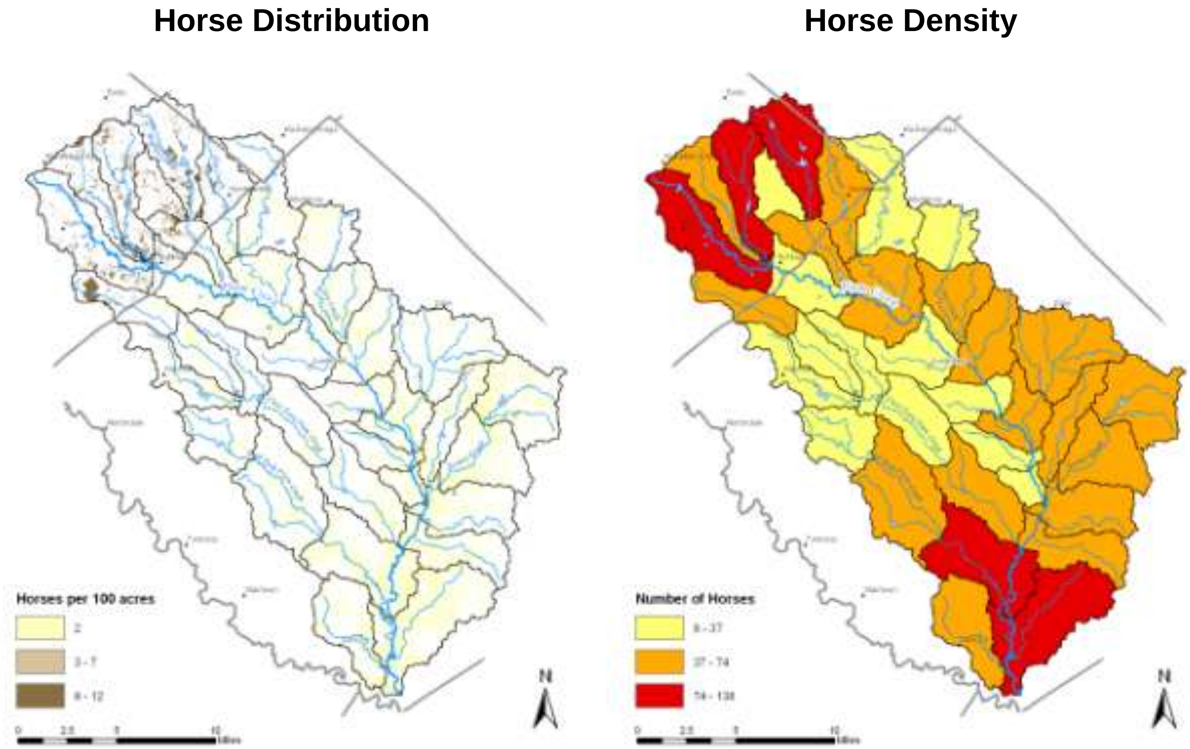

Figure F.5. Estimated horse distribution and relative density in the Plum Creek Watershed.

Cattle *E. coli* contributions were estimated in the same way as those for sheep and goats and horses. Using 2002 USDA census data for Caldwell, Hays, and Travis Counties, the total number of cattle in these areas was distributed across rangeland and pasture/hay land uses. The average density of cattle in each county was estimated and the portions of these counties within the Plum Creek Watershed yielded the estimated total number of cattle within the watershed. Based on this population density, the total potential daily *E. coli* bacteria load for each subwatershed was estimated using:

$$Cattle - Load = \#Cattle * 5.4 * 10^{9} cfu/day * 0.5$$

where $5.4*10^9$ cfu/day*0.5 is the average daily *E. coli* production per head of cattle (EPA 2001).

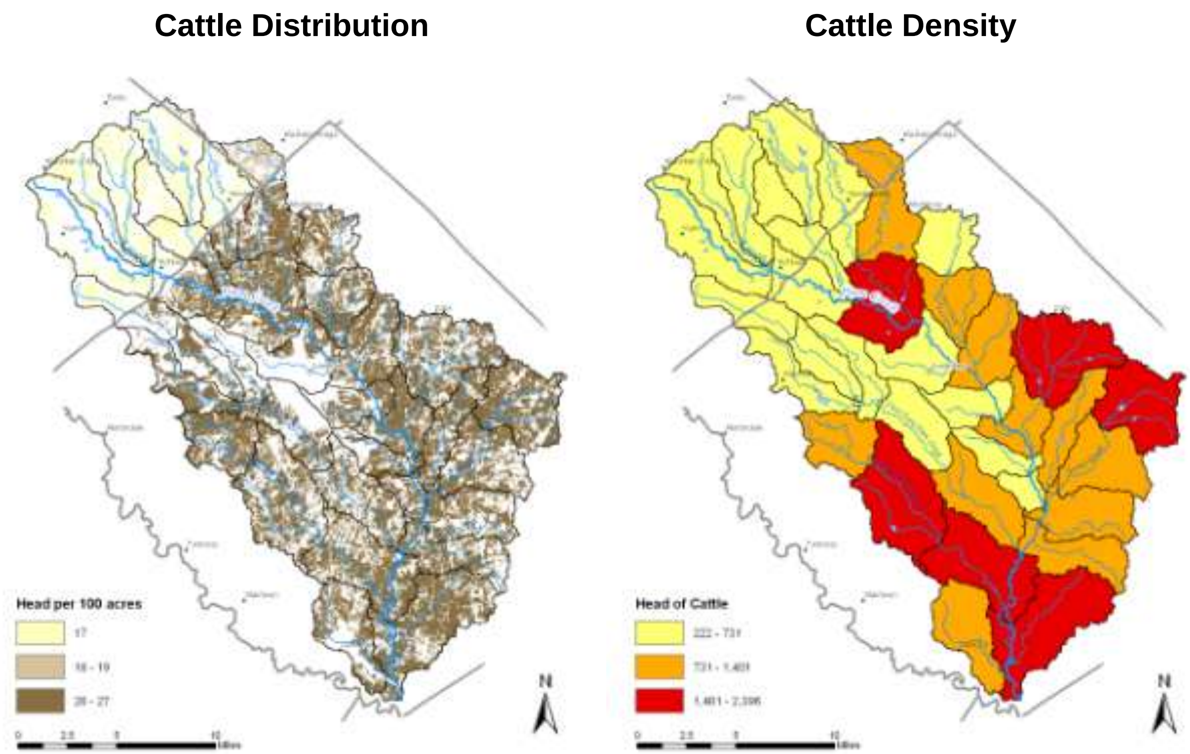

Figure F.6. Estimate cattle distribution and relative density in the Plum Creek Watershed.

URBAN RUNOFF

Results of a study commissioned by the City of Austin (1997) demonstrated a relationship between the amount of impervious surface cover and runoff bacteria concentration. This relationship was used to evaluate urban runoff potential in the Plum Creek Watershed. For each of the watershed's "major" cities (Kyle, Lockhart, and Luling), percent impervious cover within the city limits was determined based on land use classification. Percent cover was then correlated with a corresponding runoff bacteria concentration at that level of urban development based on the City of Austin study. Using 2004 total annual rainfall data from the nearby NOAA Austin Station and an assumed runoff coefficient of 1, the average daily potential rainfall depth was calculated. Using the resulting rainfall depth, potential runoff volume was calculated. Using this volume and the bacteria concentration corresponding to the appropriate level of impervious cover, the total potential daily *E. coli* load in urban runoff for each subwatershed was calculated.

WASTEWATER

SELECT was used to evaluate WWTFs based on their permitted discharge rates. Only actively discharging WWTFs in the Plum Creek Watershed (City of Lockhart #1, City of Lockhart #2, City of Luling North, City of Buda, and City of Kyle) were included in the SELECT analysis. Average maximum daily potential *E. coli* loads were calculated by assuming that each facility was discharging effluent in their subwatersheds at the 2004 permitted volume and with bacteria concentrations equal to the Texas Surface Water Quality Standard criterion (126 cfu/100 mL).

Wastewater Treatment Facility	Flow (MGD)
City of Lockhart No. 1	1.1
City of Lockhart No. 2	1.5
City of Luling North	0.9
City of Buda	0.3
City of Kyle	1.5

100%-25% BUFFER APPROACH

For SELECT analysis of the Plum Creek Watershed and consistent with EPA (2001) TMDL guidelines, a buffer was placed around streams to account for the reduced likelihood of contamination by sources located farther away from the creek and its tributaries. Within 100m of waterways, 100% transmission to the mainstem of the creek was assumed. Virtually all of the bacteria from a source within that distance from water would be expected to reach the stream alive. Beyond 100m, a 25% transmission of bacteria was assumed, since only in conditions of high rainfall would sufficient runoff occur to carry bacteria to the creek from surrounding upland areas. This reduces the estimated effects of potential inputs that are in fact far removed from the stream and less likely to add to bacterial and/or nutrient loads within Plum Creek under most circumstances. The buffer was applied to all potential pollutant sources in the watershed and affected total load contributions from each.

Appendix G: Plum Creek Permit History

Facility	Effluent Set	Begin Date	End Date	Flow (MGD)	BOD (mg/L)	TSS (mg/L)	NH3 (mg/L)	TP (mg/L)	Fecal Bacteria (colonies/100mL)
Kyle	1	5/26/2000	3/11/2003	1.5	10	15	3	-	-
11041-002	2	3/12/2003	6/25/2006	1.5	10	15	3	-	-
	3	6/26/2006	-	1.5	10	15	3	-	-
	4	-	-	3	10	15	3	-	-
	5	-	-	4.5	10	15	3	-	-
Lockhart No. 2	1	2/9/1999	7/18/2001	1.5	10	15	3	-	
10210-002	2	7/19/2001	3/8/2005	1.5	10	15	3	-	
	3	3/9/2005	-	1.5	10	15	3	-	200
Buda	6	4/1/1996	2/15/2005	0.3	10	15	3	2	-
11060-001	8	2/16/2005	-	0.6	10	15	3	2	-
	9	-	-	0.95	7	12	2	1.2	-
	10	-	-	1.5	5	12	2	0.8	-
Lockhart No. 1	9	9/14/1998	12/21/1999	1.1	10	15	3	-	-
10210-001	10	12/22/1999	3/13/2005	1.1	10	15	3	-	-
	11	3/14/2005	-	1.1	10	15	3	-	-
A & M Heep	1	6/29/2004	-	0.25	5	5	2	1	-
14377-001	2	-	-	0.5	5	5	2	1	-
	3	-	-	0.99	5	5	2	1	-
Luling North	5	11/1/1997	1/10/2005	0.9	10	15	3	-	-
10582-002	6	1/11/2005	-	0.9	10	15	3	-	-
Ranch at Clear Fork	1	9/13/2005	-	0.33	10	15	3	-	-
14439-001	2	-	-	0.7	10	15	2	-	-
Castletop 14431-001	1	3/1/2006	-	0.486	5	5	2	1	-
Railyards-Parkland	1	8/13/2001	7/27/2005	0.08	10	15	-	-	
14165-001	2	7/28/2005	-	0.08	10	15	-	-	200
	3	-	-	0.175	10	15	-	-	
	4	-	-	0.35	10	15	-	-	
Railyard	1	5/28/1999	6/13/2005	0.023	10	15	-	-	-
14060-001	2	6/14/2005	-	0.075	10	15	-	-	-
	3	-	-	0.124	10	15	-	-	-
Goforth	3	4/1/1996	5/24/2005	0.042	10	15	3	-	-
13293-001	4	5/25/2005	-	0.042	10	15	3	-	-

Appendix H: Small MS4 Stormwater Program Overview Minimal Control Measures & Compliance Strategies

Control Measure	What is Required	Best Management Practices
Public Education and Outreach	Implement a public education program to distribute educational materials to the community about the impacts of stormwater discharges on local water bodies and the steps that can be taken to reduce stormwater pollution	Brochures or fact sheets
		Recreational guides
		Alternative information sources
		A library of educational materials
		Volunteer citizen educators
		Event participation
		Educational programs
		Storm drain stenciling
		Storm water hotlines
		Economic incentives
		Public Service Announcements
		Tributary signage
Public Participation/Involvement	Provide opportunities for citizens to participate in program development and implementation	Public meetings/citizen panels
		Volunteer water quality monitoring
		Volunteer educators/speakers
		Storm drain stenciling
		Community clean-ups
		Citizen watch groups
		"Adopt A Storm Drain" programs
Illicit Discharge Detection and Elimination	Develop, implement and enforce an illicit discharge detection and elimination program	A storm sewer system map showing outfalls and receiving waters
		Legally prohibit non-storm water discharges into the MS4
		Implement a plan to detect and address non-storm water discharges into the MS4
		Educate public employees, businesses, and the general public about the hazards of illegal discharges and improper disposal of waste

<table>
<tr><th>Control Measure</th><th>What is Required</th><th colspan="2">Best Management Practices</th></tr>
<tr><td rowspan="5">Construction Site Runoff Control</td><td rowspan="5">Develop, implement, and enforce an erosion and sediment control program for construction activities that disturb 1 or more acres of land</td><td colspan="2">Have an ordinance or other regulatory mechanism requiring the implementation of proper erosion and sediment controls on applicable construction sites</td></tr>
<tr><td colspan="2">Have procedures for site plan review of construction plans that include requirements for the implementation of BMPs to control erosion and sediment and other waste at the site</td></tr>
<tr><td colspan="2">Have procedures for site inspection and enforcement of control measures</td></tr>
<tr><td colspan="2">Have sanctions to ensure compliance (established in the ordinance or other regulatory mechanism)</td></tr>
<tr><td colspan="2">Establish procedures for the receipt and consideration of information submitted by the public</td></tr>
<tr><td rowspan="5">Post-Construction Runoff Control</td><td rowspan="5">Develop, implement, and enforce a program to reduce pollutants in post-construction runoff to their MS4 from new development and redevelopment projects that result in the land disturbance of greater than or equal to 1 acre</td><td rowspan="2">Non-Structural BMPs</td><td>Planning Procedures</td></tr>
<tr><td>Site-Based BMPs</td></tr>
<tr><td rowspan="3">Structural BMPs</td><td>Stormwater Retention/Detention BMPs</td></tr>
<tr><td>Infiltration BMPs</td></tr>
<tr><td>Vegetative BMPs</td></tr>
<tr><td rowspan="5">Pollution Prevention/Good Housekeeping</td><td rowspan="5">Develop and implement an operation and maintenance program with the ultimate goal of preventing or reducing pollutant runoff from municipal operations into the storm sewer system</td><td colspan="2">Employee training on how to incorporate pollution prevention/good housekeeping techniques into municipal operations</td></tr>
<tr><td colspan="2">Maintenance procedures for structural and non-structural controls</td></tr>
<tr><td colspan="2">Controls for reducing or eliminating the discharge of pollutants from areas such as roads and parking lots, maintenance and storage yards</td></tr>
<tr><td colspan="2">Procedures for the proper disposal of waste removed from separate storm sewer systems</td></tr>
<tr><td colspan="2">Ensure that new flood management projects assess the impacts on water quality and examine existing projects for incorporation of additional water quality protection devices or practices</td></tr>
</table>

Appendix I: Draft East Hays County Wastewater Compact

Whereas the parties to this compact, the cities of Buda, Niederwald, Uhland and Kyle, Hays County and the Guadalupe-Blanco River Authority (GBRA) all function in East Hays County (EHC), and

Whereas all parties share common interests in:

- the protection of water quality,
- the beneficial reuse of water to the extent practical,
- minimizing reliance on On-Site Sewage Facilities (OSSFs),
- the provision of high quality and cost-effective water and wastewater services,

and whereas all parties recognize that much of the future water and wastewater infrastructure in EHC will have to be provided initially by the private sector in new developments, and whereas all parties understand that the common interests will be served by adopting a uniform approach, the parties jointly enter into this compact. The key elements to the compact are:

1. The parties recognize that in low-density or remote locations, OSSFs are the most practical and cost-effective means of meeting home wastewater needs. However, OSSFs provide no opportunity for effective wastewater reuse, and raises the potential for water quality impacts as systems age, the parties agree to encourage larger private developments to install centralized wastewater systems. The parties recognize that specific conditions will determine the number of housing units needed for a central wastewater system, but as an initial target agree that OSSFs would not be appropriate for developments of 10 or more homes.

2. The parties believe that domestic wastewater treatment is an important public service, with the potential to affect citizens outside of the immediate project area. The parties also recognize that proper operation and maintenance of wastewater infrastructure is essential to the public welfare. Because it is important to the public, the parties agree that central wastewater facility operations should be a public function, and that future wastewater facilities in the EHC area should be operated by a public rather than a private entity. The parties recognize that the private sector must be involved in the design, permitting and construction of wastewater facilities to serve new developments, but the parties anticipate that these new developments will at some future time become a part of a municipality. As such, the parties agree that central wastewater facilities associated with new developments should be jointly permitted (e.g. private developer and public entity) and operated by the public entity.

3. An important aspect of wastewater operations is the quality of the water produced. The parties agree that a high quality effluent that is discharged to surface waters is important and will encourage the level represented by the Texas Commission on Environmental

Quality's (TCEQ) 5-5-2-1 effluent set will be the goal for all new facilities. That is operating at full flow with a monthly average effluent quality of BOD5 of 5 mg/L, TSS of 5 mg/L, ammonia-Nitrogen of 2 mg/L and total Phosphorus of 1 mg/L. The parties recognize that this goal can be met in several ways including direct treatment, treating to a different level, and meeting the goal by use of an offsetting amount of effluent for irrigation, or through wetland polishing.

4. The parties recognize that EHC has limited water supplies and that providing good quality water to serve future growth will be a challenge. To conserve water supplies to the extent practical, the parties jointly desire new development to include provisions to minimize potable water use in irrigation. This can include a purple pipe system for irrigation and/or cisterns for providing water for toilet flushing and lawn irrigation.

5. Parties agree to jointly participate, to the extent desired, in the review of new proposed projects and plans, and in special studies involving rates or other issues.

6. All parties agree to participate in supporting the core provisions of the Compact. For example, this could include opposing a private permit applicant in the TCEQ hearing process that refuses to follow the central treatment, effluent quality, or reuse provisions of the Compact.

Agreed to on this _____ day of ____

__________________ for the City of Kyle

__________________ for the City of Buda

__________________ for the City of Niederwald

__________________ for the City of Uhland

__________________ for Hays County

__________________ for GBRA

References

American Veterinary Medical Association. 2002. U.S. Pet Ownership and Demographics Source Book. Schaumberg, Ill. Center for Information Management, American Veterinary Medical Association.

City of Austin. 1997. Evaluation of Non-point Source Controls, Volumes 1-2. COA-ERM/WQM & WRE. 1997-04.

Di Giovanni, G.D. and E. Casarez. 2006. Final Report: Upper and Lower San Antonio River, Salado Creek, Peach Creek and Leon River Below Proctor Lake Bacterial Source Tracking Project. Prepared for the Total Maximum Daily Load Program, Environmental Planning and Implementation Division, Texas Commission on Environmental Quality.

EPA. 2001. Protocol for Developing Pathogen TMDLs. Office of Water, United States Environmental Protection Agency.

EPA. 2006. An Approach for Using Load Duration Curves in Developing TMDLs. Office of Wetlands, Oceans, and Watersheds, United States Environmental Protection Agency.

Follett, C.R. 1966. Texas Water Development Board Report 12: Ground-Water Resources of Caldwell County, Texas. Prepared by the U.S. Geological Survey in cooperation with the Texas Water Development Board, Caldwell County Commissioner’s Court, and the Guadalupe-Blanco River Authority.

GBRA and UGRA. 2003. Investigation of Impacts of Oil Field Activities on the San Marcos River and Plum Creek in Caldwell County. Prepared in cooperation with the Guadalupe-Blanco River Authority and the Texas Commission on Environmental Quality under the Authorization of the Texas Clean Rivers Act.

Hellgren, E.C. 1997. Biology of feral hogs (*Sus scrofa*) in Texas. Feral Swine Symposium, Texas Cooperative Extension Service.

Hone, J. 1990. Notes on Seasonal Changes in Population Density of Feral Pigs in Three Tropical Habitats. Australian Wildlife Research 17:131-134.

Lockwood, M. 2005. White-Tailed Deer Population Trends. Federal Aid in Fish and Wildlife Restoration. Project W-127-R-14. Texas Parks and Wildlife Department.

Reed, Stowe, and Yanke. 2001. Study to Determine the Magnitude of, and Reasons for, Chronically Malfunctioning On-Site Sewage Facility Systems in Texas, Prepared in Cooperation with the Texas On-Site Wastewater Treatment Council.

Tate, J. 1984. Techniques for Controlling Wild Hogs in Great Smoky Mountains National Park: Proceedings of a Workshop. U.S.D.I. National Park Service Southeast Region, Research/Resources Manage. Rep. Ser-72. 87pp.

Texas Water Commission. 1991. Waste Load Evaluation for Plum Creek in the Guadalupe River Basin Segment 1810.

USDA. 2002. 2002 Census of Agriculture – County Data. National Agricultural Statistics Service: 560-634, 716-718, 719-729, 730-732, 733-734.

Zeckoski, R. W., B. L. Benham et al. 2005. BLSC: A Tool for Bacteria Source Characterization for Watershed Management. Applied Engineering in Agriculture 21(5):879-889.