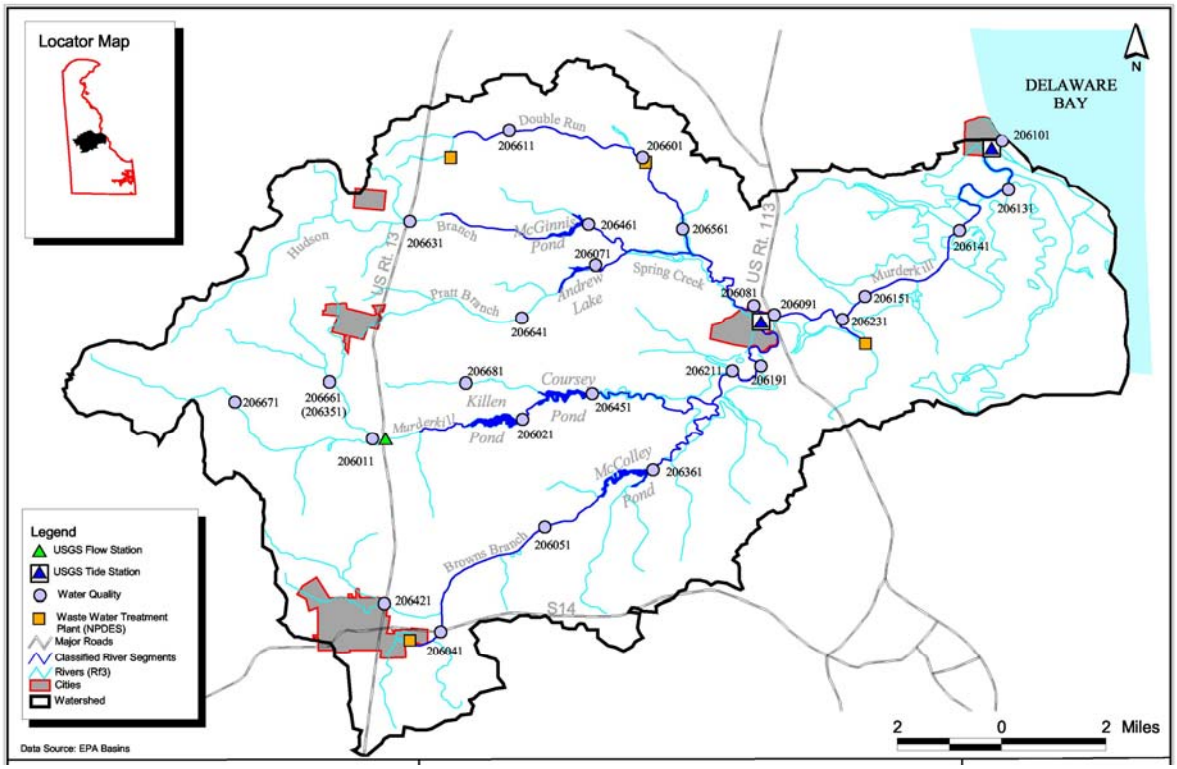
Technical Analysis for the Proposed Murderkill River Bacteria TMDLs



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DELAWARE
DIVISION OF WATER RESOURCES
Clean Water - for Today and Tomorrow

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Executive Summary

Section 303(d) of the Clean Water Act requires States to identify water quality impaired waterways and to develop Total Maximum Daily Loads (TMDLs) for the pollutants that impair those waterways. The Delaware Department of Natural Resources and Environmental Control (DNREC) has identified that the water quality of Murderkill River (segments DE220-001, DE220-002, DE220-003, DE220-004, DE220-005, DE220-L01, DE220-L02, DE220-L04) was impaired because of elevated bacteria levels. These segments were placed on the State's 1996 (1), 1998 (2), 2002 (3), and 2004 (4) 303(d) lists and were targeted for development of TMDLs.

The Murderkill River watershed is situated in the southeastern portion of Kent County, Delaware. The St. Jones River Watershed lies to the north while the Mispillion River Watershed bounds the southern edge. The Murderkill River flows eastward approximately 32 km from its headwaters west of Felton to its confluence with the Delaware Bay at Bowers Beach. The lower portion of the Murderkill River from its mouth at the Delaware Bay to the Rt. 113 Bridge at Frederica is tidal. Several free flowing tributaries such as Browns Branch, Double Run, and Hudson Branch enter the Murderkill River. In addition, a number of lakes and ponds are in the watershed including McColley Pond on Browns Branch, Killens Pond and Courseys Pond on the Murderkill River, McGinnis Pond on the Hudson Branch, and Andrews Lake on the Spring Creek Branch. The Murderkill River Watershed has a drainage area of approximately 275 km^2.

There are several point source facilities within the Murderkill River Watershed, including the Kent County Wastewater Treatment Plant, the Harrington Wastewater Treatment Plant, and the Canterburry Crossing Mobile Home Park. Therefore, pollutants come from both point and nonpoint sources. The concentration limit for these discharges will be a maximum of 33 CFU/100mL (geometric mean, minimum 5 samples within 30 days).

The Delaware DNREC adopted amended Total Maximum Daily Loads (TMDLs) for nutrients and oxygen consuming compounds for the entire Murderkill River Watershed including its tributaries and ponds in 2005 (5). The TMDLs include Waste Load Allocations (WLAs) for point sources, Load Allocations (LAs) for nonpoint sources, and a Margin of Safety (MOS).

Bacteria impairments were evaluated using the cumulative distribution approach to determine the reductions required within the watershed to achieve water quality standards (freshwater: 100CFU/100 mL geometric mean; marine water: 35 CFU/100 mL geometric mean).

In the Murderkill River Watershed, the overall bacteria loading shall be reduced by 31% in the fresh water regions and 61% in the marine regions from the 1997 - 2005

baseline levels. All tidal portions in the watershed east of US Rt. 113 are considered marine and segments west of US Rt. 113 are considered fresh.

The draft proposed TMDL for this watershed was reviewed during a public workshop held on June 5, 2006. All comments received at the workshop and during the June 1st through 30th comment period were considered by DNREC. This report has been updated to address these comments and minor modifications were made in the regulation.

1 Introduction/Background

Under Section 303(d) of the Clean Water Act (CWA), States are required to identify and establish a priority ranking for waters in which existing pollution controls are not sufficient to attain and maintain State water quality standards, establish Total Maximum Daily Loads (TMDLs) for those waters, and periodically submit the list of impaired waters (303(d) list) and TMDLs to the United States Environmental Protection Agency (EPA). If a State fails to adequately meet the requirements of section 303(d), the CWA requires the EPA to establish a 303(d) list and/or determine TMDLs for that State.

In 1996, the EPA was sued under Section 303(d) of the CWA concerning the 303(d) list and TMDLs for the State of Delaware. The suit maintained that Delaware had failed to fulfill all of the requirements of Section 303(d) and the EPA had failed to assume the responsibilities not adequately preformed by the State. A settlement in the suit was reached and the Delaware Department of Natural Resources and Environmental Control (DNREC) and the EPA signed a Memorandum of Understanding (MOU) on July 25, 1997. Under the settlement, DNREC and the EPA agreed to complete TMDLs for all 1996 listed waters on a 10-year schedule.

The Delaware Department of Natural Resources and Environmental Control has identified the waters of Murderkill River (segments DE220-001, DE220-002, DE220-003, DE220-004, DE220-005, DE220-L01, DE220-L02, DE220-L04) as water quality limited waters with respect to bacteria. These segments were placed on the State's 1996 (1), 1998 (2), 2002 (3), and 2004 (4) 303(d) lists, and targeted for TMDL development. Table 1-1 is an excerpt from the State of Delaware's 2004 303(d) List for the Murderkill River Watershed.

WATERBODY ID	SEGMENT	DESCRIPTION	SIZE AFFECTED	PROBABLE BACTERIA SOURCE(S)	TARGET DATE FOR TMDL
DE220-001	Lower	Spring Creek to mouth at Delaware Bay	12.2 km	PS, NPS	2006
DE220-002	Spring Creek	Headwaters to Murderkill River	25.4 km	PS, NPS	2006
DE220-003	Mid	McCauley and Coursey Pond to Spring Creek	14.8 km	PS, NPS	2006
DE220-004	Browns Branch	Headwaters to McCauley Pond	14.2 km	NPS	2006
DE220-005	Upper	Headwaters to Coursey Pond	11.9 km	NPS	2006
DE220-L01	McGinnis Pond	Pond east of Viola	0.13 km^2	NPS	2006
DE220-L02	Andrews Lake	Pond west of Frederica	0.07 km^2	NPS	2006
DE220-L04	Killens Pond	Pond southwest of Felton	0.30 km^2	NPS	2006

Table 1-1 Excerpt from the State of Delaware's 2004 303(d) List for the Murderkill River Watershed

2 Study Area

The Murderkill River Watershed has a drainage area of 106 square miles and is located in the southeastern portion of Kent County, Delaware (Figures 1-1 and 1-2). The Murderkill River flows eastward approximately 20 miles from its headwaters west of Felton to its confluence with the Delaware Bay at Bowers Beach. The lower portion of the Murderkill River from its mouth at the Delaware Bay to Rt. 113 Bridge at Frederica is tidal. Several free flowing tributaries such as Browns Branch, Double Run, and Hudson Branch enter the Murderkill River. In addition, a number of lakes and ponds are in the watershed including McColley Pond on Browns Branch, Killens Pond and Courseys Pond on the Murderkill River, McGinnis Pond on the Hudson Branch, and Andrews Lake on the Spring Creek Branch.

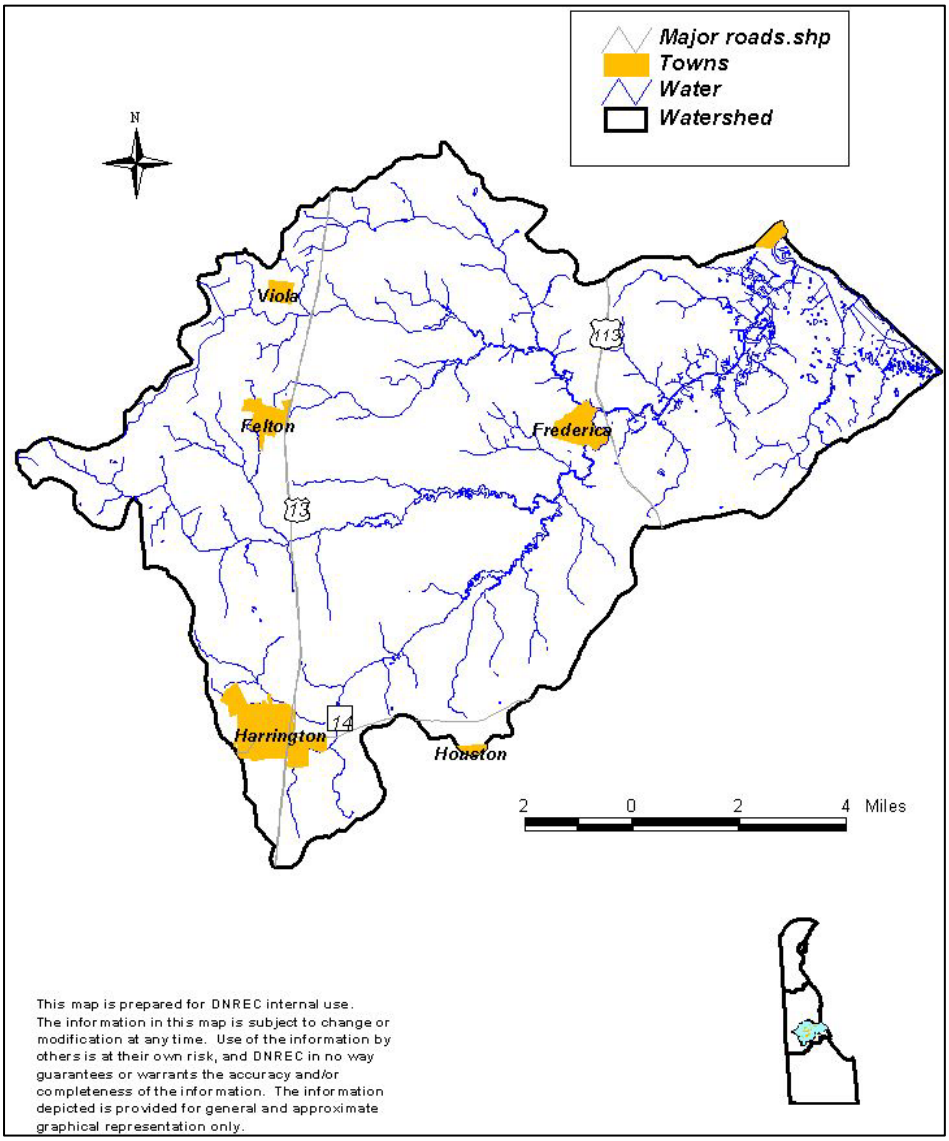

Figure 2-1 Murderkill River Watershed

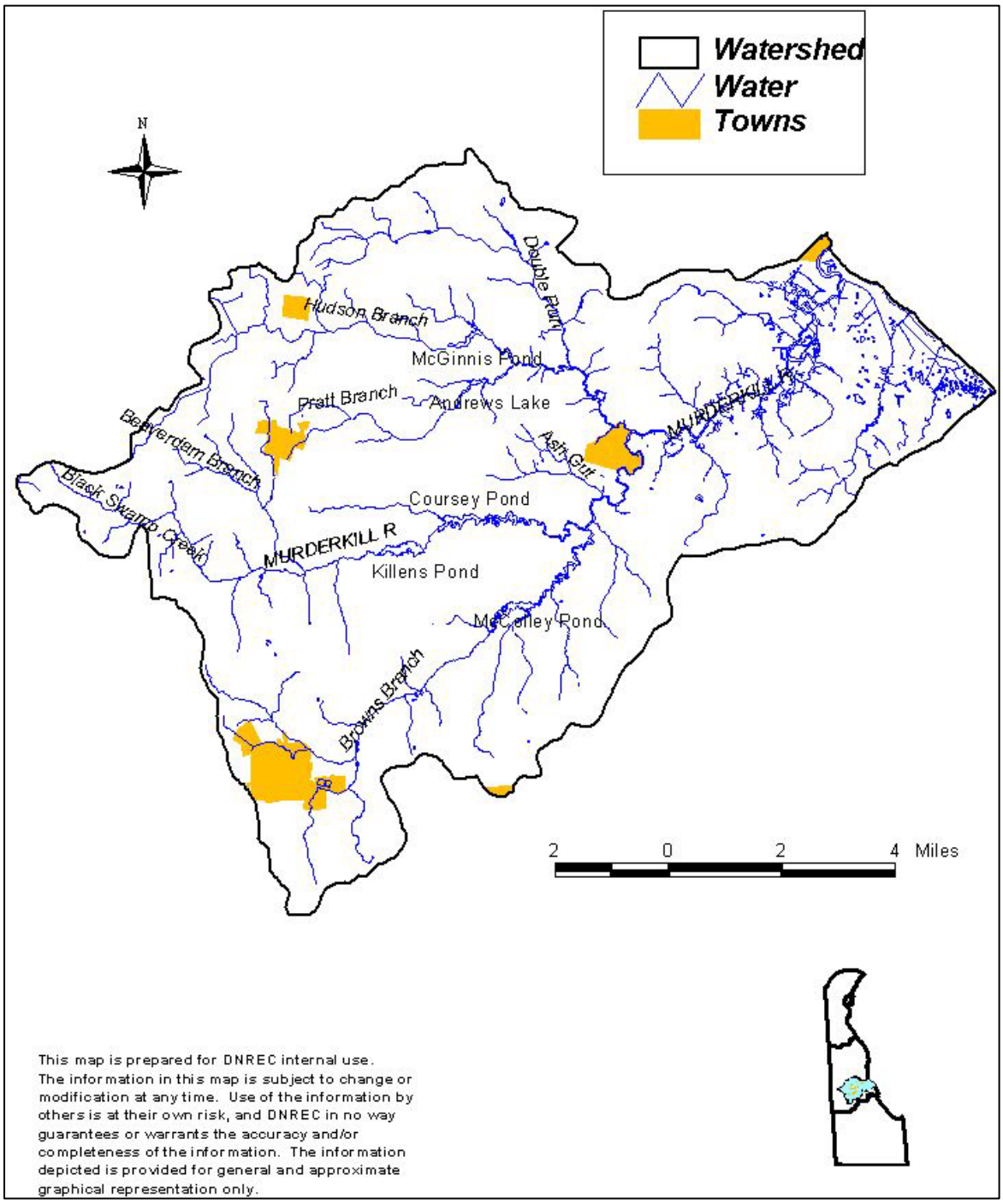

Figure 2-2 Streams and Ponds of the Murderkill River Watershed

2.1 LAND USE / LAND COVER

Figure 1-3 shows the 2002 land use map for the Murderkill River Watershed. As it can be seen from this map, about 55% of the watershed is agricultural land, 14% is urban/built up, 11% is forest, 17% is wetlands (fresh and tidal), and about 2% is water.

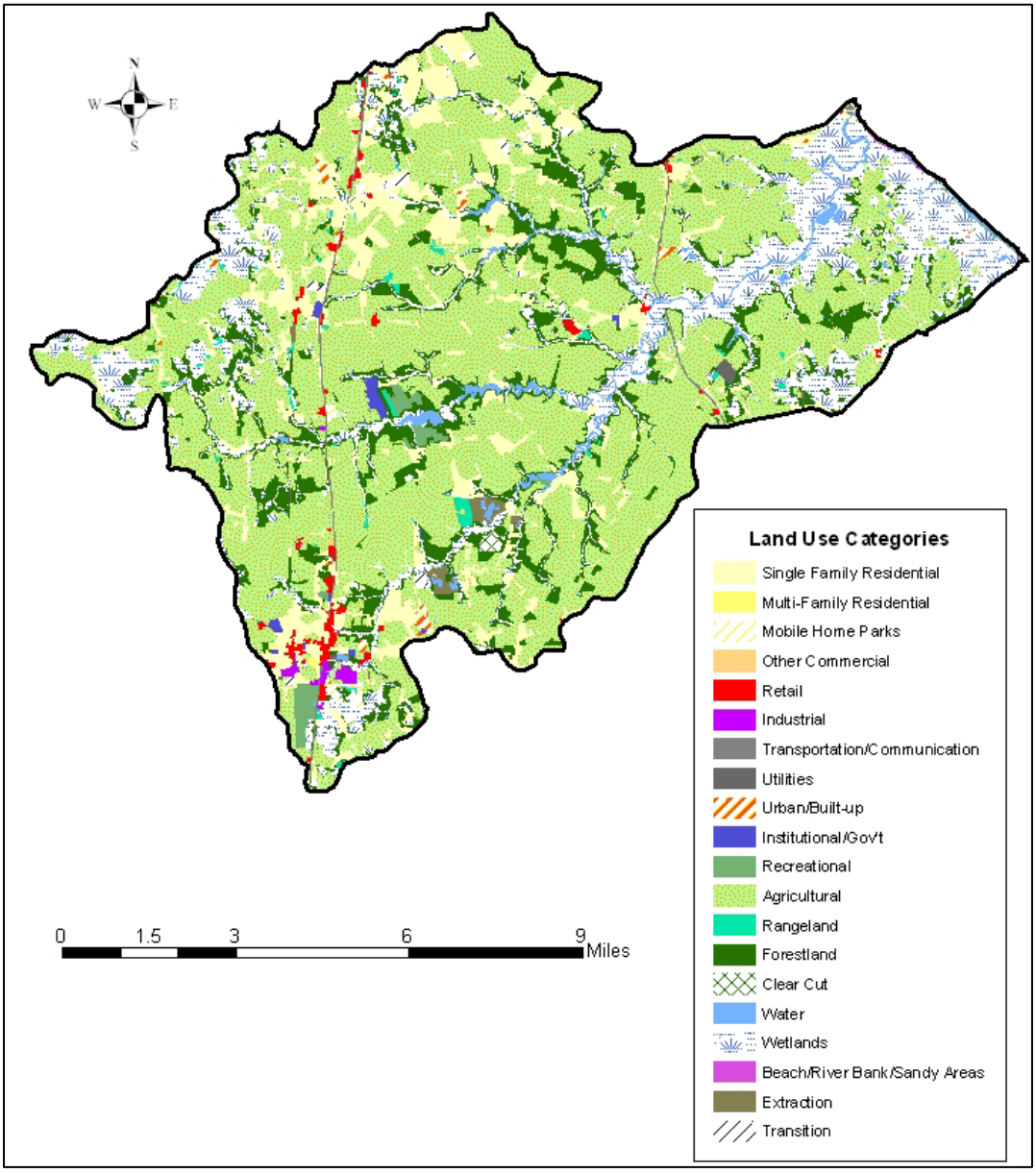

Figure 2-3 Murderkill River Watershed 2002 Land Use and Land Cover

2.2 Soils/Wetlands

The Murderkill River Watershed has predominately well-drained soils. Tidal marsh soils occupy 6% of the landscape and are found in the flood plains below the dams of Andrews Lake, McGinnis Pond, Courseys Pond, and McColley Pond and along the Delaware Bay. Broadkill, Missipilion, Westbrook, Honga, Bestpitch and Transquaking are the tidal brackish soils found in the flood plains of the watershed. Poorly drained soils, predominantly Longmarsh and Indiantown, along with some occurrences of Chicone and Zekiah, can be found above the dams in the non-tidal flood plains. About 17% of the watershed (11,890 acres) is covered by wetlands associated with poorly drained soils of which 4,259 acres are tidal and 7,105 are freshwater wetlands. About 86% of the freshwater wetlands are forested.

The well-drained upland soils are predominately Downer and Ingleside with small areas of moderately well-drained Hammonton soils in slight depressions. A few Sassafras soils occur on level landscapes. In the headwater areas of the Murderkill River, poorly drained Hurlock and Mullica soils are found. Some well to excessively well-drained sandy soils (Galestown and Evesboro soils) are found near the ponds. In shallow depressions throughout the watershed, Hammonton and Hurlock soils are encountered.

2.3 Designated Uses

Section 9 of the State of Delaware Surface Water Quality Standards, as amended July 11, 2004, specifies the following designated uses for the waters of the Murderkill River watershed:

1. Primary Contact Recreation
2. Secondary Contact Recreation
3. Fish, Aquatic Life, and Wildlife
4. Industrial Water Supply
5. Agricultural Water Supply (freshwater segments)

2.4 Applicable Water Quality Standards

The following sections of the State of Delaware Surface Water Quality Standards, as amended July 11, 2004, provide specific numeric criteria for bacteria for the waters of the Murderkill River Watershed:

A. Enterococcus Bacteria

   a. For fresh waters, the geometric average of representative samples should not exceed 100 CFU/100 mL. Fresh waters are defined as those having a salinity of less than five parts per thousand.
   b. For marine waters, the geometric mean of representative samples should not exceed 35 CFU/100 mL. Marine waters are defined as those having a salinity of greater than five parts per thousand.

All tidal portions in the watershed east of US Rt. 113 are considered marine and segments west of US Rt. 113 are considered fresh.

2.5 Point Sources

There are three point sources within the watershed: Harrington STP, Kent County STP and Canterburry Crossing MHP. The concentration limit for these discharges will a maximum level not to exceed 33 CFU/100mL (geometric mean, minimum 5 samples within 30 days). Because these facilities are discharging at or below the WQS, they will not utilize any assimilation capacity of the receiving waters.

3 Current Conditions

Recent water quality data (1997-2005) was compiled at a number of stations in the Murderkill River watershed (Figure 3-1). Precipitation data used to determine if the sample was taken on a wet vs. dry day was obtained from the Office of the Delaware State Climatologist, the closest station with an adequate daily record was located at Greenwood. A summary of the bacteria data is listed in Table 3-1, the entire data set is listed in the Appendix Section of this document.

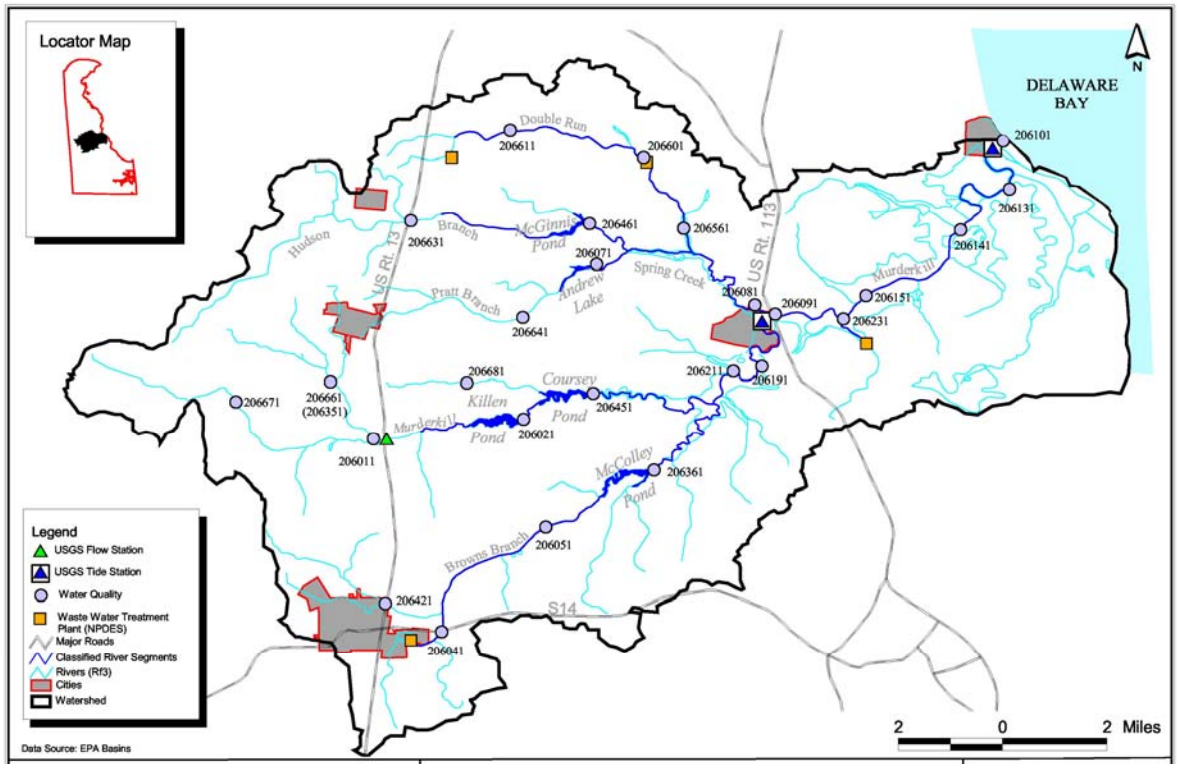

Figure 3-1 Monitoring Stations within the Murderkill River Watershed

	# samples dry weather	# samples wet weather	Average (CFU/100mL)	Geomean (CFU/100mL)	Log Std Dev
Marine segments	122	68	223	89	0.65
Fresh Segments	271	128	388	107	0.83

Table 3-1 Water Quality in the Murderkill River Watershed (1997-2005)

4 Establishment of the Bacteria TMDL for the Murderkill River Watersheds

Bacteria impairments were evaluated using the Cumulative Distribution Function Method to determine the reductions required in the Murderkill River to achieve water quality standards. This approach was developed by Lee Dunbar at the Connecticut Department of Environmental Protection and much of the following text is based upon or copied directly from documentation provided by the Connecticut Department of Environmental Protection

Overall reductions of 61% (marine) and 31% (fresh) in the bacteria loading for the Murderkill River Watersheds are required for the water quality to meet the geometric mean of 35CFU/100mL and 100CFU/100 mL, respectively.

4.1 Overview of Cumulative Distribution Function Method

This analytical methodology provides a defensible scientific and technical basis for establishing TMDLs to address recreational use impairments in urban watersheds. Representative ambient water quality monitoring data for a minimum of 21 sampling dates is required for the analysis. The reduction in bacteria density from current levels needed to achieve consistency with the criteria is quantified by calculating the difference between the cumulative relative frequency of the sample data set and the criteria adopted by Delaware to support recreational use. Delaware's adopted water quality criteria for the indicator bacteria fecal enterococci are represented by a statistical distribution of geometric mean 100 and log standard deviation 0.4 for purposes of fresh water and a statistical distribution of geometric mean 35 and log standard deviation 0.7 for purposes of marine water TMDL calculations.

The geometric mean criterion was derived by the EPA scientists from epidemiological studies at beaches where the incidence of swimming related health effects (gastrointestinal illness rate) could be correlated with indicator bacteria densities. Delaware's recommended criteria reflect an average illness rate of 12.5 illnesses (fresh) and 19 illness (marine) per 1000 swimmers exposed. This condition was predicted to exist based on studies cited in the federal guidance when the steady-state geometric mean density of fecal enterococci was 100 CFU/100mL and 35CFU/100mL, respectively. The distribution of individual sample results around the geometric mean is such that approximately half of all individual samples are expected to exceed the geometric mean and half will be below the geometric mean.

EPA also derived a formula to calculate single sample maximum criteria from this same database to support decisions by public health officials regarding the closure of beaches when an elevated risk of illness exists. Because approximately half of all individual sample results for a beach where the risk of illness is considered "acceptable" are expected to exceed the geometric mean criteria, an upper boundary to the range of individual sample results was statistically derived that will be exceeded at frequencies less than 50% based on the variability of sample data. The mean log standard deviation for fecal enterococci densities at the freshwater beach sites studied by EPA was 0.4. Using these values, 457 CFU/100mL was calculated to represent the 95th percentile upper confidence limit (5% exceedance frequency) for this statistical distribution of data and was used as the acceptable, risk based upper boundary. For marine water, 158 CFU/100mL was calculated to represent the 95th percentile upper confidence limit.

TMDLs developed using this approach are expressed as the average percentage reduction from current conditions required to achieve consistency with criteria. The procedure partitions the TMDL into regulated point source wasteload allocation (WLA) and non-point source load allocation (LA) components by quantifying the contribution of ambient monitoring data collected during periods of high storm water influence and minimal storm water influence to the current condition. TMDLs developed using this analytical approach provide an ambient monitoring benchmark ideally suited for quantifying progress in achieving water quality goals as a result of TMDL implementation.

4.2 TMDL End Point Determination

The criteria can be expressed as a cumulative frequency distribution or "criteria curve" as shown in Figure 3-1.

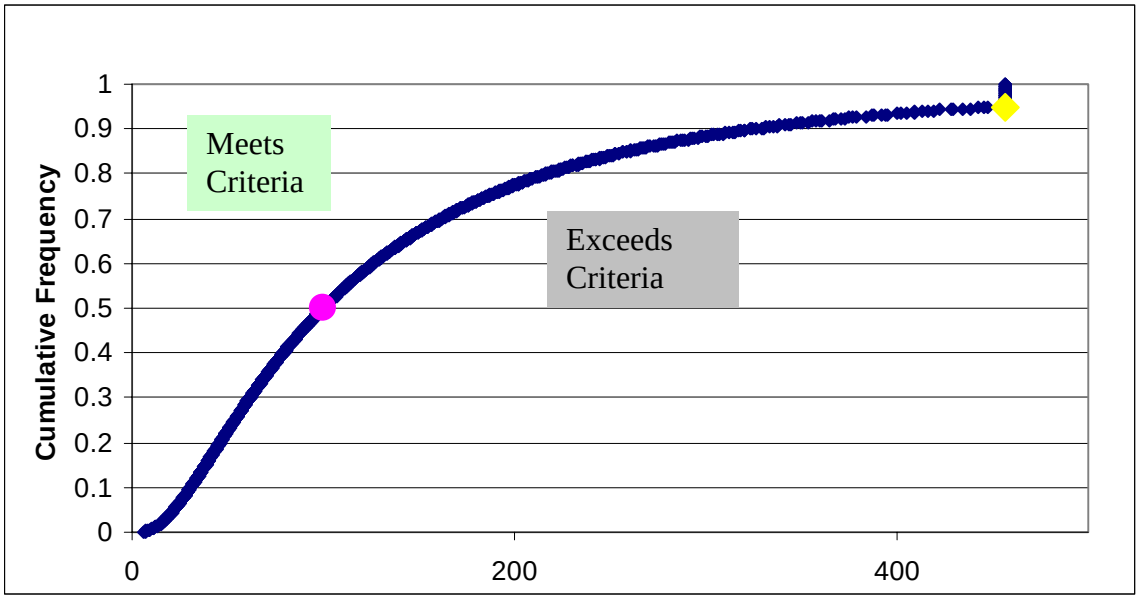

Figure 4-1Cumulative Relative Frequency Distribution representing Delaware Water Quality Standards

As with the cumulative relative frequency curve representing the criteria shown in Figure 3-1, a cumulative relative frequency curve can be prepared using site-specific sample data to represent current conditions at the TMDL monitoring sites. The TMDL for the monitored

segments are derived by quantifying the difference between these two distributions as shown conceptually in Figure 3-2. This is accomplished by calculating the reduction required at representative points on the sample data cumulative frequency distribution curve and then averaging the reduction needed across the entire range of sampling data. This procedure allows the contribution of each individual sampling result to be considered when estimating the percent reduction needed to meet a criterion that is expressed as a geometric mean.

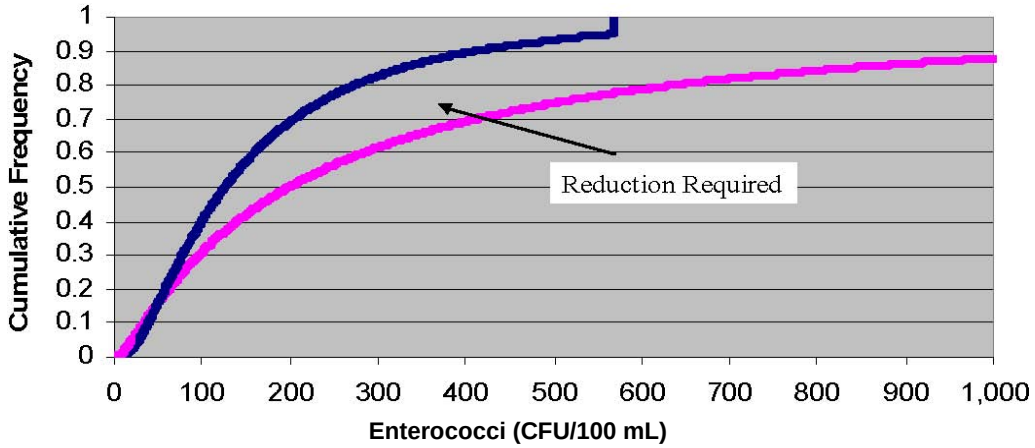

Figure 4-2 Reduction in indicator bacteria density needed from current condition (magenta line) to meet criteria (blue line) based on cumulative relative frequency distribution.

4.3 WLA and LA

Stormwater runoff in an urbanized area is considered a point source subject to regulation under the NPDES permitting program. TMDLs for indicator bacteria in waters draining urbanized areas must therefore be partitioned into a WLA to accommodate point source stormwater loadings of indicator bacteria and a LA to accommodate non-point loadings from unregulated sources. This is accomplished using the same ambient monitoring data used to establish the TMDL.

One common characteristic of urbanized areas is the high percentage of impervious surface. Much of the impervious surface is directly connected to nearby surface waters through stormwater drainage systems. As a result, runoff is rapid following rain events and flow in urban streams is typically dominated by stormwater runoff during these periods. Monitoring results for samples collected under these conditions are strongly influenced by stormwater quality. During dry conditions, urban streams contain little stormwater since urban watersheds drain quickly and base flows are reduced due to lower infiltration rates and reduced recharge of groundwater. At base flow, urban stream water quality is dominated by non-point sources of indicator bacteria since stormwater outfalls are inactive.

The relative contribution of indicator bacteria loadings occurring during periods of high or low stormwater influence to the geometric mean indicator density is estimated by calculating separate averages of the reduction needed to achieve consistency with criteria under “wet” and “dry” conditions. The reduction needed under “wet” conditions is assigned to the WLA and the reduction needed under “dry” conditions is assigned to the LA. Separate reduction goals are

established for base flow and stormwater dominated periods that can assist local communities in selection of best management practices to improve water quality. The technique also facilitates the use of ambient stream monitoring data to track future progress in meeting water quality goals.

4.4 Analytical Procedure – TMDL

1. The fecal enterococcus monitoring data is ranked from lowest to highest. In the event of ties, monitoring results are assigned consecutive ranks in chronological order of sampling date. The sample proportion (p) is calculated for each monitoring result by dividing the assigned rank (r) for each sample by the total number of sample results (n): $p = r / n$

2. Next, a single sample criteria reference value is calculated for each monitoring result from the statistical distribution used to represent the criteria following the procedure described in steps 3-6 below:

3. If the sample proportion is equal to or greater than .95, the single sample criteria reference value is equivalent to the maximum value of 457 CFU/mL (158 for marine).

4. If the sample proportion is less than .95, and greater than .50, the single sample criteria reference value is calculated as:

$$\text{criteria reference value} = \text{antilog}_{10}[\log_{10} 100 \text{ CFU/100mL} + \{F \times 0.4\}]$$

Note: 100 CFU/100mL is the geometric mean indicator bacteria criterion adopted into Delaware's Water Quality Standards, F is a factor determined from areas under the Normal probability curve for a probability level equivalent to the sample proportion, 0.4 is the $\log_{10}$ standard deviation used by EPA in deriving the national guidance criteria recommendations (0.7 for marine).

5. If the sample proportion is equal to .50, the single sample reference criteria value is equal to the geometric mean criterion adopted into the Water Quality Standards.

6. If the sample proportion is less than .50, the single sample reference criteria value is calculated as:

$$\text{criteria reference value} = \text{antilog}_{10}[\log_{10} 100 \text{ CFU/100mL} - \{F \times 0.4\}]$$

7. The percent reduction necessary to achieve consistency with the criteria is then calculated following the procedure described in steps 8-9 below:

8. If the monitoring result is less than the single sample reference criteria value, the percent reduction is zero.

9. If the monitoring result exceeds the single sample criteria reference value, the percent reduction necessary to meet criteria on that sampling date is calculated as:

percent reduction = ((monitoring result – criteria reference value)/monitoring result)x100

10. The TMDL, expressed as the average percent reduction to meet criteria, is then calculated as the arithmetic average of the percent reduction calculated for each sampling date.

11. Precipitation data is reviewed and each sampling date is designated as a "dry" or "wet" sampling event. Although a site-specific protocol may be specified in an individual TMDL analysis, typically samples collected within 48 hours of a precipitation event of 0.25 inches or greater are designated as "wet".

12. The average percent reduction for all sampling events used to derive the TMDL that are designated as "wet" is computed and established as the WLA.

13. The average percent reduction for all sampling events used to derive the TMDL that are designated as "dry" is computed and established as the LA.

4.4.1 Marine waters in the Murderkill

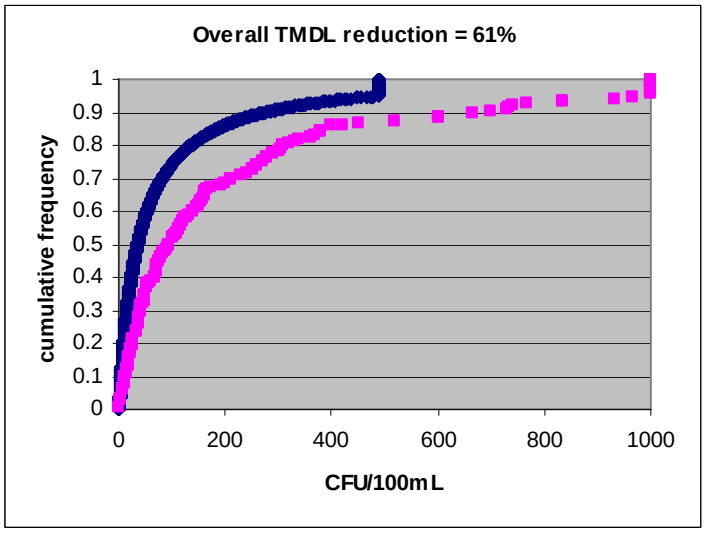

Figure 4-3 Marine waters, Overall TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.

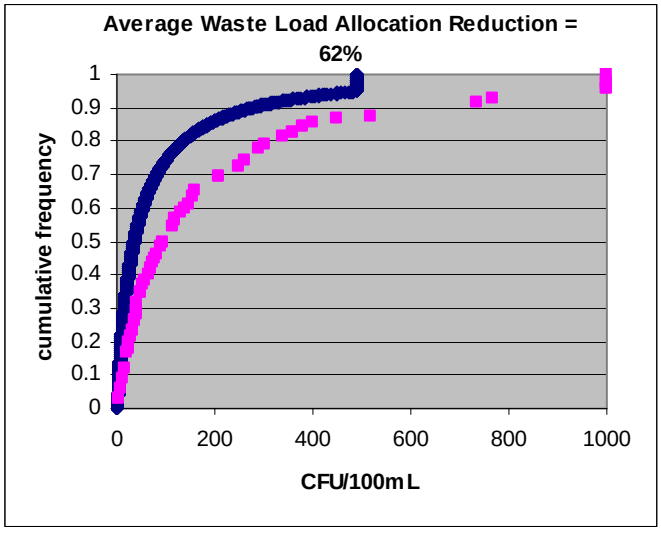

Figure 4-4 Marine waters, Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.

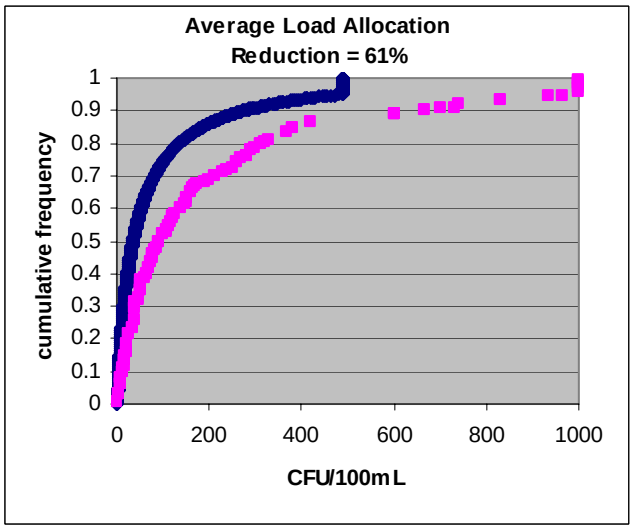

Figure 4-5 Marine waters, Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

4.4.2 Fresh waters in the Murderkill

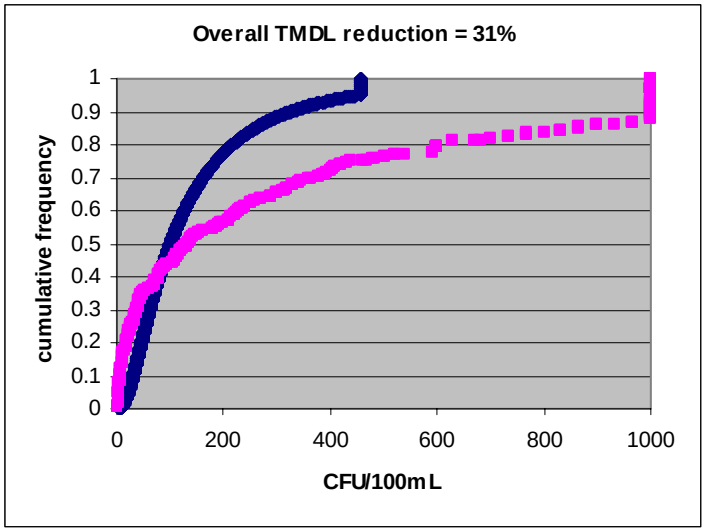

Figure 4-6 Fresh waters, Overall TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.

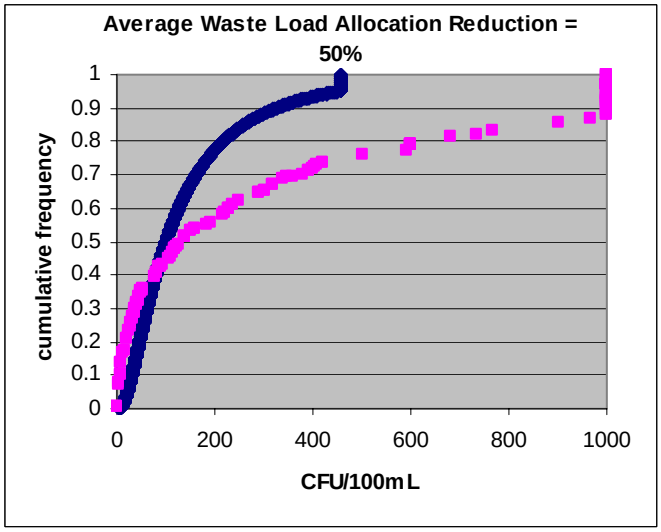

Figure 4-7 Fresh waters, Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.

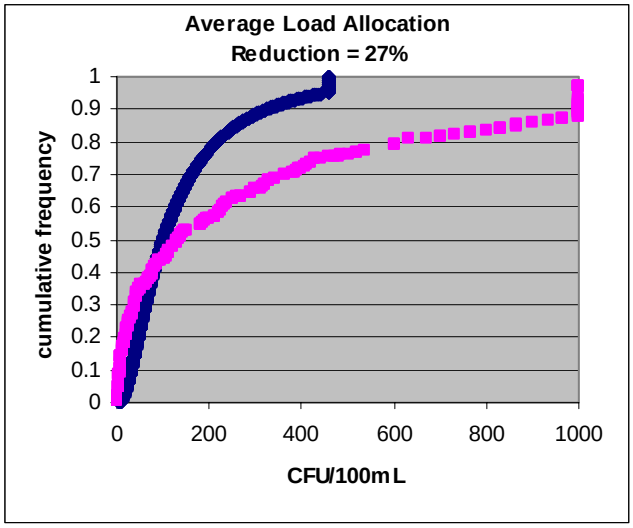

Figure 4-8 Fresh waters, Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

4.5 TMDL Reductions

Murderkill River	**Waste Load Allocation reduction**	**Load Allocation reductions**	**Overall TMDL reductions**
Marine waters	62%	61%	**61%**
Fresh Waters	50%	27%	**31%**
Harrington STP	33 CFU/100mL maximum geomean enterococcus concentration	na	**na**
Kent County STP	33 CFU/100mL maximum geomean enterococcus concentration	na	**na**
Canterburry Crossing HMP	33 CFU/100mL maximum geomean enterococcus concentration	na	**na**

Table 4-1 TMDL allocations for the Murderkill River Watershed.

With respect to bacteria, the total maximum daily load can be considered in many different ways because the water quality standard is not expressed in daily terms but as a geometric mean over time, typically a period of 30 days. A theoretical maximum, albeit an unrealistic scenario, can be calculated so that the entire loading over the 30-day period occurs in one day. A more practical approach would be to calculate the maximum load at a level corresponding to the appropriate confidence interval and risk level, e.g. a 95% confidence interval and its related single sample value. However, this approach is problematic, as it does not ensure that the geometric mean will be equal to or below the water quality standard.

An average daily maximum, calculated by multiplying the average daily flow times the water quality standard would arguably be the most appropriate measure of a daily maximum with respect to TMDL requirements. Table illustrates all of the above maximum daily loading calculations.

	Flow (m^3/day)	Current loading – wet weather (CFU/day)	Current loading – dry weather (CFU/day)	Theoretical Maximum Daily Load (CFU/day)	95% Confidence Interval Daily Load (CFU/day)	Average Daily Maximum Load (CFU/day)
USGS01484000	8,245	8.2E+9	8.2E+9	8.2E+67	4.5E+10	8.2E+9

Table 4-2 Flow and Daily Loading

4.6 Source Tracing Adjustment Factor

The Source Tracking Adjustment Factor (STAF) is a multiplier used to normalize human health risk associated with total fecal enterococci counts to enterococci counts derived exclusively from human sources. Bacteria source tracking (BST) data and the STAF, when available, will be used throughout the State to determine the sources of fecal contamination and in the development of pollution control strategies (PCSs).

5 Discussion of Regulatory Requirements for TMDLs

Federal regulations at 40 CFR Section 130 require that TMDLs must meet the following eight minimum regulatory requirements:

1. The TMDLs must be designed to achieve applicable water quality standards
2. The TMDLs must include a total allowable load as well as individual waste load allocations for point sources and load allocations for nonpoint sources
3. The TMDLs must consider the impact of background pollutants
4. The TMDL must consider critical environmental conditions
5. The TMDLs must consider seasonal variations
6. The TMDLs must include a margin of safety
7. The TMDLs must have been subject to public participation
8. There should be a reasonable assurance that the TMDLs can be met

1. The Proposed Murderkill River Watershed TMDL is designed to achieve applicable water quality standards.

Cumulative frequency distribution analysis indicates that after the proposed reductions are met, the maximum bacteria concentrations in any portion of the Murderkill will not fall above the water quality standards.

2. The Proposed Murderkill River Watershed TMDL includes a total allowable load as well as individual waste load allocations for point sources and load allocations for nonpoint sources.

Table 3-1 lists the proposed WLA and LA for the Murderkill River Watershed. The WLA reductions will be 61% and 31% for marine and fresh waters, respectively. The LA reductions will be 61% and 27% for marine and fresh waters, respectively. The NPDES point sources will have a concentration maximum not to exceed a 30 day-geometric mean of 33 CFU/100mL.

3. The proposed Murderkill River TMDL considers the impact of background pollutants.

The proposed TMDL is based upon extensive water quality monitoring and precipitation databases. The water quality database included headwater streams representing background conditions. Therefore, it can be concluded that the impact of background pollutants are considered in the proposed Murderkill River Watershed TMDL.

4. The proposed Murderkill River Watershed TMDL considers critical environmental conditions

The proposed TMDL was established based on the achieving water quality standards at all environmental conditions. Therefore, it can be concluded that consideration of critical environmental conditions was incorporated in the Murderkill River Watershed TMDL analysis.

5. The proposed Murderkill River Watershed TMDL considers seasonal variations.

Data used in the cumulative frequency distribution analyses was for a period of 7 years and included every season. Therefore, it can be concluded that consideration of seasonal variations was incorporated in the Murderkill River Watershed TMDL analysis.

6. The proposed Murderkill River Watershed TMDL considers a margin of Safety.

EPA's technical guidance allows consideration of a margin of safety as implicit or as explicit. An implicit margin of safety is when conservative assumptions are considered for model development and TMDL establishment. An explicit margin of safety is when a specified percentage of assimilative capacity is kept unassigned to account for uncertainties, lack of sufficient data, or future growth.

The indicator bacteria criteria used in this TMDL analysis were developed exclusively from data derived from studies conducted at high use public bathing areas of which half were affected by point source discharges. Therefore, the criteria provide an additional level of protection when applied to water not designated for high use bathing and without point sources such as those within these watersheds. As a result, achieving the criteria results in an "implicit" MOS. A portion of this "implicit" MOS will be removed via use of the Source Tracking Adjustment Factor (STAF), a tool that will be used in the implementation and best management practice designs during development of the Pollution Control Strategies (PCS) following the adoption of the TMDL. However, the STAF incorporates an explicit margin of safety so that a portion of the "implicit" MOS remains intact. Therefore, an adequate margin of safety is included in the bacteria TMDLs.

7.0 The proposed Murderkill River Watershed TMDL has been subject to public participation.

An important public participation activity regarding this TMDL was the formation of the Murderkill Tributary Action Team in 2001. The Tributary Action Team, made up of concerned citizens and other affected parties within the watershed will assist the DNREC in developing pollution control strategies (PCS) to implement the requirements of the proposed Murderkill River Watershed TMDL.

In addition to the public participation and stakeholder involvement mentioned above, a public workshop was held on June 5, 2006 to present the proposed Murderkill River Watershed TMDL to the public and receive comments prior to formal adoption of the TMDL regulation. Comments received within the June 1 through June 30 comment period were considered when finalizing this document.

8.0 There should be a reasonable assurance that the proposed Murderkill River Watershed TMDL can be met.

The proposed Murderkill River Watershed TMDL considers the reduction of bacteria from point and nonpoint sources. The magnitude of load reductions suggested by the proposed TMDL are feasible. Following the adoption of the TMDL, the Murderkill River Tributary Action Team will assist the Department in developing a PCS to implement the requirements of the Murderkill River Watershed TMDL Regulation. The DNREC is planning to finalize and adopt the Murderkill River PCS within one year after formal adoption of the TMDL Regulation.

6 Appendix

6.1 Marine Water Data

# sample	Date	Source	enterococcus (CFU/100 mL)	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)
1	4/2/1997	206091	1	0	0.2	0.2	DRY
2	4/2/1997	206101	3	0	0.2	0.2	DRY
3	4/2/1997	206131	110	0	0.2	0.2	DRY
4	4/2/1997	206141	46	0	0.2	0.2	DRY
5	4/2/1997	206231	230	0	0.2	0.2	DRY
6	5/21/1997	206091	123	0	0	0	DRY
7	5/21/1997	206101	16	0	0	0	DRY
8	5/21/1997	206131	19	0	0	0	DRY
9	5/21/1997	206141	280	0	0	0	DRY
10	5/21/1997	206231	153	0	0	0	DRY
11	6/4/1997	206091	340	0	0.3	0.4	**WET**
12	6/4/1997	206101	113	0	0.3	0.4	**WET**
13	6/4/1997	206131	260	0	0.3	0.4	**WET**
14	6/4/1997	206141	303	0	0.3	0.4	**WET**
15	6/4/1997	206231	380	0	0.3	0.4	**WET**
16	7/9/1997	206091	320	0	0	0	DRY
17	7/9/1997	206101	41	0	0	0	DRY
18	7/9/1997	206131	70	0	0	0	DRY
19	7/9/1997	206141	153	0	0	0	DRY
20	7/9/1997	206231	260	0	0	0	DRY
21	9/9/1997	206091	600	0	0	0	DRY
22	9/9/1997	206101	110	0	0	0	DRY
23	9/9/1997	206131	330	0	0	0	DRY
24	9/9/1997	206141	600	0	0	0	DRY
25	9/9/1997	206231	600	0	0	0	DRY
26	11/12/1997	206091	730	0	0	1.7	DRY
27	11/12/1997	206101	53	0	0	1.7	DRY
28	11/12/1997	206131	93	0	0	1.7	DRY
29	11/12/1997	206141	270	0	0	1.7	DRY
30	11/12/1997	206231	740	0	0	1.7	DRY
31	1/6/1998	206091	54	0	0	0	DRY
32	1/6/1998	206101	15	0	0	0	DRY
33	1/6/1998	206131	13	0	0	0	DRY
34	3/3/1998	206091	250	0.7	0.7	0.7	**WET**
35	3/3/1998	206101	70	0.7	0.7	0.7	**WET**
36	3/3/1998	206131	120	0.7	0.7	0.7	**WET**
37	5/27/1998	206091	160	0	0	0.1	DRY
38	5/27/1998	206101	167	0	0	0.1	DRY
39	5/27/1998	206131	210	0	0	0.1	DRY
40	5/27/1998	206141	240	0	0	0.1	DRY

41	5/27/1998	206231	280	0	0	0.1	DRY
42	7/29/1998	206091	113	0	0	0	DRY
43	7/29/1998	206101	20	0	0	0	DRY
44	7/29/1998	206131	37	0	0	0	DRY
45	7/29/1998	206141	190	0	0	0	DRY
46	7/29/1998	206231	370	0	0	0	DRY
47	9/23/1998	206091	520	0.1	0.2	0.2	**WET**
48	9/23/1998	206101	210	0.1	0.2	0.2	**WET**
49	9/23/1998	206131	450	0.1	0.2	0.2	**WET**
50	9/23/1998	206141	1967	0.1	0.2	0.2	**WET**
51	9/23/1998	206231	90	0.1	0.2	0.2	**WET**
52	4/22/1999	206091	160	0.2	0.2	0.3	**WET**
53	4/22/1999	206101	7	0.2	0.2	0.3	**WET**
54	4/22/1999	206131	21	0.2	0.2	0.3	**WET**
55	4/22/1999	206141	77	0.2	0.2	0.3	**WET**
56	4/22/1999	206231	130	0.2	0.2	0.3	**WET**
57	6/22/1999	206091	290	0.1	1.1	1.4	**WET**
58	6/22/1999	206101	16	0.1	1.1	1.4	**WET**
59	6/22/1999	206131	80	0.1	1.1	1.4	**WET**
60	6/22/1999	206141	210	0.1	1.1	1.4	**WET**
61	6/22/1999	206231	400	0.1	1.1	1.4	**WET**
62	7/7/1999	206091	967	0	0	0	DRY
63	7/7/1999	206101	10	0	0	0	DRY
64	7/7/1999	206131	67	0	0	0	DRY
65	7/7/1999	206141	260	0	0	0	DRY
66	7/7/1999	206231	1100	0	0	0	DRY
67	9/29/1999	206091	667	0	0	0	DRY
68	9/29/1999	206101	23	0	0	0	DRY
69	9/29/1999	206131	290	0	0	0	DRY
70	9/29/1999	206141	700	0	0	0	DRY
71	9/29/1999	206231	933	0	0	0	DRY
72	4/11/2000	206091	67	0	0	0.7	DRY
73	4/11/2000	206101	70	0	0	0.7	DRY
74	4/11/2000	206131	47	0	0	0.7	DRY
75	4/11/2000	206141	77	0	0	0.7	DRY
76	4/11/2000	206231	210	0	0	0.7	DRY
77	6/21/2000	206091	310	0	0	1	DRY
78	6/21/2000	206101	100	0	0	1	DRY
79	6/21/2000	206131	50	0	0	1	DRY

80	6/21/2000	206141	250	0	0	1	DRY
81	6/21/2000	206231	600	0	0	1	DRY
82	7/11/2000	206091	360	0.5	0.5	0.5	**WET**
83	7/11/2000	206101	23	0.5	0.5	0.5	**WET**
84	7/11/2000	206131	27	0.5	0.5	0.5	**WET**
85	7/11/2000	206141	70	0.5	0.5	0.5	**WET**
86	7/11/2000	206231	117	0.5	0.5	0.5	**WET**
87	9/12/2000	206091	1867	0	0	0	DRY
88	9/12/2000	206101	3	0	0	0	DRY
89	9/12/2000	206131	20	0	0	0	DRY
90	9/12/2000	206141	380	0	0	0	DRY
91	9/12/2000	206231	1000	0	0	0	DRY
92	3/14/2001	206091	42	0	0.8	0.8	**WET**
93	3/14/2001	206101	25	0	0.8	0.8	**WET**
94	3/14/2001	206131	26	0	0.8	0.8	**WET**
95	3/14/2001	206141	39	0	0.8	0.8	**WET**
96	3/14/2001	206231	37	0	0.8	0.8	**WET**
97	5/22/2001	206091	157	0.2	0.4	0.5	**WET**
98	5/22/2001	206101	11	0.2	0.4	0.5	**WET**
99	5/22/2001	206131	93	0.2	0.4	0.5	**WET**
100	5/22/2001	206141	147	0.2	0.4	0.5	**WET**
101	5/22/2001	206231	250	0.2	0.4	0.5	**WET**
102	7/31/2001	206091	733	0	0.8	0.8	**WET**
103	7/31/2001	206101	40	0	0.8	0.8	**WET**
104	7/31/2001	206131	37	0	0.8	0.8	**WET**
105	7/31/2001	206141	767	0	0.8	0.8	**WET**
106	7/31/2001	206231	1000	0	0.8	0.8	**WET**
107	9/12/2001	206091	1133	0	0	0	DRY
108	9/12/2001	206101	50	0	0	0	DRY
109	9/12/2001	206131	80	0	0	0	DRY
110	9/12/2001	206141	833	0	0	0	DRY
111	9/12/2001	206231	833	0	0	0	DRY
112	3/13/2002	206091	40	0.2	0.2	0.3	**WET**
113	3/13/2002	206101	27	0.2	0.2	0.3	**WET**
114	3/13/2002	206131	23	0.2	0.2	0.3	**WET**
115	3/13/2002	206141	57	0.2	0.2	0.3	**WET**
116	3/13/2002	206231	50	0.2	0.2	0.3	**WET**

117	6/25/2002	206091	100	0	0	0	DRY
118	6/25/2002	206101	10	0	0	0	DRY
119	6/25/2002	206131	23	0	0	0	DRY
120	6/25/2002	206141	120	0	0	0	DRY
121	6/25/2002	206231	113	0	0	0	DRY
122	7/9/2002	206091	380	0	0	0	DRY
123	7/9/2002	206101	27	0	0	0	DRY
124	7/9/2002	206131	33	0	0	0	DRY
125	7/9/2002	206141	173	0	0	0	DRY
126	7/9/2002	206231	1170	0	0	0	DRY
127	9/10/2002	206091	163	0	0	0	DRY
128	9/10/2002	206131	117	0	0	0	DRY
129	9/10/2002	206141	150	0	0	0	DRY
130	9/10/2002	206231	420	0	0	0	DRY
131	3/25/2003	206091	20	0	0	0	DRY
132	3/25/2003	206101	7	0	0	0	DRY
133	3/25/2003	206131	3	0	0	0	DRY
134	3/25/2003	206141	13	0	0	0	DRY
135	3/25/2003	206231	7	0	0	0	DRY
136	5/14/2003	206091	40	0	0	0.1	DRY
137	5/14/2003	206101	3	0	0	0.1	DRY
138	5/14/2003	206131	13	0	0	0.1	DRY
139	5/14/2003	206141	17	0	0	0.1	DRY
140	5/14/2003	206231	33	0	0	0.1	DRY
141	7/8/2003	206091	280	0	0.1	0.1	DRY
142	7/8/2003	206101	27	0	0.1	0.1	DRY
143	7/8/2003	206131	37	0	0.1	0.1	DRY
144	7/8/2003	206141	83	0	0.1	0.1	DRY
145	7/8/2003	206231	310	0	0.1	0.1	DRY
146	9/23/2003	206091	140	0.3	0.3	0.3	WET
147	9/23/2003	206101	50	0.3	0.3	0.3	WET
148	9/23/2003	206131	67	0.3	0.3	0.3	WET
149	9/23/2003	206141	93	0.3	0.3	0.3	WET
150	9/23/2003	206231	73	0.3	0.3	0.3	WET
151	3/15/2004	206091	7	0	0	0	DRY
152	3/15/2004	206101	10	0	0	0	DRY
153	3/15/2004	206131	3	0	0	0	DRY

154	3/15/2004	206141	17	0	0	0	DRY
155	3/15/2004	206231	17	0	0	0	DRY
156	6/8/2004	206091	40	0	0	0.6	DRY
157	6/8/2004	206101	60	0	0	0.6	DRY
158	6/8/2004	206131	50	0	0	0.6	DRY
159	6/8/2004	206141	93	0	0	0.6	DRY
160	6/8/2004	206231	73	0	0	0.6	DRY
161	8/4/2004	206091	1130	0.4	0.4	1.7	WET
162	8/4/2004	206101	360	0.4	0.4	1.7	WET
163	8/4/2004	206131	380	0.4	0.4	1.7	WET
164	8/4/2004	206141	1100	0.4	0.4	1.7	WET
165	8/4/2004	206231	1000	0.4	0.4	1.7	WET
166	9/22/2004	206091	107	0	0	0.3	DRY
167	9/22/2004	206101	17	0	0	0.3	DRY
168	9/22/2004	206131	50	0	0	0.3	DRY
169	9/22/2004	206141	87	0	0	0.3	DRY
170	9/22/2004	206231	93	0	0	0.3	DRY
171	3/1/2005	206091	53	0.4	0.4	0.4	WET
172	3/1/2005	206101	33	0.4	0.4	0.4	WET
173	3/1/2005	206131	37	0.4	0.4	0.4	WET
174	3/1/2005	206141	50	0.4	0.4	0.4	WET
175	3/1/2005	206231	37	0.4	0.4	0.4	WET
176	5/4/2005	206091	40	0	0.4	1.4	WET
177	5/4/2005	206101	3	0	0.4	1.4	WET
178	5/4/2005	206131	3	0	0.4	1.4	WET
179	5/4/2005	206141	3	0	0.4	1.4	WET
180	5/4/2005	206231	33	0	0.4	1.4	WET
181	7/13/2005	206091	140	0	0	0	DRY
182	7/13/2005	206101	147	0	0	0	DRY
183	7/13/2005	206131	73	0	0	0	DRY
184	7/13/2005	206141	80	0	0	0	DRY
185	7/13/2005	206231	127	0	0	0	DRY
186	9/7/2005	206091	140	0	0	0	DRY
187	9/7/2005	206101	160	0	0	0	DRY
188	9/7/2005	206131	160	0	0	0	DRY
189	9/7/2005	206141	200	0	0	0	DRY
190	9/7/2005	206231	300	0	0	0	DRY

6.2 Fresh Water Data

# sample	Date	Source	enterococcus (CFU/100 mL)	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)
1	4/1/1997	206011	420	0.2	0.2	1.6	**WET**
2	4/1/1997	206041	590	0.2	0.2	1.6	**WET**
3	4/1/1997	206051	236	0.2	0.2	1.6	**WET**
4	4/1/1997	206071	80	0.2	0.2	1.6	**WET**
5	4/1/1997	206361	120	0.2	0.2	1.6	**WET**
6	4/1/1997	206451	33	0.2	0.2	1.6	**WET**
7	4/1/1997	206461	40	0.2	0.2	1.6	**WET**
8	4/1/1997	206561	360	0.2	0.2	1.6	**WET**
9	5/20/1997	206011	320	0	0	0	DRY
10	5/20/1997	206041	225	0	0	0	DRY
11	5/20/1997	206051	80	0	0	0	DRY
12	5/20/1997	206071	7	0	0	0	DRY
13	5/20/1997	206361	6	0	0	0	DRY
14	5/20/1997	206451	28	0	0	0	DRY
15	5/20/1997	206461	2	0	0	0	DRY
16	5/20/1997	206561	220	0	0	0	DRY
17	6/2/1997	206011	420	0.1	0.1	0.1	DRY
18	6/2/1997	206041	250	0.1	0.1	0.1	DRY
19	6/2/1997	206051	290	0.1	0.1	0.1	DRY
20	6/2/1997	206071	23	0.1	0.1	0.1	DRY
21	6/2/1997	206361	12	0.1	0.1	0.1	DRY
22	6/2/1997	206451	46	0.1	0.1	0.1	DRY
23	6/2/1997	206461	17	0.1	0.1	0.1	DRY
24	6/2/1997	206561	107	0.1	0.1	0.1	DRY
25	6/4/1997	206211	87	0	0.3	0.4	**WET**
26	7/8/1997	206011	270	0	0	0	DRY
27	7/8/1997	206041	440	0	0	0	DRY
28	7/8/1997	206051	460	0	0	0	DRY
29	7/8/1997	206071	12	0	0	0	DRY
30	7/8/1997	206361	7	0	0	0	DRY
31	7/8/1997	206451	103	0	0	0	DRY
32	7/8/1997	206461	3	0	0	0	DRY
33	7/8/1997	206561	600	0	0	0	DRY
34	7/9/1997	206081	470	0	0	0	DRY
35	9/9/1997	206081	600	0	0	0	DRY
36	9/10/1997	206011	600	0.7	0.7	0.7	**WET**
37	9/10/1997	206041	600	0.7	0.7	0.7	**WET**
38	9/10/1997	206051	600	0.7	0.7	0.7	**WET**
39	9/10/1997	206071	35	0.7	0.7	0.7	**WET**
40	9/10/1997	206361	15	0.7	0.7	0.7	**WET**
41	9/10/1997	206451	153	0.7	0.7	0.7	**WET**

42	9/10/1997	206461	230	0.7	0.7	0.7	**WET**
43	9/10/1997	206561	600	0.7	0.7	0.7	**WET**
44	11/12/1997	206011	240	0	0	1.7	DRY
45	11/12/1997	206041	93	0	0	1.7	DRY
46	11/12/1997	206051	133	0	0	1.7	DRY
47	11/12/1997	206071	670	0	0	1.7	DRY
48	11/12/1997	206081	700	0	0	1.7	DRY
49	11/12/1997	206361	500	0	0	1.7	DRY
50	11/12/1997	206451	340	0	0	1.7	DRY
51	11/12/1997	206461	150	0	0	1.7	DRY
52	11/12/1997	206561	200	0	0	1.7	DRY
53	1/5/1998	206011	83	0	0	0	DRY
54	1/5/1998	206041	33	0	0	0	DRY
55	1/5/1998	206051	60	0	0	0	DRY
56	1/5/1998	206071	31	0	0	0	DRY
57	1/5/1998	206361	9	0	0	0	DRY
58	1/5/1998	206451	7	0	0	0	DRY
59	1/5/1998	206461	2	0	0	0	DRY
60	1/5/1998	206561	87	0	0	0	DRY
61	1/6/1998	206081	83	0	0	0	DRY
62	3/2/1998	206011	113	0	0	0	DRY
63	3/2/1998	206041	12	0	0	0	DRY
64	3/2/1998	206051	26	0	0	0	DRY
65	3/2/1998	206071	5	0	0	0	DRY
66	3/2/1998	206361	7	0	0	0	DRY
67	3/2/1998	206451	20	0	0	0	DRY
68	3/2/1998	206461	9	0	0	0	DRY
69	3/2/1998	206561	24	0	0	0	DRY
70	3/3/1998	206081	77	0.7	0.7	0.7	**WET**
71	5/26/1998	206011	330	0	0.1	0.1	DRY
72	5/26/1998	206041	405	0	0.1	0.1	DRY
73	5/26/1998	206051	210	0	0.1	0.1	DRY
74	5/26/1998	206071	13	0	0.1	0.1	DRY
75	5/26/1998	206361	11	0	0.1	0.1	DRY
76	5/26/1998	206451	8	0	0.1	0.1	DRY
77	5/26/1998	206461	39	0	0.1	0.1	DRY
78	5/26/1998	206561	410	0	0.1	0.1	DRY
79	5/27/1998	206081	133	0	0	0.1	DRY
80	5/27/1998	206211	600	0	0	0.1	DRY

81	7/28/1998	206011	300	0	0	0	DRY
82	7/28/1998	206041	867	0	0	0	DRY
83	7/28/1998	206051	767	0	0	0	DRY
84	7/28/1998	206071	47	0	0	0	DRY
85	7/28/1998	206361	3	0	0	0	DRY
86	7/28/1998	206451	17	0	0	0	DRY
87	7/28/1998	206461	3	0	0	0	DRY
88	7/28/1998	206561	2000	0	0	0	DRY
89	7/29/1998	206081	240	0	0	0	DRY
90	7/30/1998	206021	3	0	0	0	DRY
91	7/30/1998	206351	270	0	0	0	DRY
92	7/30/1998	206421	767	0	0	0	DRY
93	7/30/1998	206601	833	0	0	0	DRY
94	7/30/1998	206611	767	0	0	0	DRY
95	7/30/1998	206631	967	0	0	0	DRY
96	7/30/1998	206641	967	0	0	0	DRY
97	7/30/1998	206671	867	0	0	0	DRY
98	7/30/1998	206681	1200	0	0	0	DRY
99	9/21/1998	206021	6	0	0	0.1	DRY
100	9/21/1998	206421	210	0	0	0.1	DRY
101	9/21/1998	206601	250	0	0	0.1	DRY
102	9/21/1998	206611	900	0	0	0.1	DRY
103	9/21/1998	206631	733	0	0	0.1	DRY
104	9/21/1998	206641	1467	0	0	0.1	DRY
105	9/21/1998	206661	390	0	0	0.1	DRY
106	9/21/1998	206671	1200	0	0	0.1	DRY
107	9/21/1998	206681	539	0	0	0.1	DRY
108	9/22/1998	206011	1267	0.1	0.1	0.1	**WET**
109	9/22/1998	206041	1750	0.1	0.1	0.1	**WET**
110	9/22/1998	206051	1667	0.1	0.1	0.1	**WET**
111	9/22/1998	206071	900	0.1	0.1	0.1	**WET**
112	9/22/1998	206361	80	0.1	0.1	0.1	**WET**
113	9/22/1998	206451	300	0.1	0.1	0.1	**WET**
114	9/22/1998	206461	230	0.1	0.1	0.1	**WET**
115	9/22/1998	206561	1433	0.1	0.1	0.1	**WET**
116	9/23/1998	206081	500	0.1	0.2	0.2	**WET**
117	4/20/1999	206601	45	0.1	0.1	0.1	DRY

118	4/20/1999	206611	11	0.1	0.1	0.1	DRY
119	4/20/1999	206621	21	0.1	0.1	0.1	DRY
120	4/20/1999	206631	1	0.1	0.1	0.1	DRY
121	4/20/1999	206641	3	0.1	0.1	0.1	DRY
122	4/20/1999	206651	6	0.1	0.1	0.1	DRY
123	4/20/1999	206661	2	0.1	0.1	0.1	DRY
124	4/20/1999	206671	60	0.1	0.1	0.1	DRY
125	4/20/1999	206681	1	0.1	0.1	0.1	DRY
126	4/20/1999	206691	1	0.1	0.1	0.1	DRY
127	4/21/1999	206011	31	0	0.1	0.1	DRY
128	4/21/1999	206041	143	0	0.1	0.1	DRY
129	4/21/1999	206051	70	0	0.1	0.1	DRY
130	4/21/1999	206071	200	0	0.1	0.1	DRY
131	4/21/1999	206361	70	0	0.1	0.1	DRY
132	4/21/1999	206451	27	0	0.1	0.1	DRY
133	4/21/1999	206461	50	0	0.1	0.1	DRY
134	4/21/1999	206561	17	0	0.1	0.1	DRY
135	4/22/1999	206081	153	0.2	0.2	0.3	**WET**
136	4/22/1999	206211	41	0.2	0.2	0.3	**WET**
137	6/21/1999	206011	2000	1	1.3	1.4	**WET**
138	6/21/1999	206041	1567	1	1.3	1.4	**WET**
139	6/21/1999	206051	1850	1	1.3	1.4	**WET**
140	6/21/1999	206071	1067	1	1.3	1.4	**WET**
141	6/21/1999	206361	733	1	1.3	1.4	**WET**
142	6/21/1999	206451	390	1	1.3	1.4	**WET**
143	6/21/1999	206461	190	1	1.3	1.4	**WET**
144	6/21/1999	206561	2000	1	1.3	1.4	**WET**
145	6/21/1999	206601	2000	1	1.3	1.4	**WET**
146	6/21/1999	206611	2000	1	1.3	1.4	**WET**
147	6/21/1999	206621	2000	1	1.3	1.4	**WET**
148	6/21/1999	206631	2000	1	1.3	1.4	**WET**
149	6/21/1999	206641	2000	1	1.3	1.4	**WET**
150	6/21/1999	206651	2000	1	1.3	1.4	**WET**
151	6/21/1999	206661	2000	1	1.3	1.4	**WET**
152	6/21/1999	206671	1733	1	1.3	1.4	**WET**
153	6/21/1999	206681	2000	1	1.3	1.4	**WET**
154	6/21/1999	206691	769	1	1.3	1.4	**WET**

155	6/22/1999	206081	680	0.1	1.1	1.4	**WET**
156	7/6/1999	206011	700	0	0	0.1	DRY
157	7/6/1999	206041	1167	0	0	0.1	DRY
158	7/6/1999	206051	1233	0	0	0.1	DRY
159	7/6/1999	206071	23	0	0	0.1	DRY
160	7/6/1999	206361	180	0	0	0.1	DRY
161	7/6/1999	206451	40	0	0	0.1	DRY
162	7/6/1999	206461	7	0	0	0.1	DRY
163	7/6/1999	206561	2000	0	0	0.1	DRY
164	7/6/1999	206601	833	0	0	0.1	DRY
165	7/6/1999	206611	867	0	0	0.1	DRY
166	7/6/1999	206621	420	0	0	0.1	DRY
167	7/6/1999	206631	2000	0	0	0.1	DRY
168	7/6/1999	206641	2000	0	0	0.1	DRY
169	7/6/1999	206651	1300	0	0	0.1	DRY
170	7/6/1999	206661	2000	0	0	0.1	DRY
171	7/6/1999	206671	933	0	0	0.1	DRY
172	7/6/1999	206681	1233	0	0	0.1	DRY
173	7/6/1999	206691	8	0	0	0.1	DRY
174	7/7/1999	206081	833	0	0	0	DRY
175	9/27/1999	206601	520	0	0	0	DRY
176	9/27/1999	206611	270	0	0	0	DRY
177	9/27/1999	206631	800	0	0	0	DRY
178	9/27/1999	206641	380	0	0	0	DRY
179	9/27/1999	206651	210	0	0	0	DRY
180	9/27/1999	206661	147	0	0	0	DRY
181	9/27/1999	206671	340	0	0	0	DRY
182	9/27/1999	206681	240	0	0	0	DRY
183	9/27/1999	206691	23	0	0	0	DRY
184	9/28/1999	206011	430	0	0	0	DRY
185	9/28/1999	206041	7	0	0	0	DRY
186	9/28/1999	206051	23	0	0	0	DRY
187	9/28/1999	206071	10	0	0	0	DRY
188	9/28/1999	206361	3	0	0	0	DRY
189	9/28/1999	206451	3	0	0	0	DRY
190	9/28/1999	206461	3	0	0	0	DRY
191	9/28/1999	206561	230	0	0	0	DRY

192	9/29/1999	206081	2000	0	0	0	DRY
193	4/10/2000	206011	230	0	0.7	0.7	**WET**
194	4/10/2000	206041	110	0	0.7	0.7	**WET**
195	4/10/2000	206051	93	0	0.7	0.7	**WET**
196	4/10/2000	206071	160	0	0.7	0.7	**WET**
197	4/10/2000	206361	140	0	0.7	0.7	**WET**
198	4/10/2000	206451	24	0	0.7	0.7	**WET**
199	4/10/2000	206461	1	0	0.7	0.7	**WET**
200	4/10/2000	206561	215	0	0.7	0.7	**WET**
201	4/11/2000	206081	67	0	0	0.7	DRY
202	6/20/2000	206011	380	0	0.4	1	**WET**
203	6/20/2000	206041	400	0	0.4	1	**WET**
204	6/20/2000	206051	390	0	0.4	1	**WET**
205	6/20/2000	206071	220	0	0.4	1	**WET**
206	6/20/2000	206361	290	0	0.4	1	**WET**
207	6/20/2000	206451	40	0	0.4	1	**WET**
208	6/20/2000	206461	600	0	0.4	1	**WET**
209	6/20/2000	206561	600	0	0.4	1	**WET**
210	6/21/2000	206081	315	0	0	1	DRY
211	7/10/2000	206011	320	0	0	0	DRY
212	7/10/2000	206041	330	0	0	0	DRY
213	7/10/2000	206051	290	0	0	0	DRY
214	7/10/2000	206071	187	0	0	0	DRY
215	7/10/2000	206361	20	0	0	0	DRY
216	7/10/2000	206451	17	0	0	0	DRY
217	7/10/2000	206461	3	0	0	0	DRY
218	7/10/2000	206561	220	0	0	0	DRY
219	7/11/2000	206081	405	0.5	0.5	0.5	**WET**
220	9/11/2000	206011	1167	0	0	0	DRY
221	9/11/2000	206041	1400	0	0	0	DRY
222	9/11/2000	206051	1000	0	0	0	DRY
223	9/11/2000	206071	37	0	0	0	DRY
224	9/11/2000	206361	10	0	0	0	DRY
225	9/11/2000	206451	7	0	0	0	DRY
226	9/11/2000	206461	13	0	0	0	DRY
227	9/11/2000	206561	385	0	0	0	DRY
228	9/12/2000	206081	1733	0	0	0	DRY

229	3/13/2001	206011	420	0.8	0.8	0.8	**WET**
230	3/13/2001	206041	250	0.8	0.8	0.8	**WET**
231	3/13/2001	206051	220	0.8	0.8	0.8	**WET**
232	3/13/2001	206071	1	0.8	0.8	0.8	**WET**
233	3/13/2001	206361	4	0.8	0.8	0.8	**WET**
234	3/13/2001	206451	5	0.8	0.8	0.8	**WET**
235	3/13/2001	206461	1	0.8	0.8	0.8	**WET**
236	3/13/2001	206561	340	0.8	0.8	0.8	**WET**
237	3/14/2001	206081	38	0	0.8	0.8	**WET**
238	5/21/2001	206011	600	0.3	0.3	0.4	**WET**
239	5/21/2001	206041	600	0.3	0.3	0.4	**WET**
240	5/21/2001	206051	600	0.3	0.3	0.4	**WET**
241	5/21/2001	206071	36	0.3	0.3	0.4	**WET**
242	5/21/2001	206361	43	0.3	0.3	0.4	**WET**
243	5/21/2001	206451	90	0.3	0.3	0.4	**WET**
244	5/21/2001	206461	600	0.3	0.3	0.4	**WET**
245	5/21/2001	206561	290	0.3	0.3	0.4	**WET**
246	5/22/2001	206081	184	0.2	0.4	0.5	**WET**
247	7/30/2001	206011	1200	0.8	0.8	3	**WET**
248	7/30/2001	206041	2400	0.8	0.8	3	**WET**
249	7/30/2001	206051	2133	0.8	0.8	3	**WET**
250	7/30/2001	206071	90	0.8	0.8	3	**WET**
251	7/30/2001	206361	140	0.8	0.8	3	**WET**
252	7/30/2001	206451	50	0.8	0.8	3	**WET**
253	7/30/2001	206461	52	0.8	0.8	3	**WET**
254	7/30/2001	206561	2200	0.8	0.8	3	**WET**
255	9/12/2001	206081	1383	0	0	0	DRY
256	3/12/2002	206011	113	0	0	0	DRY
257	3/12/2002	206041	40	0	0	0	DRY
258	3/12/2002	206051	120	0	0	0	DRY
259	3/12/2002	206071	3	0	0	0	DRY
260	3/12/2002	206361	3	0	0	0	DRY
261	3/12/2002	206451	3	0	0	0	DRY
262	3/12/2002	206461	10	0	0	0	DRY
263	3/12/2002	206561	19	0	0	0	DRY
264	3/13/2002	206081	45	0.2	0.2	0.3	**WET**
265	6/24/2002	206011	110	0	0	0	DRY

266	6/24/2002	206041	113	0	0	0	DRY
267	6/24/2002	206051	400	0	0	0	DRY
268	6/24/2002	206071	53	0	0	0	DRY
269	6/24/2002	206361	3	0	0	0	DRY
270	6/24/2002	206451	20	0	0	0	DRY
271	6/24/2002	206461	3	0	0	0	DRY
272	6/24/2002	206561	104	0	0	0	DRY
273	6/25/2002	206081	137	0	0	0	DRY
274	7/8/2002	206011	630	0	0	0	DRY
275	7/8/2002	206041	26	0	0	0	DRY
276	7/8/2002	206051	180	0	0	0	DRY
277	7/8/2002	206071	33	0	0	0	DRY
278	7/8/2002	206361	50	0	0	0	DRY
279	7/8/2002	206451	233	0	0	0	DRY
280	7/8/2002	206461	33	0	0	0	DRY
281	7/8/2002	206561	140	0	0	0	DRY
282	7/9/2002	206081	480	0	0	0	DRY
283	9/10/2002	206011	1370	0	0	0	DRY
284	9/10/2002	206041	260	0	0	0	DRY
285	9/10/2002	206051	187	0	0	0	DRY
286	9/10/2002	206071	80	0	0	0	DRY
287	9/10/2002	206081	365	0	0	0	DRY
288	9/10/2002	206361	43	0	0	0	DRY
289	9/10/2002	206451	10	0	0	0	DRY
290	9/10/2002	206461	132	0	0	0	DRY
291	9/10/2002	206561	1000	0	0	0	DRY
292	3/25/2003	206011	20	0	0	0	DRY
293	3/25/2003	206041	20	0	0	0	DRY
294	3/25/2003	206051	93	0	0	0	DRY
295	3/25/2003	206071	3	0	0	0	DRY
296	3/25/2003	206081	17	0	0	0	DRY
297	3/25/2003	206361	7	0	0	0	DRY
298	3/25/2003	206451	3	0	0	0	DRY
299	3/25/2003	206461	5	0	0	0	DRY
300	3/25/2003	206561	17	0	0	0	DRY
301	5/14/2003	206011	133	0	0	0.1	DRY
302	5/14/2003	206041	37	0	0	0.1	DRY

303	5/14/2003	206051	70	0	0	0.1	DRY
304	5/14/2003	206071	33	0	0	0.1	DRY
305	5/14/2003	206081	44	0	0	0.1	DRY
306	5/14/2003	206361	20	0	0	0.1	DRY
307	5/14/2003	206451	10	0	0	0.1	DRY
308	5/14/2003	206461	27	0	0	0.1	DRY
309	5/14/2003	206561	33	0	0	0.1	DRY
310	7/8/2003	206011	130	0	0.1	0.1	DRY
311	7/8/2003	206041	430	0	0.1	0.1	DRY
312	7/8/2003	206051	147	0	0.1	0.1	DRY
313	7/8/2003	206071	73	0	0.1	0.1	DRY
314	7/8/2003	206081	230	0	0.1	0.1	DRY
315	7/8/2003	206361	40	0	0.1	0.1	DRY
316	7/8/2003	206451	833	0	0.1	0.1	DRY
317	7/8/2003	206461	967	0	0.1	0.1	DRY
318	7/8/2003	206561	2000	0	0.1	0.1	DRY
319	9/23/2003	206011	2000	0.3	0.3	0.3	**WET**
320	9/23/2003	206041	2000	0.3	0.3	0.3	**WET**
321	9/23/2003	206051	2000	0.3	0.3	0.3	**WET**
322	9/23/2003	206071	1430	0.3	0.3	0.3	**WET**
323	9/23/2003	206081	345	0.3	0.3	0.3	**WET**
324	9/23/2003	206361	77	0.3	0.3	0.3	**WET**
325	9/23/2003	206451	123	0.3	0.3	0.3	**WET**
326	9/23/2003	206461	107	0.3	0.3	0.3	**WET**
327	9/23/2003	206561	115	0.3	0.3	0.3	**WET**
328	3/15/2004	206011	23	0	0	0	DRY
329	3/15/2004	206041	10	0	0	0	DRY
330	3/15/2004	206051	193	0	0	0	DRY
331	3/15/2004	206071	3	0	0	0	DRY
332	3/15/2004	206081	17	0	0	0	DRY
333	3/15/2004	206361	3	0	0	0	DRY
334	3/15/2004	206451	7	0	0	0	DRY
335	3/15/2004	206461	3	0	0	0	DRY
336	3/15/2004	206561	40	0	0	0	DRY
337	6/8/2004	206011	290	0	0	0.6	DRY
338	6/8/2004	206041	310	0	0	0.6	DRY
339	6/8/2004	206051	113	0	0	0.6	DRY

340	6/8/2004	206071	330	0	0	0.6	DRY
341	6/8/2004	206081	45	0	0	0.6	DRY
342	6/8/2004	206361	10	0	0	0.6	DRY
343	6/8/2004	206451	80	0	0	0.6	DRY
344	6/8/2004	206461	70	0	0	0.6	DRY
345	6/8/2004	206561	395	0	0	0.6	DRY
346	8/4/2004	206011	320	0.4	0.4	1.7	**WET**
347	8/4/2004	206041	160	0.4	0.4	1.7	**WET**
348	8/4/2004	206051	967	0.4	0.4	1.7	**WET**
349	8/4/2004	206071	37	0.4	0.4	1.7	**WET**
350	8/4/2004	206081	410	0.4	0.4	1.7	**WET**
351	8/4/2004	206361	127	0.4	0.4	1.7	**WET**
352	8/4/2004	206451	53	0.4	0.4	1.7	**WET**
353	8/4/2004	206461	140	0.4	0.4	1.7	**WET**
354	8/4/2004	206561	1035	0.4	0.4	1.7	**WET**
355	9/22/2004	206011	120	0	0	0.3	DRY
356	9/22/2004	206041	73	0	0	0.3	DRY
357	9/22/2004	206051	77	0	0	0.3	DRY
358	9/22/2004	206071	27	0	0	0.3	DRY
359	9/22/2004	206081	114	0	0	0.3	DRY
360	9/22/2004	206361	67	0	0	0.3	DRY
361	9/22/2004	206451	10	0	0	0.3	DRY
362	9/22/2004	206461	10	0	0	0.3	DRY
363	9/22/2004	206561	94	0	0	0.3	DRY
364	3/1/2005	206011	300	0.4	0.4	0.4	WET
365	3/1/2005	206041	320	0.4	0.4	0.4	WET
366	3/1/2005	206051	120	0.4	0.4	0.4	WET
367	3/1/2005	206071	27	0.4	0.4	0.4	WET
368	3/1/2005	206081	47	0.4	0.4	0.4	WET
369	3/1/2005	206361	10	0.4	0.4	0.4	WET
370	3/1/2005	206451	140	0.4	0.4	0.4	WET
371	3/1/2005	206461	10	0.4	0.4	0.4	WET
372	3/1/2005	206561	120	0.4	0.4	0.4	WET
373	5/4/2005	206011	120	0	0.4	1.4	WET
374	5/4/2005	206041	20	0	0.4	1.4	WET
375	5/4/2005	206051	33	0	0.4	1.4	WET
376	5/4/2005	206071	20	0	0.4	1.4	WET

377	5/4/2005	206081	29	0	0.4	1.4	WET
378	5/4/2005	206361	7	0	0.4	1.4	WET
379	5/4/2005	206451	7	0	0.4	1.4	WET
380	5/4/2005	206461	12	0	0.4	1.4	WET
381	5/4/2005	206561	43	0	0.4	1.4	WET
382	7/13/2005	206011	330	0	0	0	DRY
383	7/13/2005	206041	80	0	0	0	DRY
384	7/13/2005	206051	250	0	0	0	DRY
385	7/13/2005	206071	80	0	0	0	DRY
386	7/13/2005	206081	485	0	0	0	DRY
387	7/13/2005	206361	43	0	0	0	DRY
388	7/13/2005	206451	33	0	0	0	DRY
389	7/13/2005	206461	2000	0	0	0	DRY
390	7/13/2005	206561	1615	0	0	0	DRY
391	9/7/2005	206011	180	0	0	0	DRY
392	9/7/2005	206041	190	0	0	0	DRY
393	9/7/2005	206051	520	0	0	0	DRY
394	9/7/2005	206071	30	0	0	0	DRY
395	9/7/2005	206081	365	0	0	0	DRY
396	9/7/2005	206361	130	0	0	0	DRY
397	9/7/2005	206451	70	0	0	0	DRY
398	9/7/2005	206461	210	0	0	0	DRY
399	9/7/2005	206561	1370	0	0	0	DRY