Total Maximum Daily Loads for Fecal Coliform for Goose Creek, North Carolina

[Waterbody ID NC_13-17-18a and 13-17-18b]

Final Report Submitted to EPA April 2005 (Approved July 08, 2005)

Yadkin-Pee Dee River Basin

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Total Maximum Daily Load (TMDL)

1. 303(d) Listed Watershed Body Information

State: North Carolina

Counties: Mecklenburg, Union

Major River Basin: Yadkin-Peedee River Basin

Watershed: Goose Creek Watershed, HUC 03040105, Waterbody ID 13-17-18a, 13-17-18b

Impaired Waterbody (2003 303(d) List):

Waterbody Name – (Segment ID)	Water Quality Classification	Impairment	Length (mi)
13-17-18a	Class C (aquatic life secondary contact recreation) NSW	Fecal Coliform	3.2
13-17-18b	Class C (aquatic life secondary contact recreation) NSW	Fecal Coliform Impaired Biological Integrity	13.1

Constituents of Concern: Fecal Coliform Bacteria

Designated Uses: Biological integrity, propagation of aquatic life, and secondary contact recreation.

Applicable Water Quality Standards for Class C Waters:

Fecal coliforms shall not exceed a geometric mean of 200/100mL (membrane filter count) based upon at least five consecutive samples examined during any 30-day period, nor exceed 400/100 ml in more than 20 percent of the samples examined during such period.

2. TMDL Development

Analysis/Modeling:
WinHSPF Version 2.2 in conjunction with WISe (Watershed Information System) Version 2.0.3 (used for topographic data processing) were used to develop the TMDL.

Critical Conditions:
Highest predicted instream fecal coliform concentrations occur during wet weather periods preceded by a period of dry weather. The period of highest risk to public health is during dry weather periods in the summer when recreational use of the waters is greatest and human sources of bacterial contamination dominate watershed loads.

Seasonal Variation:
WinHSPF Version 2.2 is a continuous simulation model, which contains seasonal fluctuation for the period modeled (01/01/2000 – 06/01/2004).

3. Allocation Watershed/Stream Reach

Segment 13-17-18a

Wasteload Allocation (WLA): 7.81×10^{12} counts
Load Allocation (LA): 1.14×10^{14} counts
Margin of Safety (MOS): More stringent geometric mean target of 180 counts/100 mL, as opposed to the 200 counts/100 mL standard; conservative modeling assumptions.
TMDL (WLA+LA+MOS): 1.22×10^{14} counts

TMDL Component	TMDL Allocation Category	Fecal Coliform Load Reductions
Wasteload Allocation	MS4	92.5%
Load Allocation	Nonpoint Sources	92.5%
Wasteload Allocation	Permited WWTP's	N/A

Segment 13-17-18b

Wasteload Allocation (WLA): 2.34×10^{13} counts
Load Allocation (LA): 2.06×10^{15} counts
Margin of Safety (MOS): More stringent geometric mean target of 180 counts/100 mL, as opposed to the 200 counts/100 mL standard; conservative modeling assumptions.
TMDL (WLA+LA+MOS): 2.08×10^{15} counts

TMDL Component	TMDL Allocation Category	Fecal Coliform Load Reductions
Wasteload Allocation	MS4	92.5%
Load Allocation	Nonpoint Sources	92.5%
Wasteload Allocation	Permited WWTP's	N/A

4. Public Notice Date: Febraury 15, 2005
5. Submittal Date: April 20, 2005
6. Establishment Date:
7. Endangered Species (yes or blank): yes
8. EPA Lead on TMDL (EPA or blank):
9. TMDL Considers Point Source, Nonpoint Source, or both: Both

1.0 INTRODUCTION

North Carolina's 2002 Integrated Report, which includes 305(b) reports and 303(d) lists of impaired waters, was approved by EPA Region IV on March 18th, 2003. The 2002 list identified the 17.0 mile segment of Goose Creek from its source to the Rocky River as impaired due to elevated fecal coliform concentrations. The objective of this study is to develop a fecal coliform TMDL using a watershed approach for Goose Creek. This TMDL encompasses all the stream segments listed in the 2002 303(d) list for this watershed.

In response to the high level of interest in this TMDL from local government officials and concerned citizens, a stakeholder group was formed in 2003. The stakeholder group, lead by the Mecklenburg County Water Quality Program (MCWQP) and the NC Division of Water Quality (DWQ), took an active role in the TMDL development process. MCWQP has a well developed and respected water quality management program and was able to take the lead role in both the source assessment and model development.

1.1 Background

Section 303(d) of the Clean Water Act (CWA) requires states to develop a list of waters not meeting water quality standards or which have impaired uses. This list, referred to as the 303(d) list, is submitted biennially to the U.S. Environmental Protection Agency (EPA) for review. The 303(d) process requires that a Total Maximum Daily Load (TMDL) be developed for each of the waters appearing on Part I of the 303(d) list. The objective of a TMDL is to allocate allowable pollutant loads to known sources so that actions may be taken to restore the water to its intended uses (EPA 1991). Generally, the primary components of a TMDL, as identified by EPA (1991, 2000) and the Federal Advisory Committee (FACA 1998), are as follows:

Target identification or selection of pollutant(s) and end-point(s) for consideration. The pollutant and end-point are generally associated with measurable water quality related characteristics that indicate compliance with water quality standards. North Carolina indicates known pollutants on the 303(d) list.
Source assessment. All sources that contribute to the impairment should be identified and loads quantified, where sufficient data exist.
Assimilative capacity estimation or level of pollutant reduction needed to achieve the water quality goal. The level of pollution should be characterized for the waterbody, highlighting how current conditions deviate from the target end-point. Generally, this component is identified through water quality modeling.
Allocation of pollutant loads. Allocating pollutant control responsibility to the sources of impairment. The wasteload allocation portion of the TMDL accounts for the loads associated with existing and future point sources. Similarly, the load allocation portion of the TMDL accounts for the loads associated with existing and future non-point sources, storm water, and natural background.
Margin of safety. The margin of safety addresses uncertainties associated with pollutant loads, modeling techniques, and data collection. Per EPA (2000), the margin of safety may be expressed explicitly as unallocated assimilative capacity or implicitly due to conservative assumptions.
Seasonal variation. The TMDL should consider seasonal variation in the pollutant loads and endpoint. Variability can arise due to stream flows, temperatures, and exceptional events (e.g., droughts, hurricanes).

Section 303(d) of the CWA and the Water Quality Planning and Management regulation (USEPA

2000a) require EPA to review all TMDLs for approval or disapproval. Once EPA approves a TMDL, the waterbody may be moved to Part III of the 303(d) list. Waterbodies remain on Category 4a of the list until compliance with water quality standards is achieved. Where conditions are not appropriate for the development of a TMDL, management strategies may still result in the restoration of water quality.

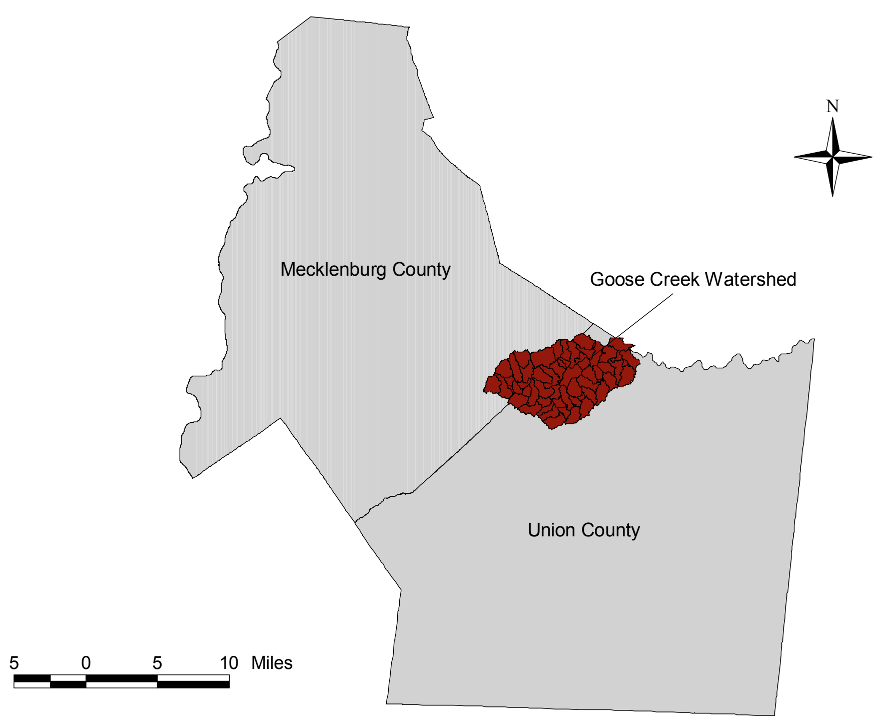
The goal of the TMDL program is to restore uses to water bodies. Thus the implementation of bacterial controls will be necessary to restore uses in these creeks. Although an implementation plan is not included in this TMDL, reduction strategies are needed. The involvement of local governments and agencies will be needed in order to develop implementation plans.

1.2 Watershed Description

The Goose Creek watershed is located in Mecklenburg County and Union County, North Carolina. The headwaters of the watershed originate in Mecklenburg County and flow into Union County, North Carolina and into the Rocky River. Stevens and Duck Creeks, which originate in Mecklenburg County, are both tributaries to Goose Creek. Stevens Creek flows into Goose Creek at the Mecklenburg-Union County line west of Stevens Mill Rd. while Duck Creek joins Goose Creek just upstream of Brief Rd. Figure 1 shows the location of the Goose Creek watershed within Mecklenburg and Union Counties.

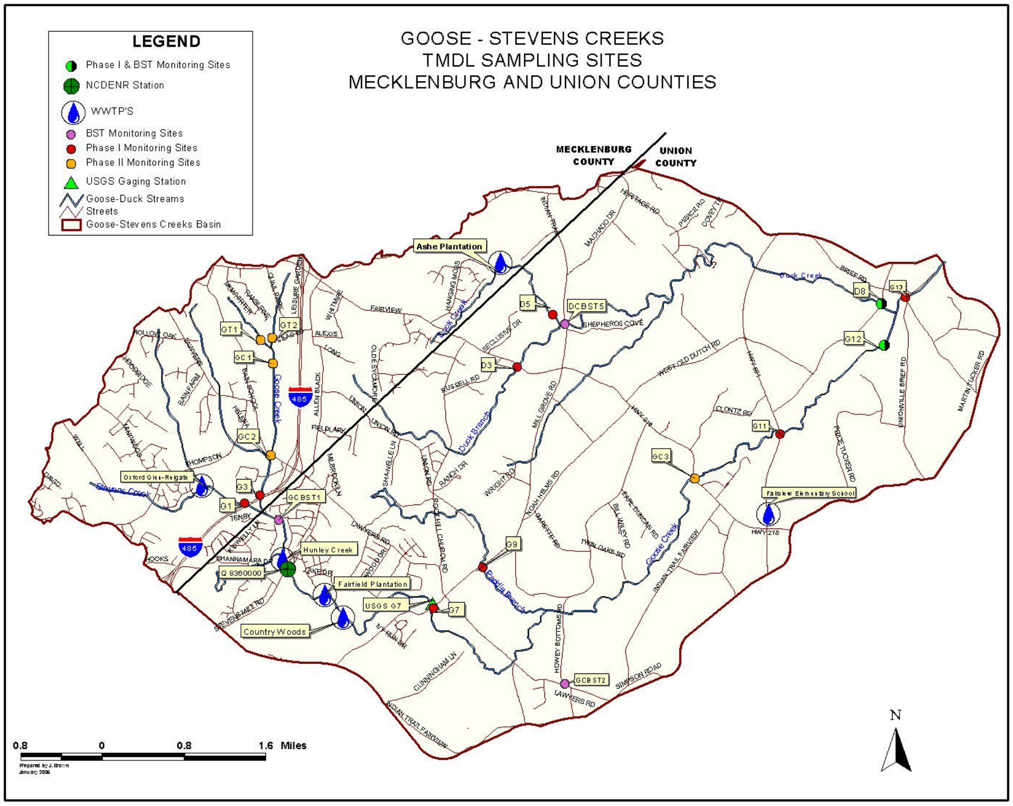
Figure 1:

Location of Goose Creek Watershed in Mecklenburg and Union Counties



Each compliance point utilized for this TMDL is associated with ambient monitoring that occurs in the watershed. Water quality and quantity data is collected at multiple locations by different agencies. For the purposes of assessing TMDL compliance, the DWQ ambient monitoring station on Goose Creek was used (Q8360000). The location of this monitoring station is illustrated in Figure 2. Other monitoring is discussed below.

Figure 2: Goose-Stevens Creek Sampling Sites in Mecklenburg and Union Counties



1.3 Water Quality Monitoring Programs

The MCWQP, DWQ, Charlotte Mecklenburg Utilities (CMU) and USGS collect ambient data in the Goose Creek watershed at regular intervals. However, CMU analyses do not include fecal coliform bacteria. DWQ maintains one ambient monitoring location in the Goose Creek watershed located in Union County on SR 1524. MCWQP maintains a monitoring location on both Goose and Stevens Creeks. The USGS maintains a flow gauge located in Goose Creek and a data summary are presented in Table 1. The USGS gauge location is shown in Figure 2.

Table 1: USGS Water Discharge Stations for the Goose Creek Watershed.

Station number	Description	Period of Record	Mean Flow for Period of Record, cfs
02124692	GOOSE CR AT FAIRVIEW, NC	November 1999 to current year	7.03

1.4 Water Quality Target

The North Carolina fresh water quality standard for fecal coliform in Class C waters (T15A:02B.0211) states: Organisms of the coliform group: fecal coliforms shall not exceed a geometric mean of 200/100 mL (membrane filter count) based upon at least five consecutive samples examined during any 30-day period, nor exceed 400/100 mL in more than 20 percent of the samples examined during such period; violations of the fecal coliform standard are expected during rainfall events and, in some cases, this violation is expected to be caused by uncontrollable nonpoint source pollution; all coliform concentrations are to be analyzed using the membrane filter technique unless high turbidity or other adverse conditions necessitate the tube dilution method; in case of controversy over results, the MPN 5-tube dilution technique will be used as the reference method**.**

Note that there are two quantitative criteria in the standard: Geometric mean of 200 and an instantaneous value of 400.

All TMDLs include the establishment of in-stream numeric endpoints, or targets, used to evaluate the attainment of water quality goals and designated use criteria. The target represents the restoration objective to be achieved by implementation of the load reductions specified by the TMDL. For the TMDLs presented in this document, the fecal coliform 30-day geometric mean of 200 c.f.u./100 ml. with no more than 20 percent of samples exceeding 400 c.f.u./100 ml. is applicable, as referenced in NC's water quality standard for fecal coliform in Class C waters (15ANCAC 2B .0211 (3)(e)).

Secondary recreation is the designated use being addressed in this TMDL. Secondary recreation is defined in NC's standards (15A NCAC 2B .0202 (57)) as including "wading, boating, other uses not involving human body contact with water, and activities involving human body contact with water where such activities take place on an infrequent, unorganized, or incidental basis."

One compliance point has been established for this TMDL, representing the DWQ ambient monitoring station located in the watershed. Compliance points are physical locations within a watershed that are used to monitor water quality conditions and assess progress in achieving the TMDL goal.

1.5 Water Quality Assessment

Phase I water quality monitoring was collected at a total of twenty sites, including five wastewater treatment plants (WWTPs) (See Figure 2). Phase I monitoring was conducted between June 2003 and December 2003. Table 6 provides the location and a site description for the Phase I monitoring sites located on Duck and Goose Creeks. Seventy-five samples were collected from three sites in the Duck Creek watershed and 172 samples, from seven locations, were collected in the Goose Creek watershed. Fifty-seven samples were collected from five WWTPs.

The median and average fecal coliform concentrations for the Duck Creek samples were 530 and 1923 colonies/100 ml, respectively (Figure 3). The median concentration for the Goose Creek samples was 510 colonies/100 ml and the average concentration was 1954 colonies/100 ml (Figure 4).

Figure 3. Duck Creek Fecal Coliform Data

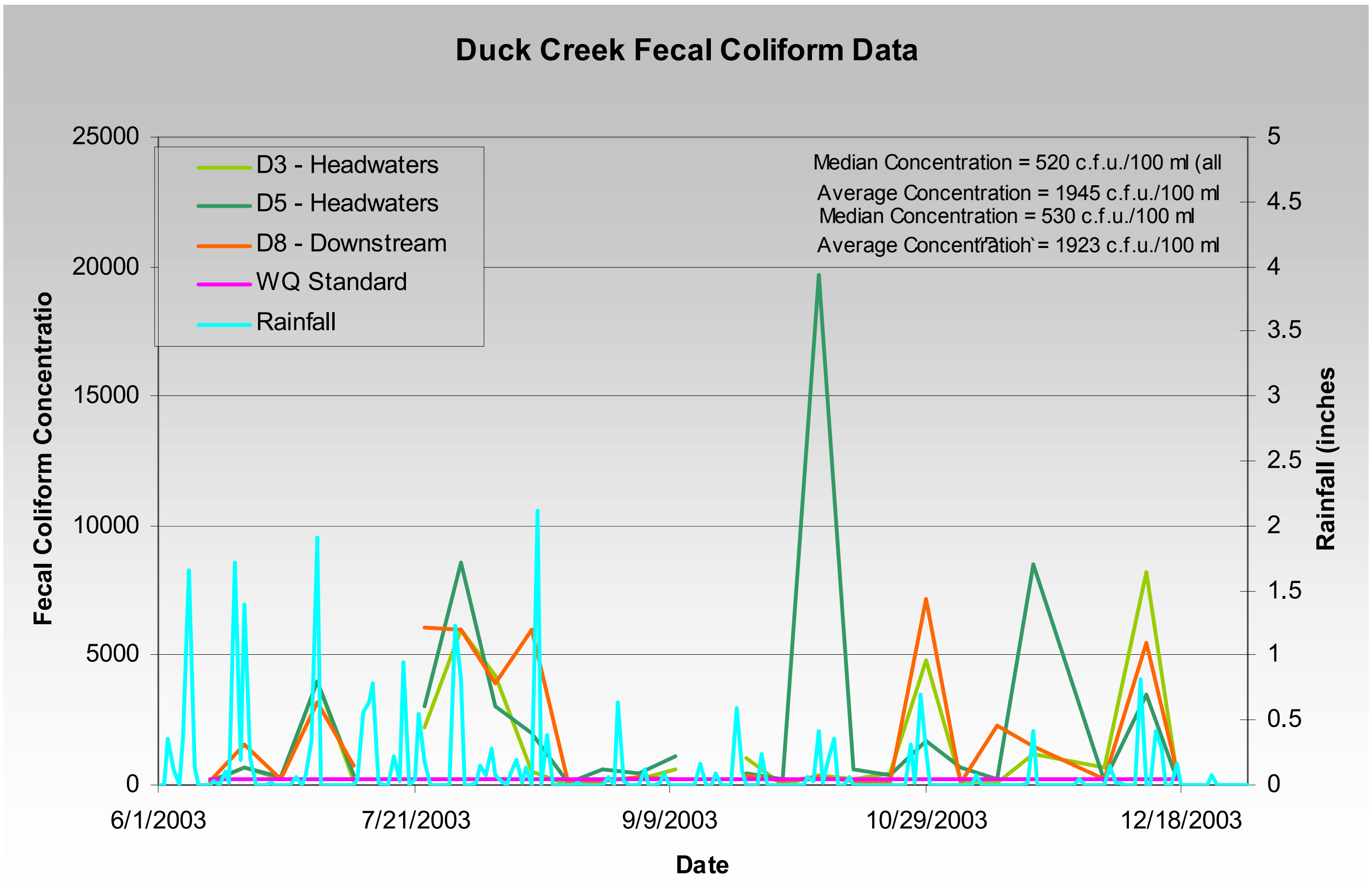
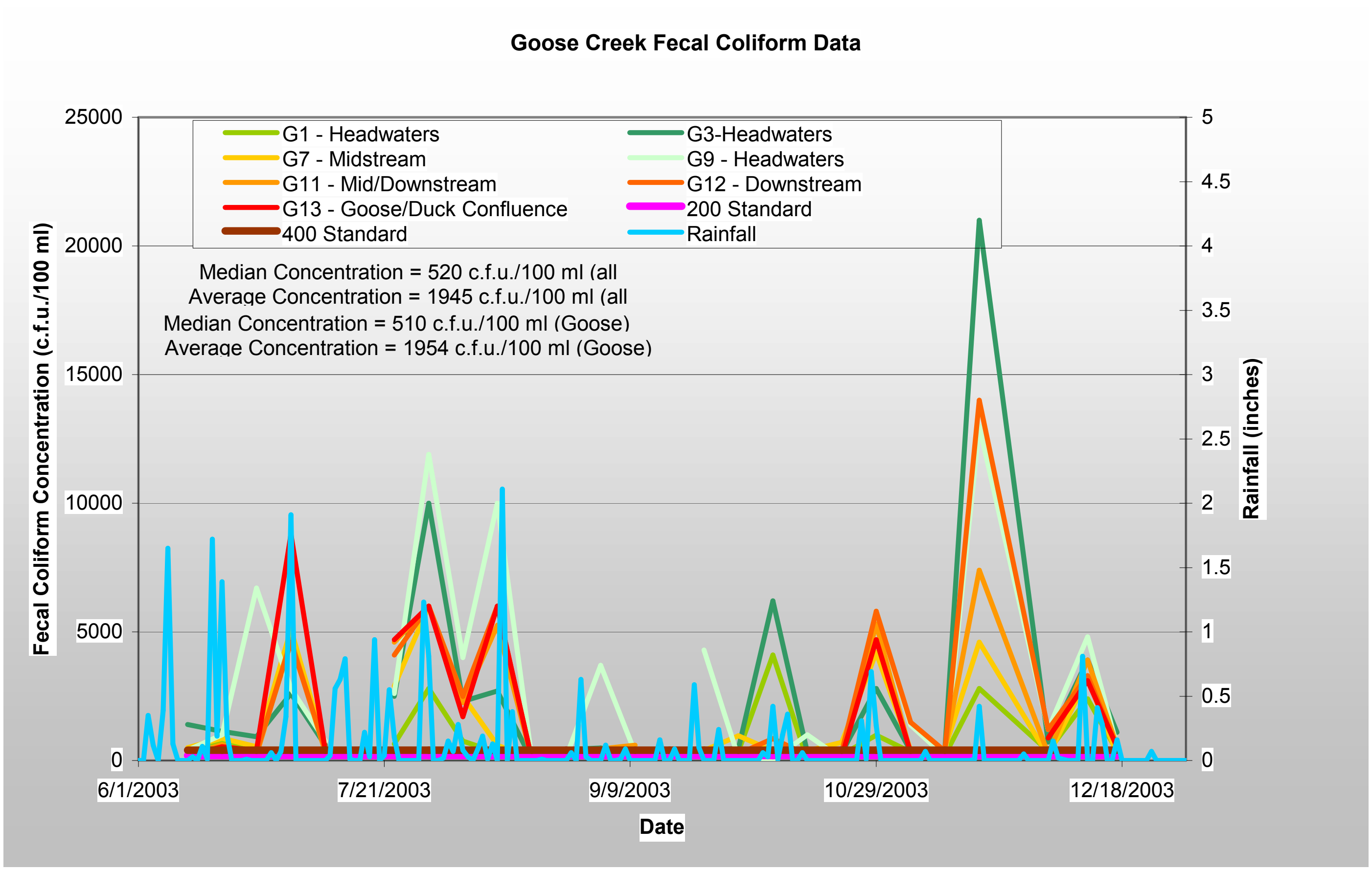
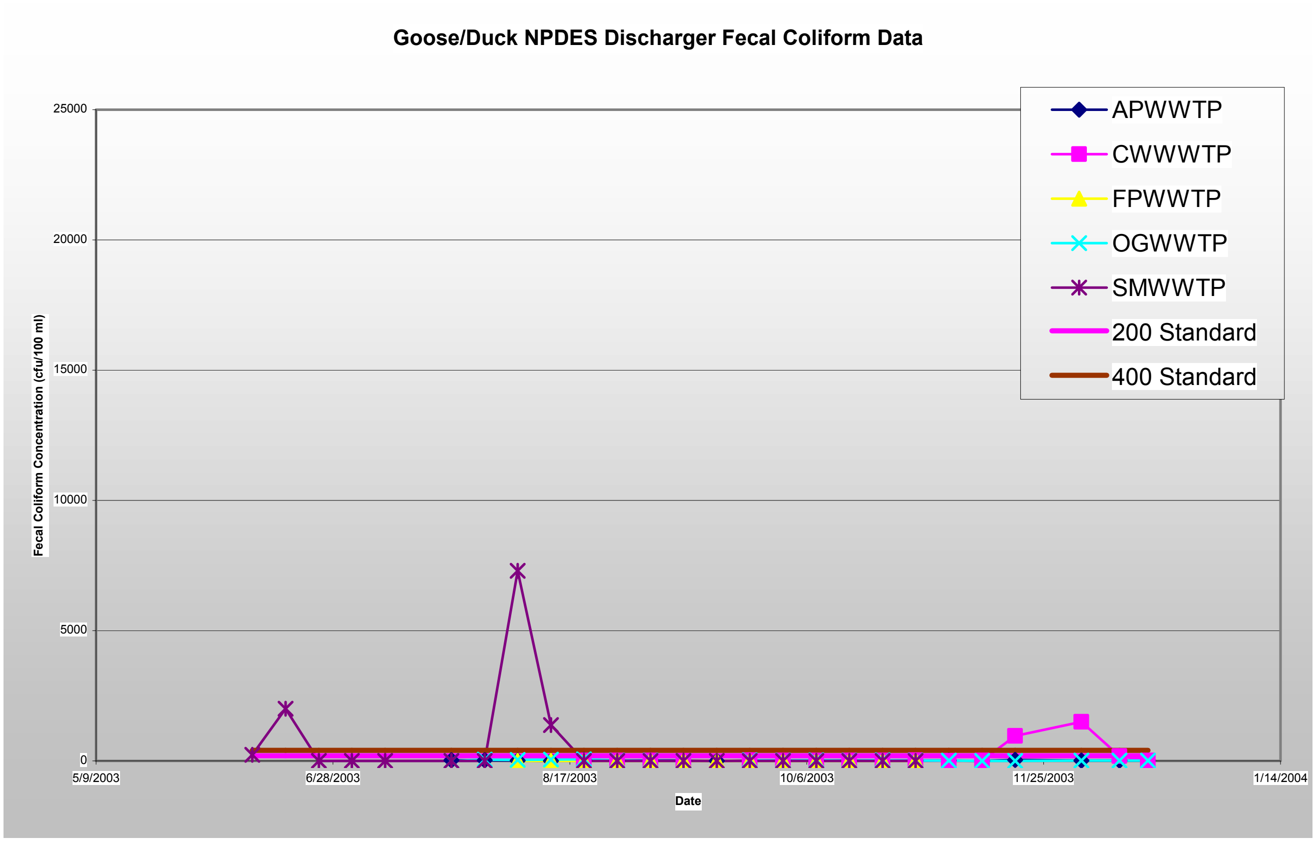


Figure 4. Goose Creek Fecal Coliform Data



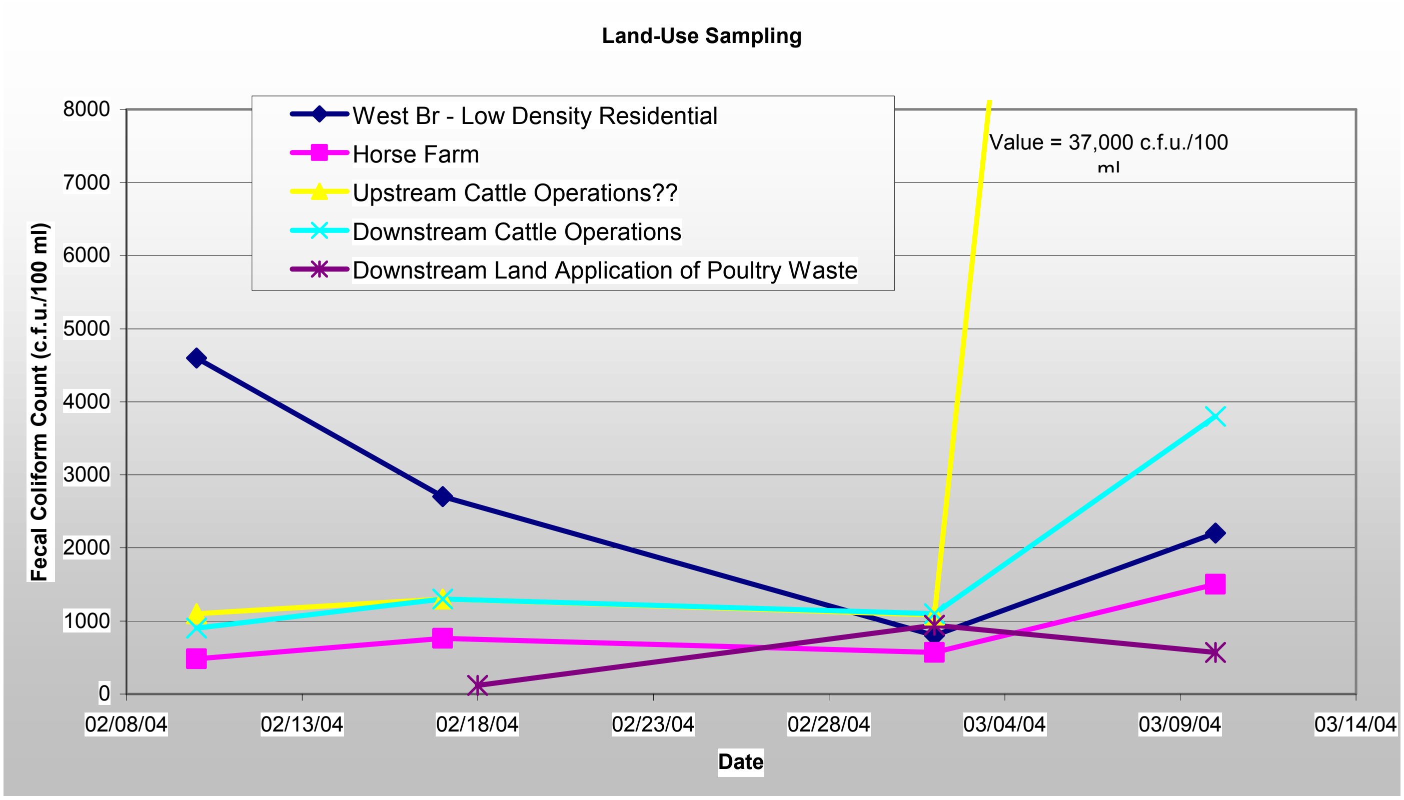
There are 5 WWTPs in the watershed that were monitored during the Phase I monitoring (Table 2). Results are graphed in Figure 5.

Figure 5. Goose/Duck NPDES Discharger Fecal Coliform Data



Phase II monitoring included monitoring of streams downstream of specific land use sites. A total of five (5) sites were identified that are representative of the targeted land uses present in the Goose Creek watershed as listed in Table 7 and shown in Figure 2. Fecal coliform monitoring results are shown in Figure 6.

Figure 6: Land Use Sampling Results



2.0 Source Assessment

Potential sources of fecal coliform in a water body are numerous and often times transient. For the purpose of this report, the sources of fecal coliform have been divided into two broad categories; point sources and non-point sources. Point sources can be defined as sources, either constant or time transient, which occur at a fixed location in a watershed. Non-point sources are generally accepted to be diffuse sources not entering a water body at a specific location. An example of a point source is wastewater treatment plants (WWTP). Examples of non-point sources are storm water runoff, dry weather flow from storm drains and ground water.

The source assessment presented in this document represents the best estimation of the sources of fecal coliform in the TMDL watershed at this time. Additional investigation into the sources and distribution of sources of fecal coliform is critical to achieving the water quality target. Therefore, it is expected that, in the future, the source assessment will be modified to reflect additional data. Specifically, there needs to be a better understanding of seasonal changes and variation in the watershed.

2.1 Point Source Assessment

All documented point source dischargers were included in the source assessment except the Fairfield Elementary School WWTP, which was not sampled. Actual discharge values for fecal coliform concentration and effluent flow rates were used throughout the TMDL. In the absence of direct measurements, permit limit values were used. Furthermore, it was assumed that discharges recorded during 2003 are typical and effectively estimate future conditions.

2.1.1 NPDES Permitted Dischargers

Table 2 identifies the permitted NPDES point source dischargers in the Goose Creek Watershed. Figure 2 is a map of the watershed showing the locations of the permitted point source dischargers.

Discharge Monitoring Reports were obtained for each NPDES permitted discharger from January 2003 to May 2004. From these reports an average flow rate and hourly fecal coliform loading rate was determined. Table 2 presents this data for each of the NPDES permitted dischargers.

Table 2: NPDES Permitted Dischargers in Goose Creek Watershed.

Facility ID	Address	Sub-watershed ID	NPDES ID	Flow Rate (cfs)	FC Loading (cfu/hr)
Oxford Glen	15349 Bexley Pl.	76	NC0063584	0.024 (0.075)	2.49E+04 (2.37E+07)
Ashe Plantation	Quarters Ln.	88	NC0065749	0.056 (0.154)	5.7E+04 (3.15E+07)
Fairview Elementary	110 Clontz Rd.	125	NC0030538	No flow (0.006)	No load (1.26E+06)
Country Woods	Country Woods Dr.	108	NC0065684	0.213 (1.036)	2.43E+05 (2.11E+08)
Hunley Creek	Stevens Mill Rd.	105	NC0072508	0.305 (0.294)	2.36E+07 (5.99E+07)
Fairfield Plantation	Stoney Ridge Rd	106	NC0034762	0.148 (0.108)	1.59E+06 (2.21E+07)

Note : permit limits are shown in parentheses.

The NPDES Phase I rule requires large and medium municipal separate storm sewer systems (MS4s) greater than 100,000 people to obtain an NPDES storm water permit. The NPDES Phase II addressed small municipal separate storm sewer systems (MS4s) serving a population of less than 100,000 people in urbanized areas. This rule applies to a unit of government such as a city or county, which owns or operates an MS4. Each permitted entity is required to develop a Storm Management Program (SWMP). Within the Goose Creek Watershed four municipalities have been designated into the Phase II program. These municipalities are Stallings, Indian Trail and Hemby Bridge within Union County and Mint Hill within Mecklenburg County. In addition to the aforementioned municipalities Mecklenburg County has also been designated into the Phase II program. The land areas of Stallings, Indian Trail and Hemby Bridge within the Goose Creek Watershed are 2.2 mi^2, 1.3 mi^2 and 0.47 mi^2 respectively. The land area of Mint Hill within the Goose Creek Watershed is 11.2 mi^2. The land area of the Goose Creek Watershed within Mecklenburg County is completely contained within Mint Hill's jurisdiction.

A recent EPA mandate (Wayland, 2002) requires NPDES permitted stormwater to be placed in the wastload allocation (WLA), which had previously been reserved for continuous point source wastewater loads. Since portions of the Goose Creek Watershed are subject to MS4 permits, the WLA in the Goose Creek TMDL will include loads from both continuous discharge facilities and wet weather discharges.

2.2 Non-Point Source Assessment

Typically, assessment of the contribution of storm water runoff is based upon estimations of wildlife, agricultural operations and typical accumulation rates on built up (urban) areas. However, for this report, build-up and wash off rates for each land-use in the TMDL watersheds were adopted from a highly calibrated water quality model for the McDowell Creek Watershed (located approximately 15 miles to the northwest of the Goose Creek Watershed) (Tetra Tech, 2003). Originally, these values were calculated from local in-stream storm water samples collected by the United States Geological Survey (USGS) from December 1993 to September 1997 (Bales et. Al, 1999). The calculated values were adjusted to obtain necessary calibration tolerances for the McDowell Creek Model. These values were directly integrated into the Goose Creek Watershed model. Table 3 presents the build-up and maximum accumulation levels used in this study.

Table 3: Rate of Accumulation and Maximum Storage of Fecal Coliform by Land-Use.

TMDL Land-Use	Rate of Accumulation of Fecal Coliform (count/acre/day)	Maximum Storage of Fecal Coliform (count per acre)	Rate of Accumulation of Fecal Coliform (count/acre/day)	Maximum Storage of Fecal Coliform (count/acre)
	Pervious Lands		Impervious Lands	
>2 Acre Residential	1.20E+10	1.20E+10	6.20E+07	1.90E+08
0.25 – 0.5 ac res	1.30E+09	1.70E+10	1.90E+08	5.80E+08
0.25 ac res	2.50E+09	1.70E+10	1.90E+08	5.80E+08
0.5 – 2 ac res	2.50E+09	1.70E+10	6.20E+07	1.90E+08
Agricultural	2.50E+09	2.60E+10	3.20E+08	9.70E+08
Forest	2.50E+09	3.50E+10	3.20E+08	9.70E+08
Golf Course	2.50E+09	6.84E+11	6.20E+07	1.90E+08
Institutional	5.50E+09	7.50E+09	6.20E+07	1.90E+08
Road/Transportation	5.50E+09	7.50E+09	6.20E+07	1.90E+08
Industrial	7.60E+09	7.50E+09	6.20E+07	1.90E+08
Commercial	8.60E+10	7.50E+09	6.20E+07	1.90E+08

While the total number of livestock operations is unknown, several in the Goose Creek watershed have been identified and are shown in Table 4.

Table 4: Known Livestock Operations in the Goose Creek Watershed

Animal Type	Estimated #	Location
Equestrian	8	Lawyers Rd. at Goose Ck. (Union Co.)
Equestrian	7-10	7300 West Duncan Rd.
Equestrian	10	8500Fairview Rd.
Equestrian	4	12300 Bain School Rd.
Bovine	150-200	13500 Lawyers Rd.
Bovine	40	12000 Bain School Rd.
Poultry	100,000	Bret Haigler Rd.
Poultry	75,000	Unionville-Brief @ Brief Rd.

2.2.1 Failing Septic Systems

Failing septic systems have been cited in many TMDLs as a significant contributor of fecal coliform to water bodies (Tennessee Department of Environment and Conservation, Division of Water Pollution Control, Watershed Management Section, 2000). Previous studies have used failure rate values ranging from 4% to 50% of all septic systems. The Mecklenburg County Health Department has estimated the local septic system failure rate to be 1%, (Daniel, 2000). The Health Department cited the following reasons for this estimate (Daniel, 2000):

- In general, Mecklenburg County soils are highly conducive to septic system operation;
- Areas where soil types are not conducive to septic system operation have been excluded from septic system use and existing systems in these areas have been targeted for integration into the CMU sanitary sewer system; and
- Mecklenburg County has been a leader in enacting septic system regulation in North Carolina, which has prevented the installation of sub-standard systems.

Many stakeholders, including Charlotte Mecklenburg Utilities, have questioned the validity of a 1% failure rate for septic systems. Personal observations and anecdotal evidence appear to indicate a much higher value. However, no documentation of a local investigation to establish a more accurate or reproducible value exists. Because of the lack of direct evidence to refute the 1% value cited by the Health Department, that value was initially adopted for the TMDLs presented in this document. However, during water quality model calibration the simulated fecal coliform concentrations during baseflow conditions were consistently lower than observed data. Because of the discrepancy in observed versus simulated, the septic system failure rate was increased to 2.4%. It is possible that the discrepancy could be due to wildlife sources that were unaccounted for in the model. However, direct inputs of fecal coliform bacteria by wildlife during baseflow conditions could not be directly accounted for in the model.

No direct accounting of the number of septic systems in use in the Goose Creek Watershed was available. An estimate of the possible number of septic systems was completed through analysis of Mecklenburg County and Union County parcel data. Essentially, a listing of all parcels was amassed, each meeting the following criteria:

1. The parcel must be at least 2 acres. The basic requirement of space for the septic system and repair field was used to eliminate parcels less than 2 acres.

2. The parcel must be built upon. Database fields in the parcel coverage indicated the presence of buildings. Any indication of a building was assumed to indicate the necessity of a septic system.

3. The parcel must not be located in an area known to be served by a wastewater treatment plant.

The resultant parcel coverage meeting the aforementioned criteria was then intersected with the watershed coverage used to construct the water quality model. Those parcels bisected by a watershed boundary were assumed to be located in the watershed containing the bulk of the parcel. An estimated 2.8 individuals were served by each septic system (Daniel, 2000), an estimated flow rate per person of 70 gallons per individual per day (Horsely and Witten, 1996) and an estimated fecal coliform concentration of 10,000 c.f.u./100 ml (Horsely and Whitten,

1996) were used to calculate the loading and flow rates. Table 5 presents the loading rates by watershed.

Table 5: Septic System Loading.

Basin	Estimated Number of systems	Individuals per System	Individuals Served	Failure Rate	Individuals per Failing System	Fecal Coliform Concentration	Flow gal/day	FC Load (cfu/day)
67	71	2.8	198.8	2.4%	4.77	10000	334	1.26E+08
68	4	2.8	11.2	2.4%	0.27	10000	19	7.12E+06
69	11	2.8	30.8	2.4%	0.74	10000	52	1.96E+07
70	42	2.8	117.6	2.4%	2.82	10000	198	7.48E+07
72	26	2.8	72.8	2.4%	1.75	10000	122	4.63E+07
73	24	2.8	67.2	2.4%	1.61	10000	113	4.27E+07
75	74	2.8	207.2	2.4%	4.97	10000	348	1.32E+08
76	100	2.8	280	2.4%	6.72	10000	470	1.78E+08
77	70	2.8	196	2.4%	4.70	10000	329	1.25E+08
79	50	2.8	140	2.4%	3.36	10000	235	8.90E+07
80	3	2.8	8.4	2.4%	0.20	10000	14	5.34E+06
81	31	2.8	86.8	2.4%	2.08	10000	146	5.52E+07
82	2	2.8	5.6	2.4%	0.13	10000	9	3.56E+06
83	43	2.8	120.4	2.4%	2.89	10000	202	7.66E+07
84	5	2.8	14	2.4%	0.34	10000	24	8.90E+06
85	15	2.8	42	2.4%	1.01	10000	71	2.67E+07
86	8	2.8	22.4	2.4%	0.54	10000	38	1.42E+07
87	3	2.8	8.4	2.4%	0.20	10000	14	5.34E+06
88	83	2.8	232.4	2.4%	5.58	10000	390	1.48E+08
89	23	2.8	64.4	2.4%	1.55	10000	108	4.10E+07
90	13	2.8	36.4	2.4%	0.87	10000	61	2.31E+07
91	8	2.8	22.4	2.4%	0.54	10000	38	1.42E+07
93	55	2.8	154	2.4%	3.70	10000	259	9.79E+07
95	15	2.8	42	2.4%	1.01	10000	71	2.67E+07
96	8	2.8	22.4	2.4%	0.54	10000	38	1.42E+07
97	4	2.8	11.2	2.4%	0.27	10000	19	7.12E+06
98	6	2.8	16.8	2.4%	0.40	10000	28	1.07E+07
99	32	2.8	89.6	2.4%	2.15	10000	151	5.70E+07
100	17	2.8	47.6	2.4%	1.14	10000	80	3.03E+07
101	9	2.8	25.2	2.4%	0.60	10000	42	1.60E+07
102	37	2.8	103.6	2.4%	2.49	10000	174	6.59E+07
104	1	2.8	2.8	2.4%	0.07	10000	5	1.78E+06
105	12	2.8	33.6	2.4%	0.81	10000	56	2.14E+07
106	7	2.8	19.6	2.4%	0.47	10000	33	1.25E+07
107	17	2.8	47.6	2.4%	1.14	10000	80	3.03E+07
108	5	2.8	14	2.4%	0.34	10000	24	8.90E+06
109	5	2.8	14	2.4%	0.34	10000	24	8.90E+06
110	9	2.8	25.2	2.4%	0.60	10000	42	1.60E+07
111	33	2.8	92.4	2.4%	2.22	10000	155	5.88E+07
112	21	2.8	58.8	2.4%	1.41	10000	99	3.74E+07

Basin	Estimated Number of systems	Individuals per System	Individuals Served	Failure Rate	Individuals per Failing System	Fecal Coliform Concentration	Flow gal/day	FC Load (cfu/day)
113	13	2.8	36.4	2.4%	0.87	10000	61	2.31E+07
114	42	2.8	117.6	2.4%	2.82	10000	198	7.48E+07
115	1	2.8	2.8	2.4%	0.07	10000	5	1.78E+06
116	13	2.8	36.4	2.4%	0.87	10000	61	2.31E+07
117	19	2.8	53.2	2.4%	1.28	10000	89	3.38E+07
118	49	2.8	137.2	2.4%	3.29	10000	230	8.72E+07
119	5	2.8	14	2.4%	0.34	10000	24	8.90E+06
120	34	2.8	95.2	2.4%	2.28	10000	160	6.05E+07
121	7	2.8	19.6	2.4%	0.47	10000	33	1.25E+07
122	31	2.8	86.8	2.4%	2.08	10000	146	5.52E+07
123	34	2.8	95.2	2.4%	2.28	10000	160	6.05E+07
124	15	2.8	42	2.4%	1.01	10000	71	2.67E+07
125	14	2.8	39.2	2.4%	0.94	10000	66	2.49E+07
126	13	2.8	36.4	2.4%	0.87	10000	61	2.31E+07
127	9	2.8	25.2	2.4%	0.60	10000	42	1.60E+07
129	15	2.8	42	2.4%	1.01	10000	71	2.67E+07

2.2.2 Ground Water

No direct monitoring of ground water was conducted for this TMDL. Literature values for fecal coliform concentration in ground water range from <10 to over 1000 c.f.u./100 ml. Initially a ground water concentration of 35 c.f.u./100 ml was adopted (HSPF default value). However, during the calibration process simulated fecal coliform concentrations during base flow were consistently lower than observed values. Because of the discrepancy, the value was raised to 50 c.f.u./100 ml for the model. It is possible that the discrepancy could be due to wildlife sources that were unaccounted for in the model. However, direct inputs of fecal coliform bacteria by wildlife during baseflow conditions could not be directly accounted for in the model.

2.3 Water Quality Monitoring

Phase I of the Goose Creek Source Assessment Strategy was initiated in June 2003 and was concluded on December 2003. A total of 304 samples were collected from 15 sites (including five (5) waste water treatment plants) during the sampling period. Table 6 presents a total of ten (10) sites that were identified as being representative of the varying land uses present in the Duck/Stevens/Goose Creek watersheds. The sites are mapped on Figure 2. All baseline monitoring sites listed in Table 5 were sampled weekly for fecal coliform and E. coli.

Table 6: Goose/Stevens Creek TMDL Source Assessment Monitoring Sites.

Site	Stream	Segment ID	Location	Descritpion
G1	Stevens Creek	13-17-18a	I-485 Bridge: Upstream (NW side of I-485); 0.5 miles SW of Lawyers Road	To define water quality in Stevens Creek
G3	Goose Creek	13-17-18a	I-485 Bridge: Upstream (NW side of I-485); 0.7 miles SW of Lawyers Road	To define water quality in upper Goose Creek
G7	Goose Creek	13-17-18b	Mill Grove Road @ USGS station	To define water quality in Goose Creek between G1, G3 and Mill Grove Rd.
G9	Paddle Branch		Mill Grove Road: 0.5 miles E of Lawyers Road	To define water quality in Paddle Branch
G11	Goose Creek	13-17-18b	Concord Hwy (Hwy 601) @ USGS station	To define water quality in Goose Creek between G7, G9 and Hwy 601
G12	Goose Creek	13-17-18b	Unionville Brief Rd.	To define water quality in Goose Creek between G11 and convergence with Duck
G13	Goose Creek	13-17-18b	Brief Road between Unionville Brief Road and Hopewell Church	To define water quality at mouth of Goose Creek
D3	Duck Branch		NC 218: Between Mill Grove Road and Russell Road	To define water quality in Duck Creek
D5	Duck Creek		Private Road @ 9902 Mill Grove Road: Bridge at bottom of hill	To define water quality in upper Duck Creek
D8	Duck Creek		Hopewell Church Road: 0.2 miles S of Brief Road	To define water quality in Duck Creek between D5 and convergence with Goose Creek

In January 2004, Phase II of the source assessment monitoring was initiated. The Goose Creek Phase II source assessment monitored specific land uses to determine baseline conditions. The Phase II monitoring was used to help determine to what extent livestock and septic tanks are contributing to fecal coliform loads in Goose Creek. A total of five (5) sites were identified that are representative of the targeted land uses present in the Goose Creek watershed as listed in Table 7 and shown in Figure 2. The monitoring sites are located upstream and downstream of a cattle operation, downstream of a horse farm, downstream of an area where chicken waste has been land applied and downstream of a residential area that utilizes septic systems. The sites are mapped on Figure 2. Phase II monitoring sites were sampled weekly for fecal coliform and E. coli for a period of six (6) weeks between February and March 2004.

Table 7: Goose/Stevens Creek TMDL Phase II Source Assessment Monitoring Sites.

Site	Stream	Location	Description
GT1	Goose Creek Tributary	12051 Bain School Rd.	To define water quality in a tributary of Goose Creek downstream of a residential community
GT2	Goose Creek Tributary	12325 Bain School Rd.	To define water quality in a tributary of Goose Creek downstream of a horse farm
GC1	Goose Creek	12309 Bain School Rd	To define water quality in Goose Creek upstream of a cattle farm
GC2	Goose Creek	13816 Lawyers Rd.	To define water quality in Goose Creek downstream of a cattle farm
GC3	Goose Creek	Goose Creek at Hwy. 218	To define water quality in Goose Creek downstream of a chicken farm

2.3.1 Bacterial Source Tracking

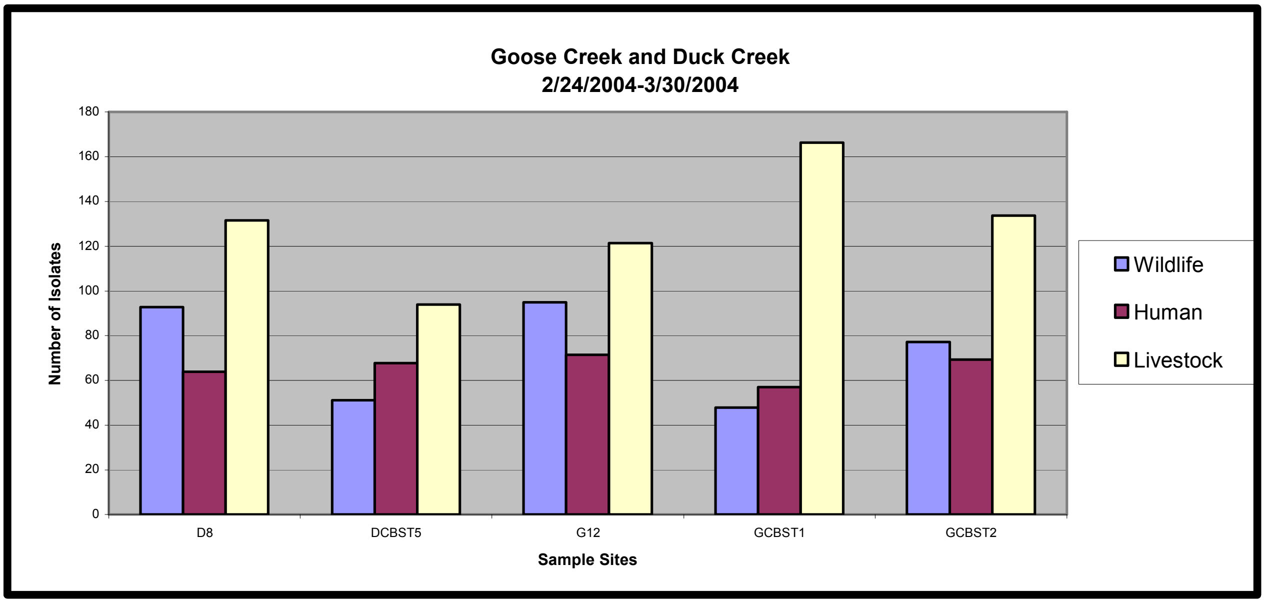
Bacterial Source Tracking (BST) using Antibiotic Resistance Analysis (ARA) was also used in the development of the TMDL to assess the contribution of specific bacteria sources to fecal coliform loads in the watershed. BST analysis was conducted by MapTech Inc. in their Blacksburg, VA laboratory. One hundred thirty six known source isolates from 17 livestock fecal samples collected in the Goose Creek watershed were combined with 168 known source isolates from 21 human and wildlife fecal samples previously collected in the Little Sugar Creek watershed. The isolates were analyzed to develop a library for discriminating between human, livestock and wildlife resources of *E. coli* bacteria. The livestock sample included 6 each from cattle and horses, and 5 from poultry. Eighty-eight human isolates were extracted from 11 samples. The 80 wildlife isolates were collected from 1 sample each of rabbit, deer, goose, raccoon and fox, 2 samples from squirrel and 3 from ducks. Statistical analysis of the resulting data showed a 76% correct classification rate. This is slightly below the Division of Water Quality's preferred level of correct classification ($\geq$ 80%).

One thousand three hundred forty unknown isolates from five sampling locations were analyzed using the database developed with the known sources. The BST monitoring sites are shown on Figure 2. Results of the analysis are given in Table 8 and graphed in Figure 7. The results indicate that a significant number of the isolates are from livestock and wildlife.

Table 8: BST Analysis Results.

Lab No.	Location No.	Date of Sample	No. of Isolates Analyzed	% Wildlife	% Human	% Livestock	No. of Isolates Wildlife	No. of Isolates Human	No. of Isolates Livestock
3NC4	D8	2/24/2004	48	0.54	0.08	0.38	25.92	3.84	18.24
3NC9	D8	3/2/2004	48	0.04	0.04	0.92	1.92	1.92	44.16
3NC14	D8	3/10/2004	48	0.65	0.06	0.29	31.20	2.88	13.92
3NC19	D8	3/16/2004	48	0.35	0.17	0.48	16.80	8.16	23.04
3NC24	D8	3/23/2004	48	0.29	0.31	0.40	13.92	14.88	19.20
3NC29	D8	3/30/2004	48	0.06	0.67	0.27	2.88	32.16	12.96
		TOTALS:	288.00				92.64	63.84	131.52
3NC5	DCBST5	2/24/2004	48	0.21	0.10	0.69	10.08	4.80	33.12
3NC10	DCBST5	3/2/2004	48	0.63	0.04	0.33	30.24	1.92	15.84
3NC15	DCBST5	3/10/2004	9	0.89	0.00	0.11	8.01	0.00	0.99
3NC20	DCBST5	3/16/2004	48	0.00	0.81	0.19	0.00	38.88	9.12
3NC25	DCBST5	3/23/2004	12	0.08	0.25	0.67	0.96	3.00	8.04
3NC30	DCBST5	3/30/2004	48	0.04	0.40	0.56	1.92	19.20	26.88
		TOTALS:	213				51.21	67.80	93.99
3NC3	G12	2/24/2004	48	0.50	0.15	0.35	24.00	7.20	16.80
3NC8	G12	3/2/2004	48	0.42	0.04	0.54	20.16	1.92	25.92
3NC13	G12	3/10/2004	48	0.31	0.17	0.52	14.88	8.16	24.96
3NC18	G12	3/16/2004	48	0.23	0.27	0.50	11.04	12.96	24.00
3NC23	G12	3/23/2004	48	0.12	0.67	0.21	5.76	32.16	10.08
3NC28	G12	3/30/2004	48	0.40	0.19	0.41	19.20	9.12	19.68
		TOTALS:	288				95.04	71.52	121.44
3NC1	GCBST1	2/24/2004	48	0.17	0.10	0.73	8.16	4.80	35.04
3NC6	GCBST1	3/2/2004	48	0.06	0.44	0.50	2.88	21.12	24.00
3NC11	GCBST1	3/10/2004	48	0.02	0.04	0.94	0.96	1.92	45.12
3NC16	GCBST1	3/16/2004	48	0.56	0.25	0.19	26.88	12.00	9.12
3NC21	GCBST1	3/23/2004	31	0.13	0.29	0.58	4.03	8.99	17.98
3NC26	GCBST1	3/30/2004	48	0.10	0.17	0.73	4.80	8.16	35.04
		TOTALS:	271				47.71	56.99	166.30
3NC2	GCBST2	2/24/2004	48	0.63	0.10	0.27	30.24	4.80	12.96
3NC7	GCBST2	3/2/2004	48	0.56	0.19	0.25	26.88	9.12	12.00
3NC12	GCBST2	3/10/2004	48	0.17	0.33	0.50	8.16	15.84	24.00
3NC17	GCBST2	3/16/2004	48	0.10	0.31	0.59	4.80	14.88	28.32
3NC22	GCBST2	3/23/2004	40	0.08	0.28	0.64	3.20	11.20	25.60
3NC27	GCBST2	3/30/2004	48	0.17	0.35	0.48	3.84	13.44	30.72
		TOTALS:	280				77.12	69.28	133.60

Figure 7: Analysis of Number of Isolates From Monitoring Sites



3.0 MODELING APPROACH

3.1 Modeling Framework

Win HSPF was selected for use in preparation of the fecal coliform TMDLs for the Goose Creek watershed. HSPF was selected for the following reasons:

1. Mecklenburg County has constructed several tools within its WISe system to mine data for direct input to HSPF. These tools allow for the relatively rapid parameterization of basic HSPF input decks with up to date local information. Namely, the datasets include topography, land-use, land-cover and impervious area.

2. Mecklenburg County staff has significant experience preparing HSPF models as well as supervising consultant preparation of HSPF models. This experience provides and ability to cross check model parameters to other calibrated models. To date, HSPF models have been prepared for the following watersheds in Mecklenburg County:

   McDowell Creek: A HSPF model was prepared for McDowell Creek to determine the effects of runoff on downstream water quality (Tetra Tech, 2003). Modeled parameters included fecal coliform bacteria, temperature and sediment

   Sugar, Little Sugar and McAlpine Creeks: HSPF models were prepared for fecal coliform TMDL calculations in the Sugar, Little Sugar and McAlpine Creek watersheds (MCDEP, 2002). Modeled parameters included fecal coliform bacteria and temperature.

3. HSPF is a spatially distributed, lumped parameter, continuous simulation model used to model water quality conditions in watersheds and river basins. HSPF calculates non-point source loadings of selected pollutants for specified land use categories in a

watershed; represents subsequent pollutant runoff response to hydrologic influences, such as precipitation; simulates point sources as constant or variable flow and load; and simulates flow and pollutant routing through a stream network. These capabilities make it well suited to modeling a largely rural watershed where non-point sources of pollution are likely to outweigh point sources.

For the Goose Creek watershed model the following elements of the model were used:

Pervious Land:
- ATEMP – Air Temperature Elevation Difference
- SNOW – Accumulation and Melting of Snow and Ice
- PWATER – Water Budget Pervious
- SEDMNT – Production and Removal of Sediment
- PQUAL – Quality Constituents Using Simple Relationships

Impervious Land:
- ATEMP – Air Temperature Elevation Difference
- SNOW – Accumulation and Melting of Snow and Ice
- IWATER – Water Budget Impervious
- SOLIDS – Accumulation and Removal of Solids
- IQUAL – Quality Constituents Using Simple Relationships

Reaches/Reservoirs:
- HYDR – Hydraulic Behavior
- ADCALC – Advection of Fully Entrained Constituents
- HTRCH – Heat Exchange and Water Temperature
- SEDTRN – Behavior of Inorganic Sediment
- GQUAL – Generalized Quality Constituents

3.2 Model Setup

Figure 8 shows the sub-watershed delineations for the Goose Creek Watershed. Sub-watershed delineation was based upon factors such as the presence of a USGS gauging station, presence of a water quality monitoring site, presence of a NCDENR compliance point and confluence of major stream segments. Sub-watershed delineation, stream cross section geometry, slope and length were determined using Mecklenburg County's version of the Watershed Information System, which is a GIS based application that allows the manipulation of digital elevation data for modeling applications. Locally developed land use data (based upon individual land parcels) was simplified and used for model preparation. For the portion of the watershed in Mecklenburg County, 2004 land-used data generated from individual parcels was used. For the parts of the watershed in Union County, 2003 parcel data in combination with 2001 aerial photography was used. Table 9 shows the land uses applied in the TMDL model along with percent imperviousness and total area of each land use represented. Figure 9 shows the distribution of the land uses throughout the watershed. Meteorological data was adopted from Charlotte/Douglas International Airport.

Figure 8:

Goose Creek Watershed Delineations

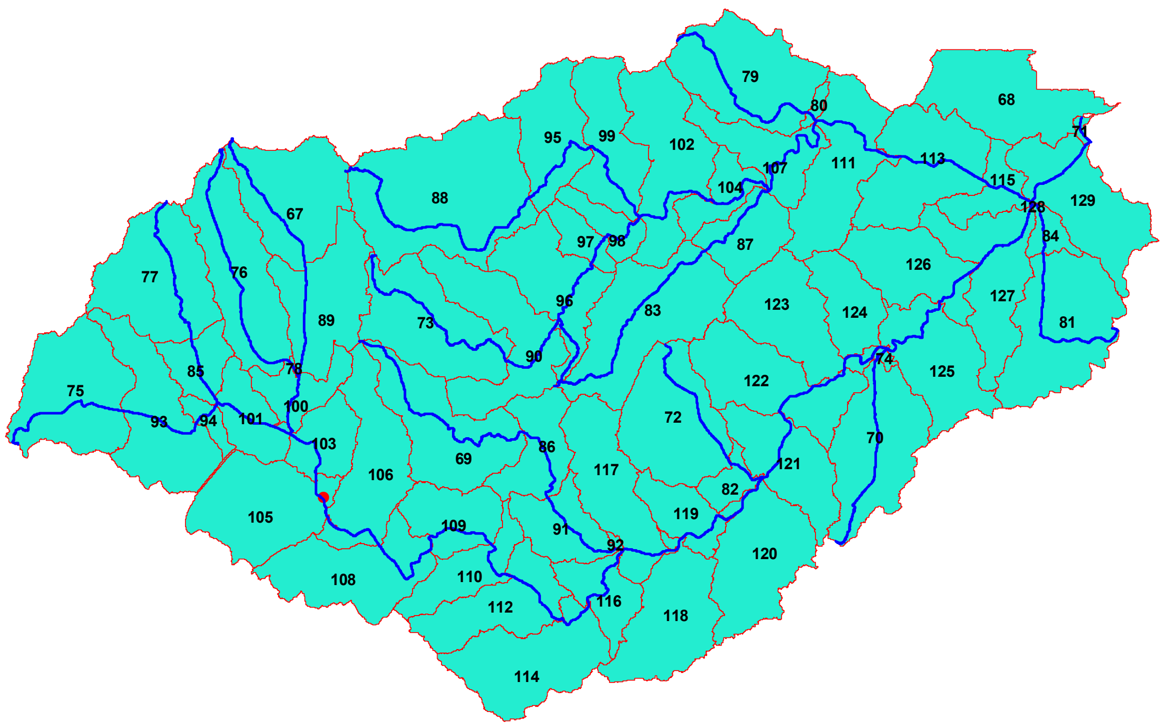
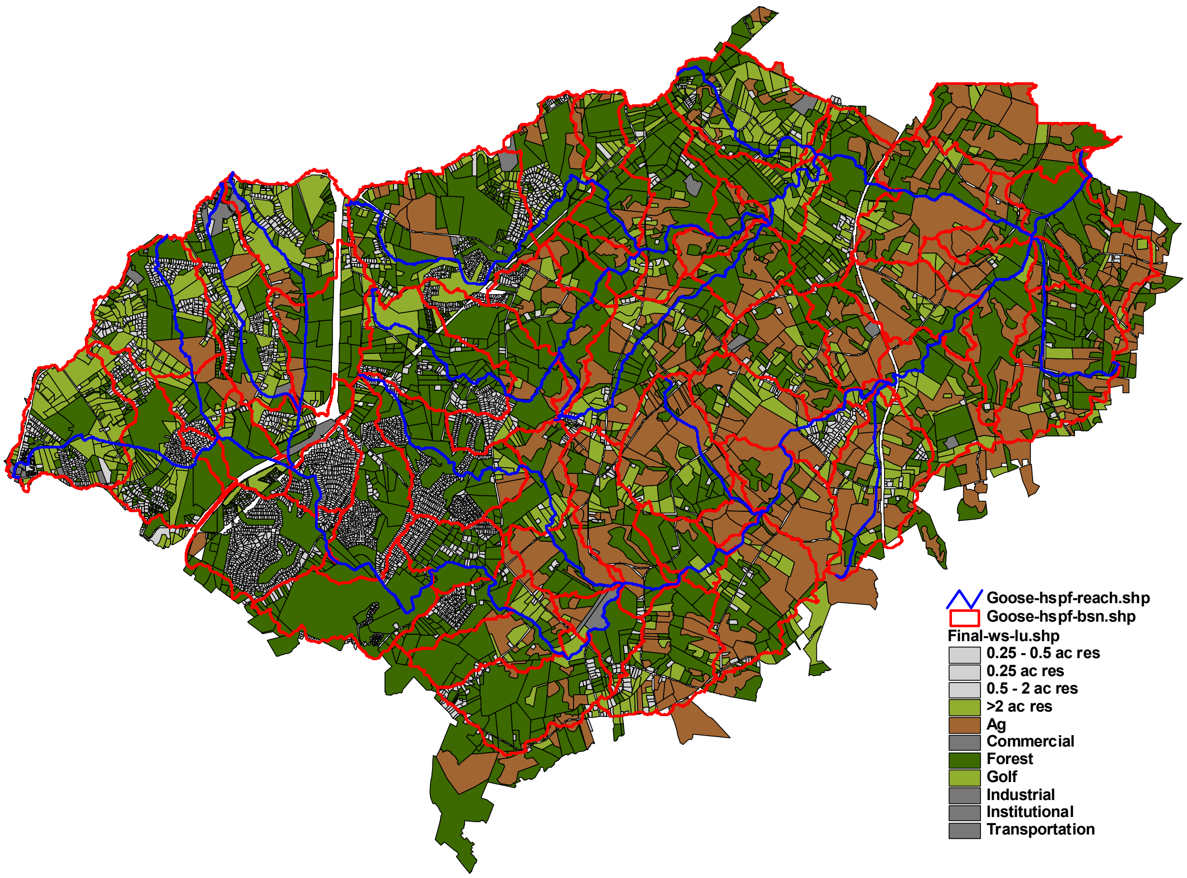


Table 9. Percent Impervious by Land-Use for TMDL Water Quality Model.

Land Use in TMDL Model	Percent Impervious	Area	Percent of Total
>2 Acre Residential	5	3945.7	14.23%
0.25 – 0.5 Acre Residential	18	957.161	3.45%
0.25 Acre Residential	30	58.431	0.21%
0.5 – 2 Acre Residential	12	1591.688	5.74%
Agricultural	2	6460.73	23.31%
Commercial	55	77.662	0.28%
Forest	2	12827.792	46.28%
Golf Course	5	289.26	1.04%
Industrial	28	113.363	0.41%
Institutional	28	67.359	0.24%
Road/Transportation	55	1330.389	4.80%

Figure 9:

Goose Creek Watershed Land Use Distribution



3.3 Fecal Coliform Source Representation

Both point and non-point sources of fecal coliform are represented in the water quality model. Certain non-point source categories are not associated with land loading processes and are represented as direct, in-stream source contributions in the model. These include failing septic systems. Land loading non-point sources are represented as indirect contributions to the stream through build-up and wash-off processes (see Section 2.2 above). The following sections describe the assumptions used for the various sources described in Section 2.0.

3.3.1 NPDES Discharges

There are 5 NPDES point source dischargers in the Goose Creek Watershed. All NPDES dischargers were represented in the model as constant (do not vary with time) sources of both flow and fecal coliform. The fecal coliform loading and discharge rate were determined from Discharge Monitoring Reports filed for each of the facilities. Long term average flow and fecal coliform concentrations were used to determine the continuous inputs for the model.

3.3.2 Land Use

Fecal coliform loading from urban areas was represented in the model as both pervious and impervious surfaces. Typically, urban loading rates are adjusted as a primary calibration parameter in the water quality model. However, for the water quality model developed for the TMDL watershed discussed in this report, loading rates were determined from a highly calibrated HSPF model prepared by Tetra Tech, Inc. for the McDowell Creek Watershed (approximately 15 miles to the Northwest). The loading values used for the Goose Creek watershed model are presented in the calibrated HSPF *.uci file included as Appendix B.

3.3.3 Failing Septic Systems

Fecal coliform loading values from failing septic systems were input to the water quality model as continuous point sources by sub-watershed. The fecal coliform loading rates are presented in Section 2.2.1 above.

3.4 Model Calibration

Calibration of a dynamic loading model involves both hydrologic and water quality components. The model must be calibrated to accurately represent hydrologic response in the watershed before reasonable water quality simulations can be performed. The hydrologic calibration involves comparison of simulated stream-flows to observed stream-flow data from stream gauging stations in the watershed. Simulated stream-flows are generated by the model using both meteorological data and the physical characteristics of the watershed. Typically, certain model parameters are altered until a reasonable match is developed between simulated and observed stream flow. Similar techniques are used to calibrate the water quality portion of the model.

Hydrologic and water quality calibration for the Goose Creek watershed model was limited from January 1, 2000 – June 1, 2004. Significant recent land-use changes occurred which would substantially impact flow and water quality; therefore, the calibration was limited to this time period.

The calibrated water quality model (*.uci file) is included as Appendix B. A condensed presentation of the hydrologic calibration data is included as Table 10 for the Goose Creek watershed. Much of the difference presented in Table 10 may be attributable to the use of a single rain gage. Table 11 presents the temperature calibration statistics for Goose Creek at SR 1524. Table 12 presents the fecal coliform calibration statistics for Goose Creek at SR 1524. Figures 10 and 11 are Cartesian and Frequency Distribution plots of the hydrologic calibration for the Goose Creek watershed model, respectively. Figure 12 is a plot of the water quality (fecal coliform) calibration for the Goose Creek Watershed (at SR 1524). Figure 13 is a plot of the simulated fecal coliform concentration presented as a 30-day geometric mean.

Table 10: Basic Hydrologic Calibration Data for Goose Creek at Hwy 601.

Flows	Goal	Simulated	Observed	Difference
Total of Highest 10% of Flows	15%	1.70E+09	1.97E+09	13.6%
Total of Lowest 50% of Flows	10%	1.10E+08	1.02E+08	7.4%
Observed Summer Flow Volume	30%	3.73E+08	3.57E+08	4.5%
Observed Fall Flow Volume	30%	2.78E+08	2.72E+08	2.3%
Observed Winter Flow Volume	30%	5.73E+08	6.69E+08	14.4%
Observed Spring Flow Volume	30%	8.45E+08	9.95E+08	7.7%
Observed Total Volume	10%	2.33E+09	2.65E+09	11.9%
Simulated Mean (cfs)	17.37			
Observed Mean (cfs)	17.95			
Simulated Range (cfs)	0.1 – 1170			
Observed Range (cfs)	0 - 1510			
Relative Error (cfs)	1.13			
Absolute Error (cfs)	11.15			
RMS Error (cfs)	39.2			
R^2 (unitless)	0.85			

Note: Goal was adopted from HSPEXP.
Note: Units in cubic feet unless noted

Table 11: Basic Temperature Calibration Data for Goose Creek at SR 1524

Simulated Mean (F)	17.37
Observed Mean (F)	17.95
Simulated Range (F)	33.4 - 83.3
Observed Range (F)	36.1 – 83.3
Relative Error (F)	0.3
Absolute Error (F)	1.69
RMS Error (F)	3.3
R^2 (unitless)	0.97
Number of values	46

Table 12: Basic Fecal Coliform Calibration Data for Goose Creek at SR 1524

Simulated Mean (cfu/100 ml)	1042
Observed Mean (cfu/100 ml)	378
Simulated Range (cfu/100 ml)	53 – 19,000
Observed Range (cfu/100 ml)	69 – 3,220
Relative Error (cfu/100 ml)	664
Absolute Error (cfu/100 ml)	880
Number of values	46
RMS Error (cfu/100 ml)	2963

Figure 10:

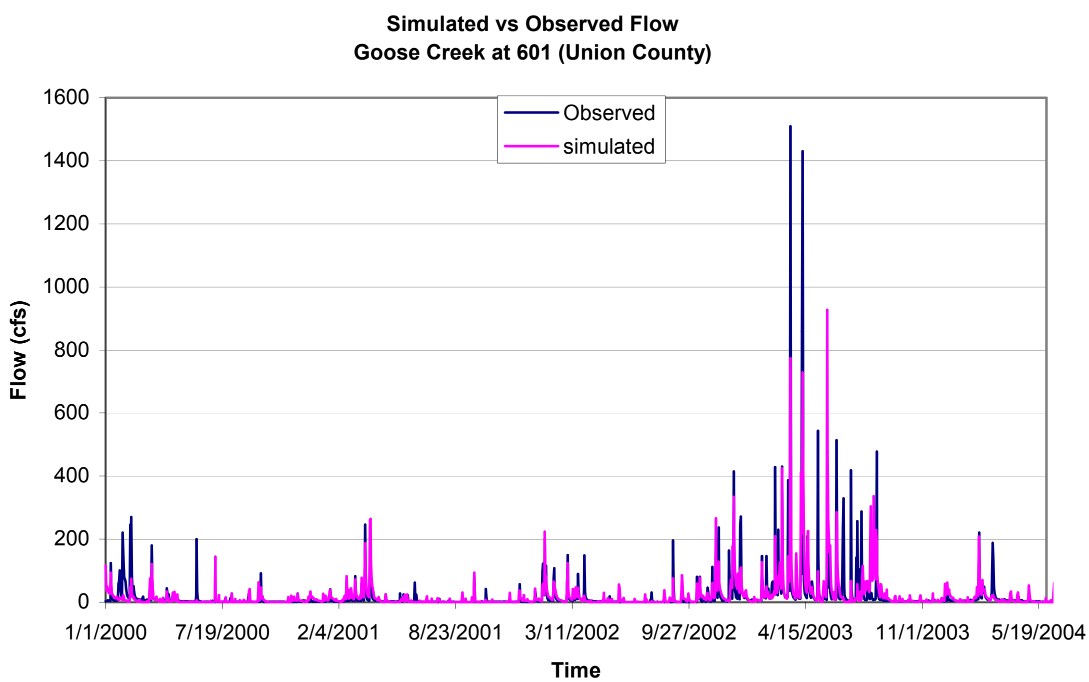


Figure 11:

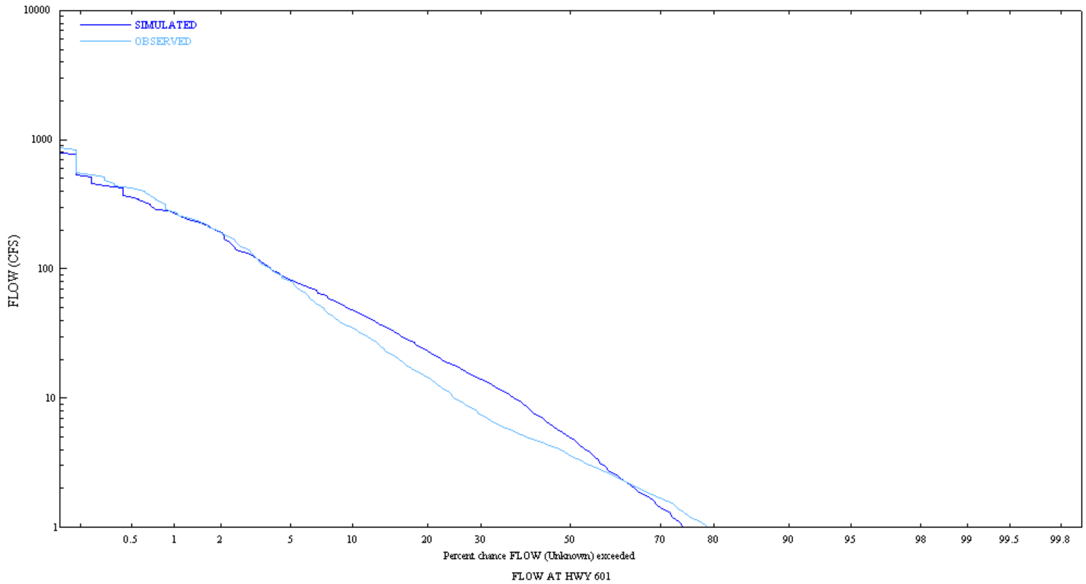
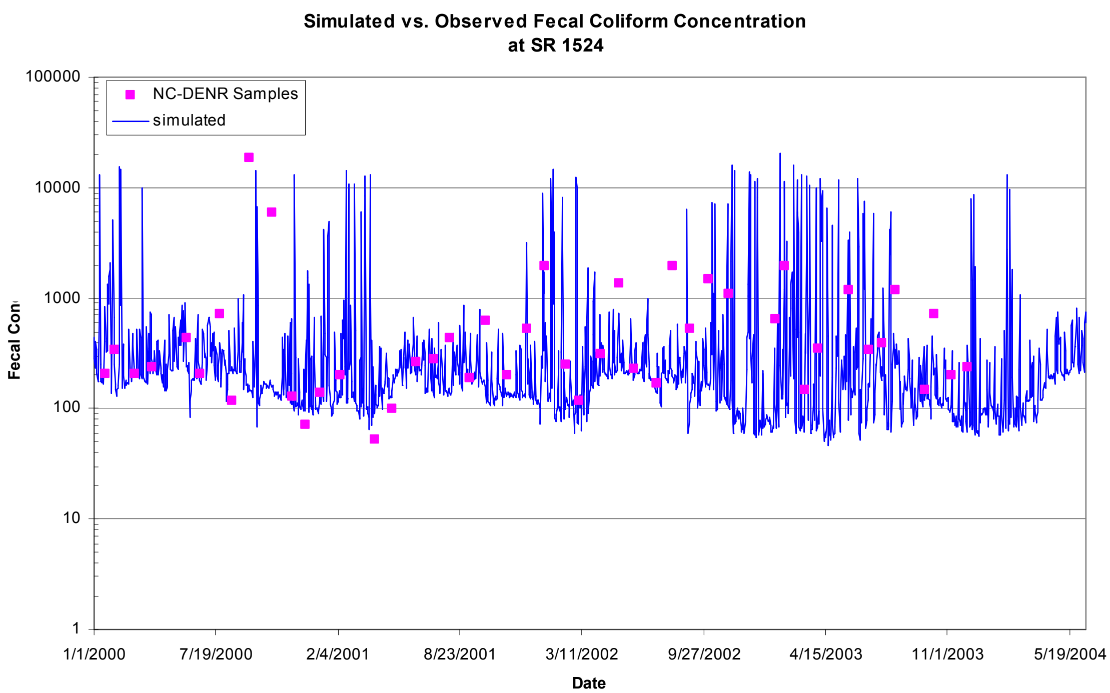


Figure 12:



In order to assess the status of the hydrologic calibration of the model the goals presented in Table 10 were adopted from HSPEXP (Lumb et. Al., 1994). Similarly, for water quality calibration, model parameters (primarily the first order decay coefficient) were adjusted until the closest match of simulated and observed concentrations were made. The closeness of the match was evaluated using the sum of the squares of the differences between simulated and observed values.

The model was evaluated by sources outside Mecklenburg County for reasonableness, completeness and basis in reality. As a result of the outside evaluation, improvements to the model were suggested and adopted.

Table 13 presents typical values for critical model parameters and values used for the Goose Creek HSPF model.

Table 13: Critical Model Parameters and Ranges

Parameter Name	Description	Typical Range	Modeled Value
Hydrology Calibration Parameters			
DEEPFR	Fraction of groundwater inflow lost to deep percolation	0 – 0.2	0.1
LZSN	Lower zone nominal storage	3.0 – 8.0	4
LZETP	Lower zone evapotranspiration parameter	0.2 – 0.7	0.4 – 0.6
SLSUR	Slope for overland flow	0.01 – 0.15	0.035
NSUR	Manning's roughness coefficient	0.15 – 0.35	0.32
LSUR	Overland flow length	200 - 500	375
INFILT	Infiltration	0.01 – 0.25	0.09
INTFW	Interflow	1.0 – 3.0	0.4
IRC	Baseflow recession parameter	0.5 - 0.7	0.3
AGWRC	Groundwater recession rate	0.92 – 0.99	0.999
Water Quality Calibration			
FSTDEC	First order decay rate for Fecal Coliform	0.00001 -	1.152
THFST	Temperature correction coefficient for first order decay of Fecal Coliform	1.0 – 2.0	1.07

Note: Typical range values for Hydrology Calibration Parameters taken from Basins Technical Note 6: Estimating Hydrology and Hydraulic Parameters for HSPF. Unites States Environmental Protection Agency – Washington D.C., EPA-823-R00-012. Water Quality Calibration typical range values are the absolute maximum and minimum allowed by Win HSPF.

3.5 Model Output

3.5.1 Current Conditions

Figure 13 presents a rolling 30-day geometric mean of predicted fecal coliform concentrations at SR 1524. Table 14 presents the relative fecal coliform loading of each of the sources accounted for in the model from 01/01/2000 thru 06/01/2004.

Figure 13:

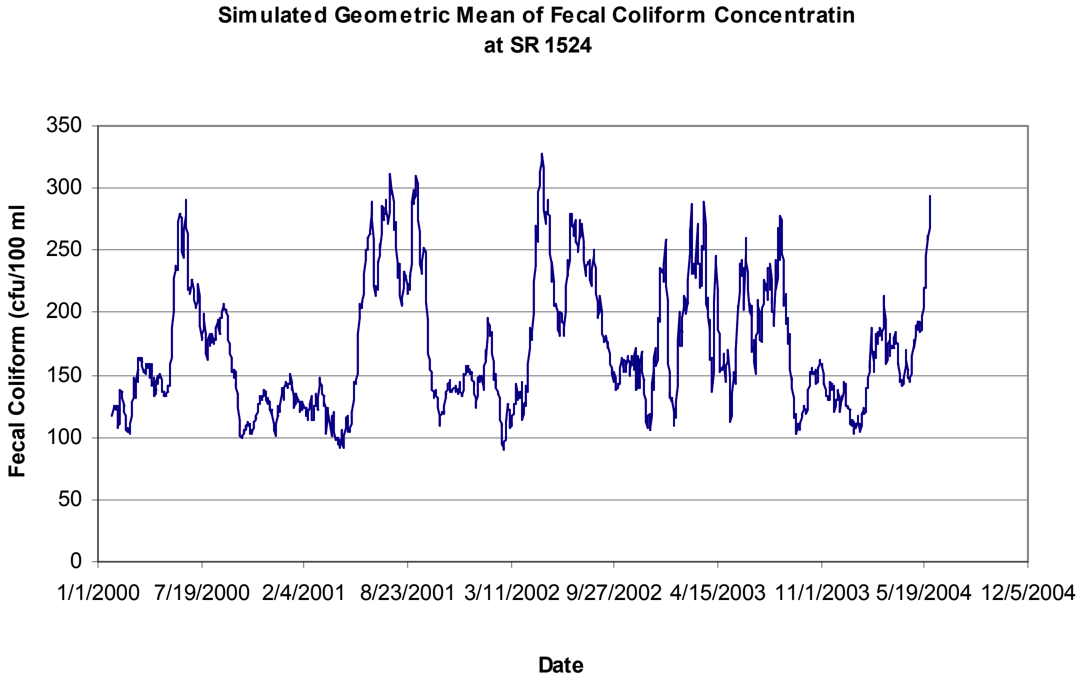


Table 14: Simulated Total Fecal Coliform Load for entire Simulation Period (01/01/2000 – 06/01/2004)

Source Category	Total Simulated Load (1×10^9 c.f.u.)	Percent of Total Load
A. Non-Point Sources (LA):	1,520,500	99.86%
B. Point Sources (WLA)	2,100	<0.14%
C. Grand Total	1,522,600	100.00%

An interpretation of the results presented in Table 14 indicates that non-point source runoff is by far the largest contributor of fecal coliform in the Goose Creek Watershed. It is critical to note, however, that as flows in Goose Creek approach 0, fecal loading from ground water, septic systems and point sources greatly impacts in-stream fecal coliform concentrations. Typically, the highest fecal coliform concentrations predicted by the WinHSPF model occurred during runoff events. However, several high concentrations of simulated fecal coliform were noted during low flow conditions. This may partially be the result of very dry conditions, particularly during the summer/fall of 2002, which caused the model to nearly "dry up." Although similar conditions are witnessed in the USGS gage history, the model tended to under-predict stream flow during extended periods without rain.

3.5.2 Critical Conditions

Results of the three and a half year long water quality simulation of the 30-day geometric mean concentration for existing conditions at SR 1524 and Goose Creek are presented in Figure 13. Critical conditions (period of maximum exceedance) for the watershed occurred on 03/06/2003, which was the result of several runoff events, which occurred in rapid succession. The date of maximum exceedance and predicted in-stream fecal concentration are presented in Table 15.

Table 15: Critical Condition for the Goose Creek Watershed

Watershed	Date of Predicted Maximum Exceedance	Value of Predicted Maximum Exceedance (30 day geomean FC Concentration [c.f.u./100 ml])
Goose Creek at SR 1524	03/06/2003	592

Table 16 presents the contribution of each of the source categories to the date of maximum exceedance listed in Table 15.

Table 16: Critical Condition Loading by Source Category (Total Loading 4/12/02 – 5/11/2002).

Source Category	**Total Simulated Load (1×10^9 c.f.u.)**	**Percent of Total Load**
A. Non-Point Sources (LA):	129,318.0	99.97%
B. Point Sources (WLA)	26.4	0.03%
C. Grand Total	129,344.4	100.00%

4.0 Allocation

4.1 Total Maximum Daily Load

The TMDL process quantifies the amount of a pollutant that can be assimilated by a water body, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations [WLAs]), non-point source loads (Load Allocations [LA]), and an appropriate margin of safety (MOS), which takes into account any lack of knowledge concerning the relationship between the effluent limitations and water quality:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR § 130.2 (I) states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measure. For fecal coliform, TMDLs are expressed as counts per 30 days to be consistent with the water quality standard. Therefore, the TMDL represents the maximum fecal coliform load that can be assimilated by the stream during the critical 30 day period while maintaining the fecal coliform water quality standard of the geometric mean of 200 c.f.u./100 ml over 30 days.

In November 2002 EPA headquarters published guidance which clarifies the regulatory requirements for establishing wasteload allocations for stormwater discharges (USEPA, 2002). In summary, this guidance states that sources which are transported to a stream via a NPDES regulated stormwater system must be considered point sources, and thus be addressed in the wasteload allocation component of a TMDL. Since Goose Creek watershed (or part of the watershed) is located in an NPDES Phase II community, pollutant loads, which are discharged to a stream reach via the stormwater conveyance system, must be considered as point sources.

The total maximum daily load of fecal coliform was determined by adding the WLA and LA. A 10% MOS was explicitly included in the TMDL analysis, functionally this made the standard 180 c.f.u./100 ml. To determine the TMDL, all permitted NPDES dischargers were modeled at permitted levels of flow and fecal coliform. These values are presented in Table 2. Model runs to determine the TMDL with NPDES dischargers at permitted levels resulted in an inability to meet the water quality standard at SR1524 during the summer of 2002. This is largely because of extreme drought conditions that existed across the North Carolina Piedmont during this time. Essentially this caused the NPDES dischargers to comprise nearly all of the flow in Goose Creek at 1524, which rendered the 180 c.f.u./100 ml (includes 10% MOS) standard to be unachievable. In order to determine the TMDL an analysis suggested by NC DENR DWQ staff to exclude the lowest flows from the TMDL analysis was performed. Unfortunately, the USGS gage in the Goose Creek Watershed (02124692) had not been in existence for the minimum 10 years to accomplish the analysis. For this reason, a nearby stream gage with a long flow history (USGS Gage #0214657975) was analyzed to determine the lowest 5% of flows at that gage. A correlation of the observed flows at USGS Gage 02124692 with the observed flows at USGS Gage 0214657975 is presented as Figure 14. The drainage area upstream of USGS Gage #0214657975 (39.6 mi^2) was compared to the drainage area upstream of SR1524 (8.69 mi^2) to determine the drainage area ratio. The drainage area ratio was then used to calculate the flow in Goose Creek that would be exceeded 95% of the time. The results of this analysis are presented in Table 17. Using the value determined from the analysis, all modeled flows at or below 0.6 c.f.s. were excluded from the TMDL analysis. The TMDL, excluding modeled flows at or below 0.6 c.f.s, is listed in Table 18.

Figure 14:

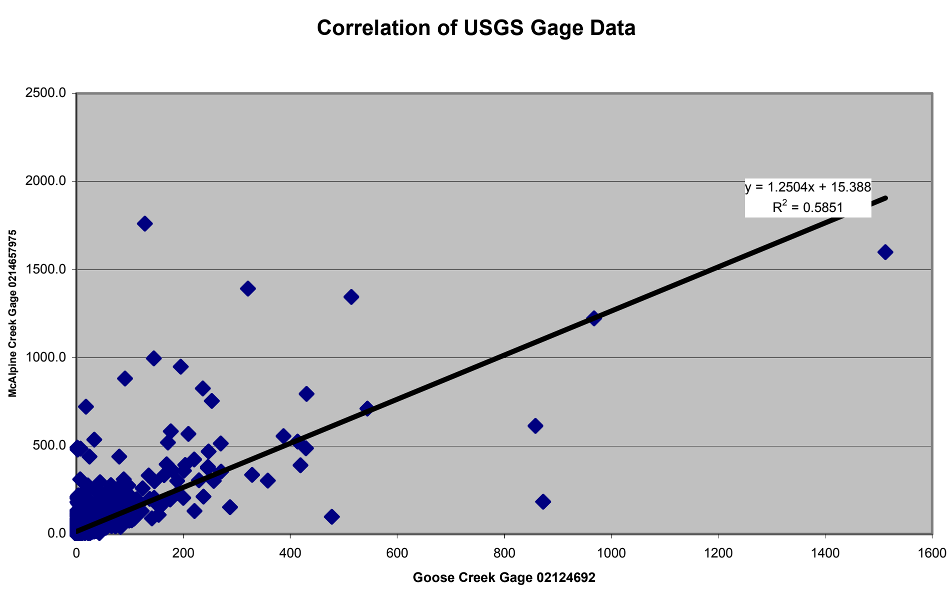


Table 17: Data used in Flow Correlation Analysis

Watershed	Drainage Area	Flow Exceeded 95% of the time
USGS Gage 0214657975 (McAlpine Creek)	39.6 mi^2	2.6 c.f.s. (observed)
Goose Creek Upstream at SR 1524	8.69 mi^2	0.6 c.f.s. (calculated)

Table 18: TMDL for Goose Creek at SR 1524

Watershed	Predicted Critical Condition	30 Day Geometric Mean during critical condition	Predicted TMDL (c.f.u./30 days)	Number of exceedances of 400/100 ml during Simulation Period (% in parentheses)
Goose Creek at SR1524	06/17/2002	177	1.58E+11	56 (3.4%)

Note: after source reduction scenario applied, critical condition shifted to 06/17/2002. All values in Table 14 reflect the shift.

In addition to the 30-day geometric mean standard, the daily model output was also evaluated for compliance with the 400/100 ml in more than 20 percent of the samples portion of the standard. For this evaluation model output (with flows excluded) was evaluated for the number of predicted in-stream concentrations in excess of 360 c.f.u./100 ml (400 c.f.u./100 ml plus a 10% MOS equates to an effective standard of 360 c.f.u./100 ml) during any 30-day period. The standard was interpreted to mean that only 6 exceedances of 400 c.f.u./100 ml during any 30 day period would be considered compliant with the standard and that 7 exceedances would be considered non compliant. The maximum number of exceedances of the 400 c.f.u./100 ml standard in model output (flows excluded) was 6. Therefore, the TMDL as presented was considered to be compliant with both parts of the standard.

4.2 Waste Load Allocations (Point Sources)

The WLA for the Goose Creek Watershed is identical to the existing Waste Load Allocation. In other words, for the TMDL current conditions should be maintained. Several of the point source dischargers discharge fecal coliform at levels much less than their permit allows. If these dischargers increase the level of fecal coliform in their effluent to permitted levels, it is likely the TMDL presented here would not be met. In addition to permitted point source dischargers, MS4 communities required to obtain a Phase II Storm Water Permit are included in the WLA. Table 19 presents the percent reductions for the MS4 areas in the Goose Creek Watershed.

Table 19: Percent Reduction for MS4 Areas to Achieve TMDL.

MS4 Designated Area	Area in Goose Creek Watershed	Percent of Watershed Area	Percent Reduction
Mint Hill	7195 ac	26%	92.5%
Hemby Bridge	298 ac	1%	92.5%
Indian Trail	855 ac	3%	92.5%
Stallings	1400 ac	5%	92.5%

4.3 Load Allocations (Non-Point Sources)

The LA for the Goose Creek Watershed is presented in Table 19. Modeling results indicate the vast majority of fecal coliform loading is from build-up and wash-off of pollutants from the land surface. Because of this, the TMDL has focused on this source. Table 20 presents the percent reductions needed from the major allocation categories to meet the TMDL requirements. Table 21 presents the TMDL components necessary to meet the water quality target. Figure 15 displays the 30 geometric mean fecal coliform concentration for the Goose Creek Watershed for both current conditions and TMDL conditions. Note that the day exhibiting the highest 30 geometric mean concentration during current conditions (with permitted dischargers discharging at permit limits) was 03/06/2003. This 30-day period was typified by higher than average flows with several runoff events. After the load reductions necessary to achieve the water quality standard were input to the model the period of maximum exceedance shifted to 07/07/2002 (30 day geometric mean value of 177), which was a period of very low flows dominated by WWTP effluent and ground water flow to the stream. The cause of the shift was the drastic reduction of NPS fecal coliform in the model to achieve the water quality standard. This drastic reduction shifted the critical condition from a 30-day period of wet weather (NPS dominated sources of fecal coliform) to a 30-day period of dry weather (WWTP dominated sources of fecal coliform).

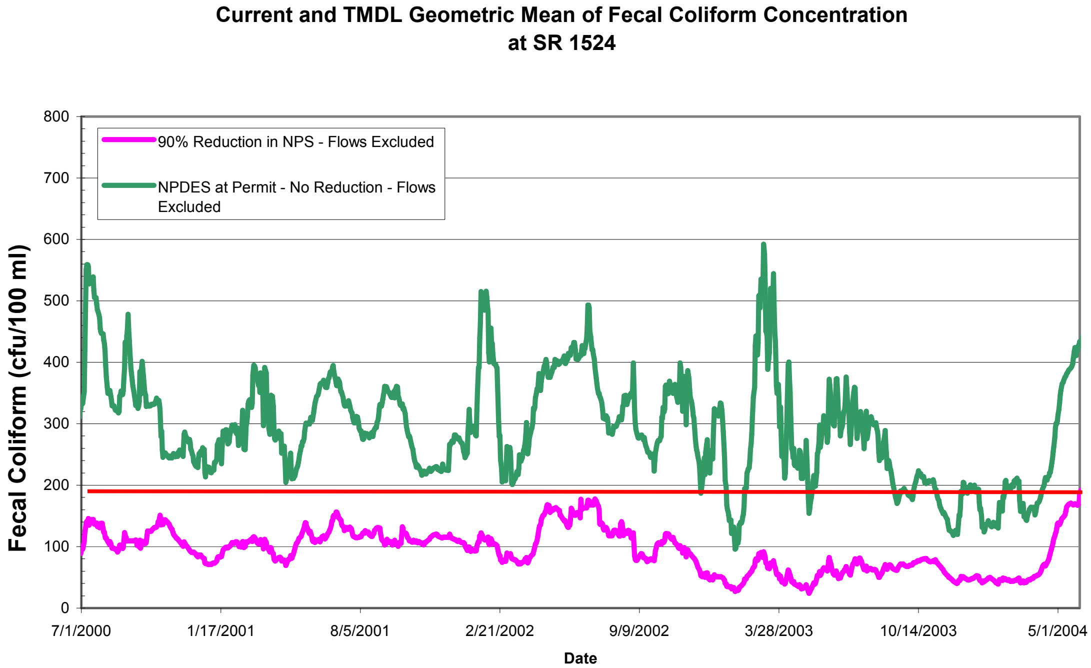
Table 20: Percent load reductions necessary to meet TMDL requirements for Goose Creek Watershed.

Source Category	Percent Reduction
MS4	92.5%
Permitted WWTPs	N/A
Nonpoint Sources	92.5%

Table 21: TMDL components to meet the water quality target.

Segment	WLA	LA	MOS	TMDL
13-17-18a	7.81×10^{12}	1.14×10^{14}	Explicit & Implicit	1.22×10^{14}
13-17-18b	2.34×10^{13}	2.06×10^{15}	Explicit & Implicit	2.08×10^{15}

Figure 15:



5.0 Implementation Plan

The TMDL analysis was performed using the best data available to specify the fecal coliform reductions necessary to achieve water quality criteria. The intent of meeting the criteria is to support the designated use classifications in the watershed. A detailed implementation plan is not included in this TMDL. The involvement of local land owners and agencies will be needed in order to develop an implementation plan. In general, reductions in fecal coliform loads should be sought through identification and installation of additional agricultural and urban BMPs to reduce loads during runoff events.

6.0 Stream Monitoring

NCDENR will continue monthly monitoring on Stevens Mill Rd. in Union County. MCWQP will continue monthly fecal coliform monitoring on Stevens Creek at Thompson Rd. and on Goose Creek at Country Woods Dr. The continued monitoring of fecal coliform will allow for the evaluation of progress towards the goal of achieving water quality standards and intended best uses. Moreover the Storm Water Management Program (SWMP) required in MS4 permits is a good means of achieving the continued and enhanced monitoring.

7.0 Future Efforts

The most prevalent sources of fecal coliform loading appear to be storm water runoff from forest, agriculture and urban land uses. Addressing the agricultural sources will require voluntary adoption of BMPs, facilitated by existing cost-share programs and educational efforts. Urban sources can be addressed by the implementation of structural BMPs. Possible increased fecal coliform levels from new development can be addressed by the adoption of post construction ordinances that require riparian buffers and Low Impact Development (LID) techniques.

8.0 Public Participation

Mecklenburg County involved an interactive stakeholder group involving individuals representing diverse community interests from the Mecklenburg and Union Counties, Charlotte Mecklenburg Utilities, Sierra Club, DENR-DWQ, University of North Carolina at Charlotte, local developers, and community members. A series of stakeholder group meetings were held to communicate and discuss TMDL development.

A draft of the TMDL was publicly noticed through various means, including notification in the Charlotte Observer on February 26th , 2005 (Appendix C-2). DWQ electronically distributed the draft TMDL and public comment information to known interested parties. The TMDL was also available from the Division of Water Quality's website at http://h2o.enr.state.nc.us/tmdl/ during the comment period. The public comment period lasted for a minimum of 30-days and ended on March 15, 2005. An article entitled, "Study of creek finds bacterial problem, is silent on solution." was published in the Charlotte Observer on March 27th, 2005 (Appendix C-3). The last stakeholder group meeting minutes are included in Appendix C-4.

9.0 References

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10.0 Appendices

Appendix A-1. Fecal coliform results from the NCDENR monitoring site located on Goose Creek at Stevens Mill Rd.

Date	FC Observation (#/100ml)
1/28/1997	6300
2/18/1997	10
3/26/1997	120
4/16/1997	450
5/20/1997	81
6/23/1997	290
7/30/1997	1600
8/26/1997	300
9/24/1997	820
10/28/1997	160
11/20/1997	27
1/5/1998	200
1/20/1998	750
2/18/1998	340
3/12/1998	81
4/27/1998	300
5/20/1998	600
6/15/1998	180
7/21/1998	2600
8/6/1998	210
9/29/1998	340
10/13/1998	73
11/5/1998	80
12/8/1998	310
1/25/1999	380
2/4/1999	230
3/4/1999	27
4/28/1999	6300
5/11/1999	1400
6/15/1999	110
7/21/1999	54
8/19/1999	170
9/8/1999	60
10/18/1999	110
11/18/1999	600
12/29/1999	60
1/19/2000	210
2/3/2000	340
3/6/2000	210
4/4/2000	240
5/30/2000	440
6/22/2000	210
7/25/2000	720

Date	FC Observation (#/100ml)
8/14/2000	120
9/11/2000	19000
10/17/2000	6000
11/20/2000	130
12/12/2000	73
1/4/2001	140
2/7/2001	200
4/5/2001	53
5/3/2001	100
6/12/2001	270
7/10/2001	280
8/6/2001	440
9/6/2001	190
10/2/2001	640
11/7/2001	200
12/10/2001	530
1/7/2002	2000
2/12/2002	250
3/6/2002	120
4/9/2002	320
5/9/2002	1400
6/4/2002	230
7/10/2002	170
8/5/2002	2000
9/3/2002	530
10/3/2002	1500
11/5/2002	1100
1/21/2003	660
2/6/2003	2000
3/10/2003	150
4/1/2003	350
5/21/2003	1200
6/23/2003	340
7/16/2003	390
8/6/2003	1200
9/24/2003	150
10/8/2003	730
11/6/2003	200
12/3/2003	240

Appendix A-2 Fecal Coliform data from WWTP effluent samples

Site	Date	Fecal Coliform (Colonies/100 ml)	Fecal Coliform (Colonies/100 ml)	Fecal Coliform (Colonies/100 ml)	Fecal Coliform (Colonies/100 ml)	Fecal Coliform (Colonies/100 ml)
		APWWTP	CWWWTP	FPWWTP	OGWWTP	HCWWTP
	6/11/2003					230
	6/18/2003					2000
	6/25/2003					5
	7/2/2003					5
	7/9/2003					5
APWWTP	7/23/2003	25			6	5
APWWTP	7/30/2003	25			50	5
APWWTP	8/6/2003	10		5	31	7300
APWWTP	8/13/2003	6		5	44	1380
APWWTP	8/20/2003	40	10	5	60	5
APWWTP	8/27/2003	10	10	5	10	5
APWWTP	9/3/2003	19	13	5	13	5
APWWTP	9/10/2003	10	6	5	5	5
APWWTP	9/17/2003	0		5		5
APWWTP	9/24/2003	10	19	5	25	5
APWWTP	10/1/2003	10	10	5	10	5
APWWTP	10/8/2003	10	10	5	20	5
APWWTP	10/15/2003	10	10	5	10	5
APWWTP	10/22/2003	10	10	5	20	5
APWWTP	10/29/2003	10	20	5	10	5
APWWTP	11/5/2003	10	6		10	
APWWTP	11/12/2003	5	10		5	
APWWTP	11/19/2003	40	960		6	
APWWTP	12/3/2003	10	1500		10	
APWWTP	12/11/2003	10	180		10	
APWWTP	12/17/2003	10	10		10	

Appendix A-3 Fecal coliform concentrations and 30 day geometric mean

Date	G1	G1 30 day geomean	G3	G3 30 day geomean	G7	G7 30 day geomean	G9	G9 30 day geomean
6/11/2003	210		1400		500		400	
6/18/2003	720		1130		860		1000	
6/25/2003	300		920		540		6700	
7/2/2003	4600	676	2600	1395	5100	1043	2800	1655
7/9/2003	590	875	580	1119	470	1027	760	1943
7/16/2003		934		1115		1090		2425
7/23/2003	640	1202	2500	1556	2900	1908	2600	1769
7/30/2003	2800	1019	10000	2438	6000	2015	11900	2865
8/6/2003	760	1108	2300	3860	2500	3517	4000	4983
8/13/2003	310	806	2700	3530	600	2260	10000	5931
8/20/2003	60	446	30	1168	60	857	90	2558
8/27/2003	140	211	420	529	190	362	150	857
9/3/2003	400	180	490	359	450	236	3700	841
9/10/2003	193	160	250	198	330	203	310	353
9/17/2003		221		372		304		556
9/24/2003	450	326	400	366	395	389	4300	1702
10/1/2003	350	312	480	363	960	500	112	530
10/8/2003	4100	864	6200	1060	380	524	38	264
10/15/2003	40	401	320	786	380	484	1000	368
10/22/2003	220	335	310	737	700	558	60	126
10/29/2003	980	434	2800	1146	4200	807	5800	339
11/5/2003	330	231	370	566	400	818	1370	831
11/12/2003	200	345	380	591	480	867	160	526
11/19/2003	2800	652	21000	1696	4600	1388	13000	2016
12/3/2003	370	511	720	1207	180	631	1200	1360
12/11/2003	2400	840	3900	2176	3200	1062	4800	1860
12/17/2003	370	979	1100	2838	220	874	560	2545

Appendix A-3 Fecal coliform concentrations and 30 day geometric mean

Date	G11	G11 30 day geomean	G12	G12 30 day geomean	G13	G13 30 day geomean
6/11/2003	210		190		200	
6/18/2003	620		460		540	
6/25/2003	220		320		390	
7/2/2003	4700	606	4600	599	8800	780
7/9/2003	310	668	410	726	370	910
7/16/2003		684		845		1083
7/23/2003	4600	1885	4100	1977	4700	2483
7/30/2003	6000	2045	6000	2161	6000	2185
8/6/2003	2250	3960	2500	3947	1700	3633
8/13/2003	5250	4249	6000	4383	6000	4118
8/20/2003	70	1492	60	1524	60	1384
8/27/2003	140	583	240	682	210	599
9/3/2003	450	390	240	379	280	381
9/10/2003	600	227	250	171	190	161
9/17/2003		336		243		224
9/24/2003	290	428	240	243	370	270
10/1/2003	88	248	250	247	210	245
10/8/2003	280	193	850	371	400	314
10/15/2003	200	194	210	322	140	257
10/22/2003	160	168	340	351	160	208
10/29/2003	5300	467	5800	770	4700	453
11/5/2003	280	467	1480	885	310	425
11/12/2003	410	559	360	1012	420	559
11/19/2003	7400	1457	14000	2565		849
12/3/2003	260	686	1200	1730	880	486
12/11/2003	3900	1324	3300	2114	3100	1046
12/17/2003	560	1432	520	2317	520	1124

Appendix A-3 Fecal coliform concentrations and 30 day geometric mean

Date	D3	D3 30 day geomean	D5	D5 30 day geomean	D8	D8 30 day geomean
6/11/2003	70		131		160	
6/18/2003	640		640		1550	
6/25/2003	194		260		194	
7/2/2003	4000	432	4000	543	3200	626
7/9/2003	120	494	380	709	730	915
7/16/2003		453		734		768
7/23/2003	2200	1018	3000	1658	6100	2424
7/30/2003	6000	1166	8600	2140	6000	2990
8/6/2003	4200	3813	3000	4262	3900	5226
8/13/2003	550	2350	2000	3527	6000	5410
8/20/2003	25	767	80	1425	110	1982
8/27/2003	250	347	600	733	150	788
9/3/2003	250	171	480	463	300	415
9/10/2003	590	174	1140	403	240	186
9/17/2003		333		690		221
9/24/2003	1040	535	450	627	390	304
10/1/2003	5	145	250	504	169	251
10/8/2003	360	123	19700	1304	260	258
10/15/2003	230	144	570	1060	130	217
10/22/2003	460	117	350	996	90	151
10/29/2003	4800	654	1700	1608	7200	385
11/5/2003	150	525	680	693	70	277
11/12/2003	100	427	240	558	2300	568
11/19/2003	1200	542	8500	1239	1500	1148
12/3/2003	640	328	130	652	210	475
12/11/2003	8200	891	3500	982	5500	1413
12/17/2003	400	1260	220	960	530	979

Appendix A-4 Goose/Stevens Creek TMDL Phase II Source Assessment Monitoring Results

Date	Site	FC Concentration (col/100 ml)
02/10/04	GT1	4600
02/17/04	GT1	2700
03/02/04	GT1	800
03/10/04	GT1	2200
02/10/04	GT2	480
02/17/04	GT2	760
03/02/04	GT2	570
03/10/04	GT2	1500
02/10/04	GC1	1100
02/17/04	GC1	1300
03/02/04	GC1	1080
03/10/04	GC1	37000
02/10/04	GC2	900
02/17/04	GC2	1300
03/02/04	GC2	1100
03/10/04	GC2	3800
02/18/04	GC3	120
03/02/04	GC3	940
03/10/04	GC3	570

Appendix B: HSPF UCI File

```
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GLOBAL
  UCI Created by WinHSPF for Exist_hyd
  START       2000/01/01 00:00  END    2004/06/15 23:00
  RUN INTERP OUTPT LEVELS    1    0
  RESUME     0 RUN     1                          UNITS      1
END GLOBAL

FILES
<FILE>  <UN#>***<----FILE NAME------------------------------------------
-------->
MESSU      24   wq-cal2.Exist_hyd.ech
           91   wq-cal2.Exist_hyd.out
WDM1       25   exist-hyd.wdm
WDM2       26   ..\..\..\BASINS\data\met_data\gooseall.wdm
BINO       92   Exist_hyd.hbn
END FILES

OPN SEQUENCE
    INGRP              INDELT 01:00
      PERLND     101
      PERLND     102
      PERLND     103
      PERLND     104
      PERLND     105
      PERLND     106
      PERLND     107
      PERLND     108
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      RCHRES      70
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      RCHRES     106
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      RCHRES     111
      RCHRES     113
      RCHRES     115
      RCHRES     129
    END INGRP
END OPN SEQUENCE

PERLND
```

```
  ACTIVITY
*** <PLS >               Active Sections
***
*** x -  x ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC
***
  101  112    1    1    1    1    0    0    1    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
*** < PLS>                       Print-flags
PIVL  PYR
*** x  - x ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC
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1    9
  END PRINT-INFO

  BINARY-INFO
*** < PLS>               Binary Output Flags
PIVL  PYR
*** x  - x ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC
  101  112    4    4    4    4    4    4    4    4    4    4    4    4
1    9
  END BINARY-INFO

  GEN-INFO
***            Name                  Unit-systems   Printer BinaryOut
*** <PLS >                              t-series Engl Metr Engl Metr
*** x -  x                               in  out
  101     >2 ac res                       1    1    0    0   92    0
  102     0.25 - 0.5 ac res               1    1    0    0   92    0
  103     0.25 ac res                     1    1    0    0   92    0
  104     0.5 - 2 ac res                  1    1    0    0   92    0
  105     Ag                              1    1    0    0   92    0
  106     Forest                          1    1    0    0   92    0
  107     Golf                            1    1    0    0   92    0
  108     Institutional                   1    1    0    0   92    0
  109     Road                            1    1    0    0   92    0
  110     Transportation                  1    1    0    0   92    0
  111     Industrial                      1    1    0    0   92    0
  112     Commercial                      1    1    0    0   92    0
  END GEN-INFO

  SNOW-PARM1
*** < PLS>       LAT     MELEV     SHADE    SNOWCF    COVIND     KMELT
TBASE
*** x  - x   degrees      (ft)                          (in)  (in/d.F)
(F)
  101  112       40.      800.       0.3       1.2       10.        0.
0.
  END SNOW-PARM1

  PWAT-PARM1
*** <PLS >                   Flags
*** x -  x CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE IFFC  HWT IRRG
  101  112    1    1    1    1    1    0    1    1    1    1    0    0
  END PWAT-PARM1
```

```
  PWAT-PARM2
*** < PLS>    FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY
AGWRC
*** x  - x                (in)   (in/hr)      (ft)             (1/in)
(1/day)
  101           0.25        4.      0.09      375.     0.035        1.
0.999
  102  104        0.        4.      0.09      375.     0.035        1.
0.999
  105  107      0.25        4.      0.09      375.     0.035        1.
0.999
  108  112        0.        4.      0.09      375.     0.035        1.
0.999
  END PWAT-PARM2

  PWAT-PARM3
*** < PLS>    PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP
AGWETP
*** x  - x   (deg F)   (deg F)
  101  112       40.       35.        2.        2.       0.1      0.15
0.01
  END PWAT-PARM3

  PWAT-PARM4
*** <PLS >     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP
*** x -  x      (in)      (in)                       (1/day)
  101           0.02       0.4      0.32       0.4       0.3       0.6
  102  104      0.02       0.4      0.32       0.4       0.3       0.4
  105  107      0.02       0.4      0.32       0.4       0.3       0.6
  108  112      0.02       0.4      0.32       0.4       0.3       0.4
  END PWAT-PARM4

  PWAT-STATE1
*** < PLS>  PWATER state variables (in)
*** x  - x      CEPS      SURS       UZS      IFWS       LZS      AGWS
GWVS
  101  112        0.        0.      0.35        0.       4.2        1.
0.
  END PWAT-STATE1

  MON-INTERCEP
*** <PLS >  Interception storage capacity at start of each month (in)
*** x -  x  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
  101       0.1  0.1  0.1  0.1  0.3  0.3  0.3  0.3  0.2  0.1  0.1  0.1
  102  104 0.15 0.15 0.15 0.15  0.3  0.3  0.3  0.3 0.12 0.15 0.15 0.15
  105  107  0.1  0.1  0.1  0.1  0.3  0.3  0.3  0.3  0.2  0.1  0.1  0.1
  108  112 0.15 0.15 0.15 0.15  0.3  0.3  0.3  0.3 0.12 0.15 0.15 0.15
  END MON-INTERCEP

  MON-UZSN
*** <PLS >  Upper zone storage at start of each month  (inches)
*** x -  x  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
  101  112 0.08 0.08 0.08 0.35 0.35 0.35 0.35 0.35 0.35 0.35  0.1 0.08
  END MON-UZSN

  MON-INTERFLW
*** <PLS >  Interflow inflow parameter for start of each month
```

```
*** x -  x  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
  101  112 0.25 0.25 0.25  0.5  1.5  1.5  1.5  1.5  1.5 0.25 0.25 0.25
  END MON-INTERFLW

  MON-IRC
*** <PLS >  Interflow recession constant at start of each month (/day)
*** x -  x  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
  101  112  0.1  0.1  0.1 0.35 0.45 0.45 0.45 0.35 0.35  0.3  0.1  0.1
  END MON-IRC

  MON-LZETPARM
*** <PLS >  Lower zone evapotransp   parm at start of each month
*** x -  x  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
  101  112 0.15 0.15  0.3  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.3 0.15
  END MON-LZETPARM

  SED-PARM2
*** <PLS >      SMPF      KRER      JRER     AFFIX     COVER      NVSI
*** x -  x                                  (/day)           lb/ac-day
  101             1.     0.552      1.81      0.06      0.25      0.45
  102  104        1.     0.552      1.81     0.001      0.25      1.75
  105  107        1.     0.552      1.81      0.06      0.25      0.45
  108  112        1.     0.552      1.81     0.001      0.25      1.75
  END SED-PARM2

  SED-PARM3
*** <PLS >  Sediment parameter 3
*** x -  x      KSER      JSER      KGER      JGER
  101  112        1.      1.25       0.1       1.5
  END SED-PARM3

  NQUALS
*** <PLS >
*** x -  xNQUAL
  101  112    1
  END NQUALS

  PQL-AD-FLAGS
***                        Atmospheric Deposition Flags
*** < PLS>  QUAL1  QUAL2  QUAL3  QUAL4  QUAL5  QUAL6  QUAL7  QUAL8
QUAL9 QUAL10
*** x  - x <F><C> <F><C> <F><C> <F><C> <F><C> <F><C> <F><C> <F><C>
<F><C> <F><C>
  101  112   0  0   0  0   0  0   0  0   0  0   0  0   0  0   0  0   0
0   0  0
  END PQL-AD-FLAGS

  QUAL-PROPS
*** <PLS >  Identifiers and Flags
*** x -  x     QUALID      QTID  QSD VPFW VPFS  QSO  VQO QIFW VIQC QAGW
VAQC
  101  112FECAL COLIFO    LBS     0    0    0    1    0    1    0    1
0
  END QUAL-PROPS

  QUAL-INPUT
***         Storage on surface and nonseasonal parameters
```

```
***            SQO   POTFW   POTFS   ACQOP  SQOLIM   WSQOP    IOQC
AOQC
*** <PLS >  qty/ac qty/ton qty/ton    qty/  qty/ac   in/hr qty/ft3
qty/ft3
*** x -  x                          ac.day
  101      1.7E+07      0.      0.   8.6e9 2.6E+10     2.5  14160.
14160.
  102  104 1.7E+07      0.      0. 5.5E+09 1.7E+10     2.5  14160.
14160.
  105      1.7E+07      0.      0. 7.6E+106.84E+11     2.5  14160.
14160.
  106      1.7E+07      0.      0. 1.2E+10 3.5E+10     2.5  14160.
14160.
  107      1.7E+07      0.      0. 1.3E+09 1.2E+10     2.5  14160.
14160.
  108  112 1.7E+07      0.      0. 2.5E+09 7.5E+09     2.5  14160.
14160.
  END QUAL-INPUT

END PERLND

IMPLND
  ACTIVITY
*** <ILS >               Active Sections
*** x -  x ATMP SNOW IWAT  SLD  IWG IQAL
  101  112    1    1    1    1    0    1
  END ACTIVITY

  PRINT-INFO
*** <ILS > ******** Print-flags ******** PIVL  PYR
*** x -  x ATMP SNOW IWAT  SLD  IWG IQAL *********
  101  112    4    4    4    4    4    4    1    9
  END PRINT-INFO

  BINARY-INFO
*** <ILS > **** Binary-Output-flags **** PIVL  PYR
*** x -  x ATMP SNOW IWAT  SLD  IWG IQAL *********
  101  112    4    4    4    4    4    4    1    9
  END BINARY-INFO

  GEN-INFO
***             Name             Unit-systems   Printer BinaryOut
*** <ILS >                           t-series Engl Metr Engl Metr
*** x -  x                            in  out
  101     >2 ac res                    1    1    0    0   92    0
  102     0.25 - 0.5 ac res            1    1    0    0   92    0
  103     0.25 ac res                  1    1    0    0   92    0
  104     0.5 - 2 ac res               1    1    0    0   92    0
  105     Ag                           1    1    0    0   92    0
  106     Forest                       1    1    0    0   92    0
  107     Golf                         1    1    0    0   92    0
  108     Institutional                1    1    0    0   92    0
  109     Road                         1    1    0    0   92    0
  110     Transportation               1    1    0    0   92    0
  111     Industrial                   1    1    0    0   92    0
  112     Commercial                   1    1    0    0   92    0
  END GEN-INFO
```

```
  SNOW-PARM1
*** < ILS>       LAT     MELEV     SHADE    SNOWCF    COVIND     KMELT
TBASE
*** x  - x   degrees      (ft)                          (in)  (in/d.F)
(F)
  101  112       40.      800.       0.3       1.2       10.        0.
32.
  END SNOW-PARM1

  IWAT-PARM1
*** <ILS >        Flags
*** x -  x CSNO RTOP  VRS  VNN RTLI
  101  112    1    0    1    0    0
  END IWAT-PARM1

  IWAT-PARM2
*** <ILS >      LSUR     SLSUR      NSUR     RETSC
*** x -  x      (ft)                          (in)
  101  110      500.    0.0027      0.05      0.05
  111           500.    0.0012      0.05      0.05
  112           500.    0.0025      0.05      0.05
  END IWAT-PARM2

  IWAT-PARM3
*** <ILS >    PETMAX    PETMIN
*** x -  x   (deg F)   (deg F)
  101  112       40.       35.
  END IWAT-PARM3

  IWAT-STATE1
*** <ILS >  IWATER state variables (inches)
*** x -  x      RETS      SURS
  101  112       0.2      0.01
  END IWAT-STATE1

  SLD-PARM2
***             KEIM      JEIM    ACCSDP    REMSDP
*** <ILS >                         tons/      /day
*** x -  x                        ac.day
  101            0.1        2.     0.014     0.085
  102           0.09        2.      0.02     0.085
  103           0.08        2.     0.028     0.085
  104           0.08        2.     0.016     0.085
  105  107       0.1        2.     0.014     0.085
  108  110      0.08        2.     0.015     0.085
  111           0.09        2.     0.028     0.085
  112           0.08        2.     0.015     0.085
  END SLD-PARM2

  NQUALS
*** <ILS >
*** x -  xNQUAL
  101  112    1
  END NQUALS

  IQL-AD-FLAGS
```

```
***                         Atmospheric Deposition Flags
*** < ILS>  QUAL1  QUAL2  QUAL3  QUAL4  QUAL5  QUAL6  QUAL7  QUAL8
QUAL9 QUAL10
*** x  - x <F><C> <F><C> <F><C> <F><C> <F><C> <F><C> <F><C> <F><C>
<F><C> <F><C>
  101  112   0  0   0  0   0  0   0  0   0  0   0  0   0  0   0  0   0
0   0  0
  END IQL-AD-FLAGS

  QUAL-PROPS
*** <ILS >    Identifiers and Flags
*** x -  x      QUALID    QTID  QSD VPFW  QSO  VQO
  101  112FECAL COLIFO            0    0    1    0
  END QUAL-PROPS

  QUAL-INPUT
***         Storage on surface and nonseasonal parameters
***            SQO   POTFW   ACQOP  SQOLIM   WSQOP
*** <ILS >  qty/ac qty/ton    qty/  qty/ac   in/hr
*** x -  x                  ac.day
  101         5E+08      0. 6.2E+07 1.9E+08     0.8
  102  103    5E+08      0. 1.9E+08 5.8E+08     0.8
  104         5E+08      0. 6.2E+07 1.9E+08     0.8
  105  106    5E+08      0. 3.2E+08 9.7E+08     0.8
  107  112    5E+08      0. 6.2E+07 1.9E+08     0.8
  END QUAL-INPUT

END IMPLND

RCHRES
  ACTIVITY
*** RCHRES  Active sections
*** x -  x HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG
   67  129    1    1    0    1    1    1    0    0    0    0
  END ACTIVITY

  PRINT-INFO
*** RCHRES  Printout level flags
*** x -  x HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR
   67  129    4    4    4    4    4    4    4    4    4    4    1    9
  END PRINT-INFO

  BINARY-INFO
*** RCHRES  Binary Output level flags
*** x -  x HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR
   67  129    4    4    4    4    4    4    4    4    4    4    1    9
  END BINARY-INFO

  GEN-INFO
***              Name        Nexits   Unit Systems   Printer
*** RCHRES                               t-series  Engl Metr LKFG
*** x -  x                                 in  out
   67     67                     1          1    1   91    0    0   92
0
   69     69                     1          1    1   91    0    0   92
0
```

70	70	1	1	1	91	0	0	92	0
71	71	1	1	1	91	0	0	92	0
72	72	1	1	1	91	0	0	92	0
73	73	1	1	1	91	0	0	92	0
74	74	1	1	1	91	0	0	92	0
75	75	1	1	1	91	0	0	92	0
76	76	1	1	1	91	0	0	92	0
77	77	1	1	1	91	0	0	92	0
78	78	1	1	1	91	0	0	92	0
79	79	1	1	1	91	0	0	92	0
80	80	1	1	1	91	0	0	92	0
81	81	1	1	1	91	0	0	92	0
82	82	1	1	1	91	0	0	92	0
83	83	1	1	1	91	0	0	92	0
84	84	1	1	1	91	0	0	92	0
85	85	1	1	1	91	0	0	92	0
86	86	1	1	1	91	0	0	92	0
87	87	1	1	1	91	0	0	92	0
88	88	1	1	1	91	0	0	92	0
89	89	1	1	1	91	0	0	92	0
90	90	1	1	1	91	0	0	92	0
91	91	1	1	1	91	0	0	92	0
92	92	1	1	1	91	0	0	92	0
93	93	1	1	1	91	0	0	92	0
94	94	1	1	1	91	0	0	92	0
95	95	1	1	1	91	0	0	92	0
96	96	1	1	1	91	0	0	92	0
97	97	1	1	1	91	0	0	92	0

98	98	1	1	1	91	0	0	92	0
99	99	1	1	1	91	0	0	92	0
100	100	1	1	1	91	0	0	92	0
101	101	1	1	1	91	0	0	92	0
102	102	1	1	1	91	0	0	92	0
103	103	1	1	1	91	0	0	92	0
104	104	1	1	1	91	0	0	92	0
105	105	1	1	1	91	0	0	92	0
106	106	1	1	1	91	0	0	92	0
107	107	1	1	1	91	0	0	92	0
108	108	1	1	1	91	0	0	92	0
109	109	1	1	1	91	0	0	92	0
110	110	1	1	1	91	0	0	92	0
111	111	1	1	1	91	0	0	92	0
112	112	1	1	1	91	0	0	92	0
113	113	1	1	1	91	0	0	92	0
114	114	1	1	1	91	0	0	92	0
115	115	1	1	1	91	0	0	92	0
116	116	1	1	1	91	0	0	92	0
117	117	1	1	1	91	0	0	92	0
118	118	1	1	1	91	0	0	92	0
119	119	1	1	1	91	0	0	92	0
120	120	1	1	1	91	0	0	92	0
121	121	1	1	1	91	0	0	92	0
122	122	1	1	1	91	0	0	92	0
123	123	1	1	1	91	0	0	92	0
124	124	1	1	1	91	0	0	92	0
125	125	1	1	1	91	0	0	92	0

```
  126     126                    1         1    1   91    0    0   92
0
  127     127                    1         1    1   91    0    0   92
0
  128     128                    1         1    1   91    0    0   92
0
  129     129                    1         1    1   91    0    0   92
0
  END GEN-INFO

  HYDR-PARM1
***         Flags for HYDR section
***RC HRES  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT
for each
*** x  - x  FG FG FG FG  possible   exit *** possible   exit
possible   exit
   67  129   0  1  1  1    4  0  0  0  0       0  0  0  0  0       1  1
1  1  1
  END HYDR-PARM1

  HYDR-PARM2
*** RCHRES FTBW FTBU        LEN      DELTH      STCOR         KS       DB50
*** x -  x              (miles)       (ft)       (ft)                  (in)
   67         0.  67.       1.7       127.        3.2        0.3       0.01
   69         0.  69.      2.55       157.        3.2        0.3       0.01
   70         0.  70.       2.1        89.        3.2        0.3       0.01
   71         0.  71.      0.29         0.        3.2        0.3       0.01
   72         0.  72.      1.56       103.        3.2        0.3       0.01
   73         0.  73.      2.34       168.        3.2        0.3       0.01
   74         0.  74.      0.15         3.        3.2        0.3       0.01
   75         0.  75.      1.53       115.        3.2        0.3       0.01
   76         0.  76.       2.7       143.        3.2        0.3       0.01
   77         0.  77.      1.69       124.        3.2        0.3       0.01
   78         0.  78.       0.2         8.        3.2        0.3       0.01
   79         0.  79.      2.03       155.        3.2        0.3       0.01
   80         0.  80.      0.13         7.        3.2        0.3       0.01
   81         0.  81.      1.82       132.        3.2        0.3       0.01
   82         0.  82.      0.43         8.        3.2        0.3       0.01
   83         0.  83.      2.45        88.        3.2        0.3       0.01
   84         0.  84.      0.56        28.        3.2        0.3       0.01
   85         0.  85.      0.71        23.        3.2        0.3       0.01
   86         0.  86.      0.89        27.        3.2        0.3       0.01
   87         0.  87.      1.01        34.        3.2        0.3       0.01
   88         0.  88.      2.86       177.        3.2        0.3       0.01
   89         0.  89.      1.07        31.        3.2        0.3       0.01
   90         0.  90.      0.85        23.        3.2        0.3       0.01
   91         0.  91.      1.05        32.        3.2        0.3       0.01
   92         0.  92.      0.02         1.        3.2        0.3       0.01
   93         0.  93.      0.88        23.        3.2        0.3       0.01
   94         0.  94.      0.31        13.        3.2        0.3       0.01
   95         0.  95.      1.05        30.        3.2        0.3       0.01
   96         0.  96.      1.74        64.        3.2        0.3       0.01
   97         0.  97.      0.35        13.        3.2        0.3       0.01
   98         0.  98.       0.5        10.        3.2        0.3       0.01
   99         0.  99.      0.97        43.        3.2        0.3       0.01
  100         0. 100.      0.66        16.        3.2        0.3       0.01
  101         0. 101.      0.84        19.        3.2        0.3       0.01
```

```
  102        0. 102.      1.08       19.        3.2        0.3       0.01
  103        0. 103.      0.71       17.        3.2        0.3       0.01
  104        0. 104.      0.76       11.        3.2        0.3       0.01
  105        0. 105.      0.54        6.        3.2        0.3       0.01
  106        0. 106.      0.56       13.        3.2        0.3       0.01
  107        0. 107.      1.37       17.        3.2        0.3       0.01
  108        0. 108.      1.05       12.        3.2        0.3       0.01
  109        0. 109.      0.72       19.        3.2        0.3       0.01
  110        0. 110.      0.55       14.        3.2        0.3       0.01
  111        0. 111.      1.08       16.        3.2        0.3       0.01
  112        0. 112.      0.77        8.        3.2        0.3       0.01
  113        0. 113.        1.       11.        3.2        0.3       0.01
  114        0. 114.       0.4        5.        3.2        0.3       0.01
  115        0. 115.       0.5        3.        3.2        0.3       0.01
  116        0. 116.      0.81        7.        3.2        0.3       0.01
  117        0. 117.       0.6        6.        3.2        0.3       0.01
  118        0. 118.      0.15        2.        3.2        0.3       0.01
  119        0. 119.      0.68        7.        3.2        0.3       0.01
  120        0. 120.      0.49        7.        3.2        0.3       0.01
  121        0. 121.      0.82        5.        3.2        0.3       0.01
  122        0. 122.       0.9        8.        3.2        0.3       0.01
  123        0. 123.      0.59        5.        3.2        0.3       0.01
  124        0. 124.       0.1        1.        3.2        0.3       0.01
  125        0. 125.      1.03       14.        3.2        0.3       0.01
  126        0. 126.       0.6        6.        3.2        0.3       0.01
  127        0. 127.      0.88        9.        3.2        0.3       0.01
  128        0. 128.      0.04        0.        3.2        0.3       0.01
  129        0. 129.      0.89        5.        3.2        0.3       0.01
  END HYDR-PARM2

  HYDR-INIT
***         Initial conditions for HYDR section
***RC HRES       VOL  CAT Initial value  of COLIND     initial  value
of OUTDGT
*** x  - x     ac-ft      for each possible   exit  for each possible
exit,ft3
   67  129        5.        4.  4.5  4.5  4.5  4.2       2.1  1.2  0.5
1.2  1.8
  END HYDR-INIT

  SED-GENPARM
*** RCHRES    BEDWID    BEDWRN       POR
*** x -  x      (ft)      (ft)
   67  129       25.       10.       0.4
  END SED-GENPARM

  SAND-PM
*** RCHRES         D         W       RHO     KSAND    EXPSND
*** x -  x      (in)  (in/sec)  (gm/cm3)
   67  129     0.014       1.5      2.65     0.005        4.
  END SAND-PM

  SILT-CLAY-PM
*** RCHRES         D         W       RHO     TAUCD     TAUCS         M
*** x -  x      (in)  (in/sec)    gm/cm3    lb/ft2    lb/ft2  lb/ft2.d
   67  129    0.0011     0.001       2.2      0.15     0.195      1.25
  END SILT-CLAY-PM
```

```
  SILT-CLAY-PM
*** RCHRES         D          W        RHO     TAUCD     TAUCS         M
*** x -  x      (in)  (in/sec)    gm/cm3    lb/ft2    lb/ft2  lb/ft2.d
   67  129  0.00001    0.0001        2.2       0.1     0.075      2.25
  END SILT-CLAY-PM

  SSED-INIT
*** RCHRES     Suspended sed concs (mg/l)
*** x -  x      Sand      Silt      Clay
   67  129        1.       10.       10.
  END SSED-INIT

  BED-INIT
*** RCHRES    BEDDEP  Initial bed composition
*** x -  x      (ft)      Sand      Silt      Clay
   67  127        8.      0.38      0.26      0.36
  128             6.      0.38      0.26      0.36
  129             8.      0.38      0.26      0.36
  END BED-INIT

  GQ-GENDATA
*** RCHRES NGQL TPFG PHFG ROFG CDFG SDFG PYFG  LAT
*** x -  x                                     deg
   67  129    1    2    2    2    2    2    2    0
  END GQ-GENDATA

  GQ-AD-FLAGS
***        Atmospheric Deposition Flags
*** RCHRES GQUAL1 GQUAL2 GQUAL3
*** x -  x <F><C> <F><C> <F><C>
   67  129   0  0   0  0   0  0
  END GQ-AD-FLAGS

  GQ-QALDATA
*** RCHRES                GQID       DQAL    CONCID      CONV     QTYID
*** x -  x                         concid
   67  129FECAL COLIFO                10.      #       0.0035  #
  END GQ-QALDATA

  GQ-QALFG
*** RCHRES HDRL OXID PHOT VOLT BIOD  GEN SDAS
*** x -  x
   67  129    0    0    0    0    0    1    0
  END GQ-QALFG

  GQ-GENDECAY
*** RCHRES    FSTDEC     THFST
*** x -  x    (/day)
   67  129     1.152      1.07
  END GQ-GENDECAY

END RCHRES

FTABLES

  FTABLE     67
```

```
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
      0.         0.        0.        0.
      1.1       5.1       0.6       3.4
      2.3       6.1       4.4      36.2
      3.4       6.9      11.6     135.1
      4.6       7.7      20.9     322.4
      5.7      14.7      36.6     619.7
      6.8      23.5      62.7    1129.5
       8.      31.3       98.    1924.7
      9.1      36.2     139.8    3033.3
      25.      40.4     4000.    50000.
 END FTABLE 67

 FTABLE     71
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
      0.         0.        0.        0.
      2.2       5.3       4.2      47.9
      4.4       5.5       13.     215.3
      6.7       5.7      23.6     522.6
      8.9       5.9      35.1     947.8
     11.1       6.1      47.4    1483.5
     13.3       6.2      60.6    2124.8
     15.5       6.4      74.5    2871.2
     17.8       6.6       89.    3724.4
      20.       6.8     104.1    4682.1
 END FTABLE 71

 FTABLE     69
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
      0.         0.        0.        0.
      0.8      20.2       2.5       9.2
      1.6      22.9      16.9     118.3
      2.3       28.      34.1     323.8
      3.1      43.2      54.5     616.8
      3.9      46.6      81.8    1006.8
      4.7      52.6      117.    1524.2
      5.4      58.3     157.1    2170.7
      6.2      64.3     202.8    2956.6
       7.      65.1     251.3    3893.5
 END FTABLE 69

 FTABLE     70
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
      0.         0.        0.        0.
      0.8       3.3       0.7       5.2
      1.6       7.6       3.3      32.8
      2.4      22.3      15.9     105.2
      3.2      30.6      34.7     249.6
       4.      48.5      65.6     506.5
```

```
      4.8      52.8     105.2      932.
      7.2      53.8     146.8     1504.2
      7.6      53.8      189.     2205.6
      20.      53.8     231.5     3023.7
 END FTABLE 70

 FTABLE     72
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      2.4      23.9      38.3     516.1
      4.7      38.5     108.1    2291.4
      7.1      57.5     227.5    5767.5
      9.5      77.1     386.2   11548.6
     11.9       84.     581.8   20054.9
     14.2      90.7     794.2   31197.9
     16.6     101.2    1024.9   44944.2
      19.     110.8    1281.2   61492.3
     21.3      131.    1564.3    80997.
 END FTABLE 72

 FTABLE     73
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
       1.       9.4       0.9        5.
       2.      23.3      11.6      70.9
       3.      31.8      36.2     290.2
       4.       38.      68.5     713.6
       5.      42.9     106.8    1340.9
       6.      47.2     149.8    2173.8
       7.      51.3     197.2    3216.2
       8.      54.9     248.7    4483.2
       9.      57.4     303.1    5975.7
 END FTABLE 73

 FTABLE     86
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      0.9       0.9       0.3       4.9
      1.8       5.1       1.9      34.9
      2.8       5.8       6.6     112.6
      3.7       7.1      12.2     241.4
      4.6      10.1      19.5     426.5
      5.5      13.5      29.9     693.8
      6.5      16.9      43.7    1068.1
      7.4      19.5      60.6    1568.3
      8.3      21.2      79.5    2220.2
 END FTABLE 86

 FTABLE     75
rows cols                               ***
  10    4
```

```
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.8       4.2       2.6      48.7
      3.7       7.2       9.6      210.
      5.5       11.       26.     600.2
      7.4      13.3      49.2    1383.9
      9.2      16.3       78.    2571.9
      11.      20.2     113.3    4229.9
     12.9      24.1     155.8    6412.5
     14.7      28.1     205.7    9176.7
     16.6      32.2     264.4   12606.7
  END FTABLE 75

  FTABLE     76
 rows cols                             ***
   10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      3.4      24.4      26.3     202.2
      6.8       59.     160.2    1699.8
     10.1      80.5     403.5    5764.1
     13.5      99.4     715.9   12813.5
     16.9     129.3    1122.8   23223.7
     20.3     150.4    1621.7    37416.
     23.7     161.4    2175.7   55441.7
      27.     175.1    2775.3   77272.8
     30.4     199.9    3448.3  103110.8
  END FTABLE 76

  FTABLE     77
 rows cols                             ***
   10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
       2.       4.2       3.7      47.9
       4.      19.6       35.     586.9
      5.9       35.     101.8    2310.1
      7.9      42.5     196.4    5675.9
      9.9      47.6     302.9   10644.4
     11.9      51.9     418.1   17140.5
     13.9      57.3     542.8   25154.6
     15.8      65.5     681.7   34784.7
     17.8       71.     833.9    46165.
  END FTABLE 77

  FTABLE     89
 rows cols                             ***
   10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
       1.       2.1       0.1       1.4
      1.9       2.5       0.9      10.5
      2.9       2.8       2.3      34.2
      3.9       3.5       4.3      73.7
      4.8       8.5       7.1     132.8
      5.8      18.6      16.7     252.1
      6.8      22.6      34.5     528.1
```

```
      7.7      24.2      56.4     967.5
      20.      26.1      500.     8500.
 END FTABLE 89

 FTABLE     79
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.2       11.        2.      22.1
      2.4      21.3      17.3     222.3
      3.6      31.6      46.8     695.3
      4.8      42.8      87.6    1485.7
       6.      45.7     136.9    2616.8
      7.2      49.2     191.3    4113.8
      8.4      51.8     249.1     5960.
      9.6      53.6     309.7    8139.5
     10.7      55.4     372.7   10650.9
 END FTABLE 79

 FTABLE     88
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.8      12.5       6.9      84.7
      3.7      23.2       44.     683.5
      5.5      32.8     101.2    2071.8
      7.4      54.9     185.1    4390.1
      9.2      67.1     301.3    7890.8
     11.1      72.2     432.6   12646.2
     12.9      76.2     574.2   18636.9
     14.8      79.9     725.2   25891.8
     16.6      83.8     885.1   34431.1
 END FTABLE 88

 FTABLE     81
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.1      12.8        1.       7.3
      2.2      16.3       11.     106.7
      3.3      23.1      27.8     353.5
      4.4      26.5      51.1     784.2
      5.5      29.4       79.    1422.5
      6.6       34.     110.9    2290.3
      7.7       39.     148.5    3404.6
      8.7      43.6     191.2    4782.3
      9.8      46.5     237.4     6439.
 END FTABLE 81

 FTABLE     91
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
```

```
      1.4       1.6        1.      22.4
      2.9       3.9       4.5      97.7
      4.3       9.2      13.8     282.2
      5.7       12.       33.     731.7
      7.2      19.5      56.7    1454.5
      8.6      21.3      85.1    2458.6
      10.      22.5      116.    3740.7
     11.5      23.7     148.7     5294.
     12.9      24.8     183.4    7123.7
  END FTABLE 91

  FTABLE     83
 rows cols                               ***
   10    4
     depth      area    volume  outflow1 ***
        0.        0.        0.        0.
       0.9       4.3       1.4       7.5
       1.8      43.1       16.      70.1
       2.8      61.5      60.9     316.7
       3.7      70.2     122.2     804.7
       4.6      76.4     190.8    1521.7
       5.5      81.7     266.2    2463.3
       6.5      87.4     348.8    3635.5
       7.4      91.6     437.5    5054.4
       8.3      115.     533.1    6717.2
  END FTABLE 83

  FTABLE     82
 rows cols                               ***
   10    4
     depth      area    volume  outflow1 ***
        0.        0.        0.        0.
       0.8       0.5       0.1       2.6
       1.6       0.6       0.5      17.3
       2.4       0.9        1.      42.3
       3.2       1.4       1.6       77.
        4.       2.2       2.6      124.
       4.8       5.3       4.6     193.9
       5.6       7.7       8.8      325.
       6.4      10.2      15.4     540.8
       7.2      10.7      23.7     863.1
  END FTABLE 82

  FTABLE     93
 rows cols                               ***
   10    4
     depth      area    volume  outflow1 ***
        0.        0.        0.        0.
       2.1       1.5        2.      40.8
       4.2       7.8      11.9     239.7
       6.3       17.      35.8     828.4
       8.5       22.      82.5    2159.4
      10.6      31.6     147.5    4440.3
      12.7      37.2     227.5    7892.5
      14.8      39.1     315.8   12507.5
      16.9       41.     408.1   18204.6
       19.      43.2     504.6   24949.8
```

```
  END FTABLE 93

  FTABLE     92
 rows cols                                     ***
   10    4
     depth      area    volume  outflow1 ***
        0.        0.        0.        0.
       0.8        0.        0.       0.2
       1.6        0.        0.       3.2
       2.4       0.1        0.      14.3
       3.2       0.1       0.1      53.6
        4.       0.2       0.2     146.8
       7.2       0.2       0.3     306.4
       7.4       0.2       0.4     529.7
       7.8       0.2       0.6     804.6
       20.       0.2       20.     3500.
  END FTABLE 92

  FTABLE     87
 rows cols                                     ***
   10    4
     depth      area    volume  outflow1 ***
        0.        0.        0.        0.
       0.9       2.4       0.5        7.
       1.8        5.       2.7      41.2
       2.8       8.2       8.3     122.3
       3.7      15.2      18.8      281.
       4.6      19.9      34.3     570.6
       5.5      21.7      52.9    1007.8
       6.4      22.9      73.2    1586.9
       7.4      23.7      94.6     2311.
       8.3      24.5     116.9    3167.6
  END FTABLE 87

  FTABLE     95
 rows cols                                     ***
   10    4
     depth      area    volume  outflow1 ***
        0.        0.        0.        0.
       2.9       8.2       5.4      91.7
       5.9      22.8      49.9     819.7
       8.8      29.8     129.3    3009.5
      11.8      38.1      233.    6832.8
      14.7      45.8     362.3   12571.9
      17.7       53.     518.6   20486.4
      20.6       59.      693.   30702.9
      23.6      66.4     888.4   43337.5
      26.5      75.1    1103.5   58549.6
  END FTABLE 95

  FTABLE     78
 rows cols                                     ***
   10    4
     depth      area    volume  outflow1 ***
        0.        0.        0.        0.
       1.2       0.6       0.1       2.7
       2.4       0.8       0.6      38.2
```

```
      3.7       0.9       1.5     124.7
      4.9       2.5       2.9     293.9
      6.1       2.9       6.1     648.7
      7.3       3.2       9.7    1190.8
      8.5       3.6      13.8     1930.
      9.7       4.1      18.5    2893.4
      11.       4.5      23.6    4084.6
 END FTABLE 78

 FTABLE    100
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      2.1       3.2       3.2      50.1
      4.2      11.3       24.     442.4
      6.3      16.9      65.5    1670.4
      8.5      24.8     125.3    3991.3
     10.6      27.1      195.     7498.
     12.7      30.1     272.3   12198.6
     14.8      32.4     355.9   18087.1
     16.9      34.9     446.5    25193.
      19.      37.5     544.5   33578.5
 END FTABLE100

 FTABLE     85
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      3.2       4.8       3.2      83.9
      6.5      17.1      35.6     983.4
      9.7      22.6     100.3    3887.6
      13.      26.5     182.6    9099.6
     16.2      29.3     274.6   16531.1
     19.4      32.5     376.3   26169.4
     22.7      35.8      488.   38096.2
     25.9      38.5     609.4   52404.4
     29.2      42.6     741.6   69185.7
 END FTABLE 85

 FTABLE     99
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.7       3.4       1.9      45.2
      3.5       8.4       10.     238.2
      5.2      11.8      25.6     683.8
       7.      23.8      60.3     1693.
      8.7      32.7     110.5    3664.7
     10.5       42.     177.2     6760.
     12.2      46.6     255.3    11059.
      14.      49.8     339.5    16516.
     15.7      54.1     429.9    23129.
 END FTABLE 99
```

```
 FTABLE     96
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      2.3        5.       4.2      46.3
      4.5      32.4       28.     341.8
      6.8      45.4     115.9    1516.9
      9.1      52.2     225.3    3812.5
     11.3      59.1     350.1    7321.2
     13.6      66.7     491.3   12114.8
     15.9      80.7     656.8   18316.6
     18.1     116.9     861.8   26140.4
     20.4     124.9    1124.8   35935.9
 END FTABLE 96

 FTABLE     97
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      0.9       0.9       0.1       3.4
      1.9        1.       0.8      31.4
      2.8       1.6       1.9      98.7
      3.8       2.4       3.6     208.2
      4.7       3.7       6.1     376.2
      5.7       4.9       10.     627.9
      6.6        7.      15.4    1001.9
      7.6       8.1      22.3     1534.
      8.5       8.4      30.2    2248.6
 END FTABLE 97

 FTABLE     98
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.2       0.9       0.2        5.
      2.4       1.2        1.      35.7
      3.6       3.1       3.5     114.9
      4.8       5.2       8.6     347.5
       6.       5.5       15.     744.2
      7.2       6.1      22.2    1285.9
      8.4       7.4      30.3    1969.6
      9.6       9.3      39.7    2806.9
     10.8      12.6      51.6    3817.3
 END FTABLE 98

 FTABLE     94
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.2       1.1       0.2       5.1
      2.5       1.3        1.      46.2
      3.7       1.4       2.4     141.4
      4.9        3.       5.4     331.6
```

```
      6.1       3.4       9.8     705.7
      7.4       4.3      15.1    1261.3
      8.6       4.7      21.3    2005.3
      9.8       6.5      28.2    2944.2
     11.1       7.5       37.    4130.3
  END FTABLE 94

  FTABLE     80
 rows cols                               ***
   10    4
     depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.3       1.5       0.2      10.4
      2.5       1.8       1.7     191.3
      3.8        2.       3.9     623.9
      5.1       2.2       6.4    1284.4
      6.4       2.4       9.2    2173.1
      7.6       2.6      12.3    3298.1
      8.9       2.9      15.8    4705.2
     10.2       3.2      19.7    6408.2
     11.4       3.3      23.8    8405.1
  END FTABLE 80

  FTABLE    101
 rows cols                               ***
   10    4
     depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      2.5       1.2       1.6      47.7
      4.9       1.5       4.4     157.9
      7.4       1.9       8.1     347.6
      9.9       4.1      15.8     659.7
     12.4       16.      26.3     1173.
     14.8      16.7      45.7    1950.7
     17.3      17.2      71.1    3087.6
     19.8      17.8      99.7    4592.7
     22.2      18.5     131.9    6494.7
  END FTABLE101

  FTABLE    103
 rows cols                               ***
   10    4
     depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.7       2.2       1.8      26.6
      3.3       3.3       6.9     168.6
       5.       4.3      15.4     468.1
      6.7       6.6      27.8     999.2
      8.3        8.      46.5    1876.1
      10.       9.2      66.7    3099.2
     11.6      10.6      88.8    4639.3
     13.3      14.9     112.8    6495.7
      15.      17.5     140.3    8693.5
  END FTABLE103

  FTABLE    105
 rows cols                               ***
```

```
   10    4
     depth       area     volume  outflow1 ***
        0.         0.         0.        0.
       1.3         1.        0.4       8.4
       2.7        1.5        1.7      40.8
        4.        2.3        3.8     100.4
       5.3        3.4         7.     192.1
       6.6        6.2       12.3     335.2
        8.        8.5       21.8      595.
       9.3        9.8       34.1    1004.6
      10.6       12.1       47.8    1564.9
      11.9       13.1       64.1    2284.4
  END FTABLE105

  FTABLE    106
 rows cols                                ***
   10    4
     depth       area     volume  outflow1 ***
        0.         0.         0.        0.
       1.5        1.6        1.5      31.1
       3.1        4.9        8.1     212.8
       4.6        5.4       20.9     742.7
       6.1        5.8       34.6    1601.6
       7.7        6.4       49.1    2742.6
       9.2        9.2       64.9    4153.1
      10.7        10.       83.1    5853.1
      12.3        12.      102.4    7835.1
      13.8       13.7       124.   10118.4
  END FTABLE106

  FTABLE    108
 rows cols                                ***
   10    4
     depth       area     volume  outflow1 ***
        0.         0.         0.        0.
       3.5        2.8        4.8      82.1
       6.9        8.2       19.7     307.7
      10.4       28.7       77.3    1115.1
      13.9        35.      188.8    3438.4
      17.4       39.6      319.5    7314.6
      20.8       47.4      469.1   12717.5
      24.3       52.7      642.5   19805.6
      27.8       58.1       832.   28626.9
      31.2       67.2     1047.8   39327.2
  END FTABLE108

  FTABLE    109
 rows cols                                ***
   10    4
     depth       area     volume  outflow1 ***
        0.         0.         0.        0.
       4.2         3.        6.2     171.2
       8.5       15.1       38.7     1467.
      12.7       24.3      118.9    5711.7
       17.       28.2      226.3   13322.6
      21.2       30.4      344.6   24135.5
      25.5       31.9      470.6   38057.1
```

```
      29.7      34.9     607.7   55246.8
       34.      36.7      755.   75980.8
      38.2      53.3     915.1  100346.9
  END FTABLE109

  FTABLE    102
 rows cols                               ***
   10    4
     depth      area    volume  outflow1 ***
        0.        0.        0.        0.
        1.       1.8       0.7       8.8
       2.1       3.2       2.8      44.1
       3.1       4.5       6.6     114.1
       4.2       5.8      12.2     230.3
       5.2       7.5      20.4     416.8
       6.2      10.8      30.2     687.4
       7.3      12.2       42.    1044.1
       8.3      17.1      56.2    1488.9
       9.4      23.2      74.8    2042.3
  END FTABLE102

  FTABLE    110
 rows cols                               ***
   10    4
     depth      area    volume  outflow1 ***
        0.        0.        0.        0.
       1.7       2.7       2.2      57.7
       3.4       4.7       7.6     261.6
       5.2       5.7       19.     737.5
       6.9       6.1      31.5    1535.1
       8.6       7.7      45.1    2600.1
      10.3       8.3      60.5    3954.5
       12.       8.8      76.8    5594.9
      13.8      10.2       94.    7504.9
      15.5      12.4     113.2    9713.3
  END FTABLE110

  FTABLE    104
 rows cols                               ***
   10    4
     depth      area    volume  outflow1 ***
        0.        0.        0.        0.
       1.1       5.5       0.5       3.2
       2.2       5.8       3.1      29.9
       3.3       6.7       7.8      100.
       4.4      15.1      17.3      238.
       5.5      19.2      34.5     520.6
       6.6      19.6      55.7     996.7
       7.7      19.7      78.1    1637.4
       8.8      19.9      101.    2425.6
       9.9      20.1     124.2    3351.2
  END FTABLE104

  FTABLE    112
 rows cols                               ***
   10    4
     depth      area    volume  outflow1 ***
```

```
       0.         0.         0.         0.
       1.        4.7        0.6        5.3
       2.        5.5        3.7       37.4
       3.        6.2        7.9        97.
       4.        6.8       13.1      184.9
       5.        7.4       19.2      302.6
       6.        10.       27.5      456.9
       7.        12.       38.7      676.1
       8.       12.9       51.7      968.4
       9.        17.       66.9     1332.4
 END FTABLE112

 FTABLE     84
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.8       3.3       2.6      75.5
      3.6      10.9      13.3     520.2
      5.3      11.8      30.8    1581.9
      7.1      12.5      50.4    3239.9
      8.9      12.9      71.1    5474.6
     10.7      13.3      92.8    8246.6
     12.4      13.6     115.4   11529.1
     14.2       14.     138.8   15335.3
      16.      14.4     163.2   19664.4
 END FTABLE 84

 FTABLE    114
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      0.9       0.9       0.3       8.8
      1.8       1.6       1.3      36.3
      2.8       1.8       2.7      82.7
      3.7        2.       4.3     145.4
      4.6       2.2       6.1     225.2
      5.5       2.5       8.1     323.3
      6.5       4.4      10.5     441.6
      7.4      16.4      17.5     622.5
      8.3      19.5      34.4     1057.
 END FTABLE114

 FTABLE    116
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      0.8        3.       0.2        2.
      1.7       3.9       1.3      12.6
      2.5       4.3       3.1      34.2
      3.3       4.7       5.6      67.6
      4.2       5.1       8.6     114.3
       5.       5.4      12.1     173.5
      5.8       6.1      16.2     246.9
      6.6      10.3      21.4     337.3
```

```
      20.      18.2      150.     2500.
  END FTABLE116

  FTABLE    117
 rows cols                               ***
   10    4
     depth      area    volume  outflow1 ***
        0.        0.        0.        0.
       1.9       1.9        2.      34.7
       3.8       7.8      12.4     178.7
       5.6      11.3      40.1     821.7
       7.5      11.7      68.7    1888.8
       9.4      11.9      98.1    3311.2
      11.3      12.3     128.6    5063.5
      13.1      16.5     161.3    7137.9
       15.      18.2     198.8    9566.1
      16.9      20.9     240.3   12377.8
  END FTABLE117

  FTABLE    118
 rows cols                               ***
   10    4
     depth      area    volume  outflow1 ***
        0.        0.        0.        0.
       0.9       0.6       0.1       6.3
       1.9       0.8       0.7      43.2
       2.8       0.8       1.3     105.9
       3.8       0.9        2.     190.5
       4.7        1.       2.8     297.5
       5.7       1.1       3.8     428.8
       6.6       4.5       4.9     585.3
       7.6       5.6       7.3     805.1
       8.5       6.5      12.6    1232.7
  END FTABLE118

  FTABLE     74
 rows cols                               ***
   10    4
     depth      area    volume  outflow1 ***
        0.        0.        0.        0.
       0.8       0.2       0.1       6.9
       1.6       0.3       0.2      21.5
       2.4       0.4       0.3      44.5
       3.2       0.4       0.6      77.5
        4.       0.6        1.     124.3
       4.8       1.2       1.7     199.1
       5.6       2.6       3.1     334.8
       6.4       2.7       5.1     556.2
       7.2        3.       7.4     856.7
  END FTABLE 74

  FTABLE    119
 rows cols                               ***
   10    4
     depth      area    volume  outflow1 ***
        0.        0.        0.        0.
       2.3       2.7       2.6      69.7
```

```
      4.5       4.9      12.9     402.6
      6.8       5.3      28.9    1280.6
       9.       5.7      45.5    2582.2
     11.3        6.      62.8    4256.5
     13.6       6.4      81.1    6275.5
     15.8      11.7      101.    8636.4
     18.1      16.1     126.2   11368.7
     20.3      21.1     157.8   14514.9
 END FTABLE119

 FTABLE    120
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.9       2.6       1.9      43.1
      3.7       3.3       6.4     191.9
      5.6       4.8      12.6     446.6
      7.4       7.2      25.2     937.9
      9.3       9.2      40.9    1778.8
     11.1       9.6      57.6    2915.8
      13.      10.1      75.6    4336.6
     14.8      10.5      94.7    6040.3
     16.7      11.9     115.6    8028.7
 END FTABLE120

 FTABLE    121
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
       2.        4.       3.4      36.7
       4.       7.8      14.4     172.1
       6.       8.4      37.5     588.2
       8.        9.      61.8    1246.5
      10.       9.7      87.5    2119.3
      12.      10.5     114.7    3191.1
      14.      13.5     143.6    4460.8
     16.1      17.4     176.1    5938.6
     18.1      19.8     214.3    7654.3
 END FTABLE121

 FTABLE    122
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.1       3.2       0.8      11.6
      2.2        4.        3.      40.5
      3.3        5.       6.2      85.8
      4.4      11.9      10.9     153.3
      5.5      15.3      23.6     292.9
      6.6      16.9      42.5     572.3
      7.7      24.3      65.8     996.5
      8.8      26.5      93.9     1572.
      10.      27.5      124.     2297.
 END FTABLE122
```

```
 FTABLE    123
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      2.3       3.9       1.3      29.6
      4.5       4.5       8.1     156.2
      6.8       6.7      23.7     587.9
      9.1        8.      45.3    1373.6
     11.4       8.5       68.    2490.2
     13.6      11.1      91.7    3898.2
     15.9      11.7     117.2    5587.4
     18.2      12.3     144.4    7564.1
     20.5      13.2     174.1    9841.4
 END FTABLE123

 FTABLE    124
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      0.8       0.1        0.       0.7
      1.6       0.2       0.1       3.8
      2.4       0.2       0.2       8.4
      3.2       0.2       0.4      14.4
       4.       0.6       0.6      21.8
      4.8       0.7        1.      32.4
      5.6       0.8       1.5      46.8
      6.4       0.9       2.1      65.9
      20.       1.1       20.    20000.
 END FTABLE124

 FTABLE    125
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.6       1.4       1.7      33.1
      3.3       2.7        5.     105.6
      4.9       4.6      11.2     232.4
      6.6       7.6      23.5     496.9
      8.2       9.9       39.      939.
      9.8      10.8      55.8    1534.5
     11.5      11.6      73.9    2273.1
     13.1      15.6      93.4    3151.6
     14.8      20.7     116.7    4176.4
 END FTABLE125

 FTABLE     90
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      0.8       1.1       0.3       4.4
      1.6       3.6       1.3      26.7
      2.4      12.3       4.8      74.8
```

```
      3.2      17.5      15.1     211.7
      4.1      21.3      30.2     480.5
      4.9      21.8      47.1     878.3
      5.7      22.1      64.4    1388.1
      6.5      22.4      82.1     2000.
      7.3      22.8     100.2    2709.1
 END FTABLE 90

 FTABLE    126
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.4       7.3       0.8       6.4
      2.8       7.7       3.6      47.9
      4.2        8.       7.6     137.9
      5.6      23.5      22.5     343.5
      7.1      24.1      63.3    1087.6
      8.5      24.8      106.    2327.1
      9.9      25.4     149.6    3979.8
     11.3      29.2     194.7    6012.4
     12.7      34.3     242.5    8421.1
 END FTABLE126

 FTABLE    127
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      2.6       2.5       3.4      53.5
      5.2       6.9       15.     251.9
      7.9      12.8      42.6      858.
     10.5      14.4      79.2    1973.9
     13.1      15.3     119.3    3534.6
     15.7      16.1     162.1    5512.4
     18.4      18.6     207.3    7898.4
      21.      19.8      256.   10694.1
     23.6      20.6     307.5    13904.
 END FTABLE127

 FTABLE    128
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      0.8       0.2        0.       1.2
      1.7       0.2       0.1       7.7
      2.5       0.2       0.2      19.2
      3.3       0.3       0.3      35.1
      4.2       0.3       0.5      55.7
       5.       0.3       0.6      81.1
      5.8       0.3       0.8     111.8
      6.7       0.3       1.1     148.8
      20.       0.5       20.     5000.
 END FTABLE128

 FTABLE    107
```

```
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.8       5.4       3.8      30.2
      3.7      12.8      19.2     165.5
      5.5      25.2      52.3     533.6
      7.3      26.2      96.3    1194.5
      9.2      27.1     144.3    2121.6
      11.      28.3     194.7    3294.9
     12.9      29.5     247.7    4712.4
     14.7      30.9     303.4    6374.5
     16.5      32.7     362.6    8285.9
 END FTABLE107

 FTABLE    111
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.4       7.3       5.4      44.1
      2.9      17.9      21.2     304.2
      4.3      20.6       45.     791.2
      5.7       25.      72.7    1495.5
      7.1      26.2     103.5    2426.5
      8.6      27.4     135.7    3561.5
      10.      27.9     169.1    4889.5
     11.4      28.3     203.2     6407.
     12.9      29.1     238.7    8115.2
 END FTABLE111

 FTABLE    113
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      1.4        1.       0.7       14.
      2.8       2.2       2.2      48.4
      4.2       5.6       6.5      118.
      5.6        7.      19.2     354.1
       7.       7.7      34.1     783.3
      8.4       8.8      49.9    1375.7
      9.8       16.      67.4     2123.
     11.2      17.6      90.4    3037.8
     12.6      21.5     116.5    4130.2
 END FTABLE113

 FTABLE    115
rows cols                               ***
  10    4
    depth      area    volume  outflow1 ***
       0.        0.        0.        0.
      2.6       0.8        1.      33.7
      5.1       4.3       4.7     137.7
      7.7        6.      21.6     633.6
     10.3       6.5      40.9    1628.2
     12.8        7.      61.3    3025.6
```

```
      15.4       9.8       83.    4797.2
       18.      10.3     106.9    6935.3
      20.5      12.4      133.    9443.8
      23.1      12.8     161.1   12329.8
  END FTABLE115

  FTABLE    129
 rows cols                               ***
   10    4
     depth      area    volume  outflow1 ***
        0.        0.        0.        0.
       0.9       6.1       0.7       3.7
       1.8       7.2        4.      26.1
       2.7       7.9       8.4      67.1
       3.6       8.8      13.9     127.3
       4.6       10.      20.9     209.7
       5.5      13.8      30.3     321.5
       6.4      15.5      43.4     477.3
       7.3      16.9      58.4     688.1
       20.      21.1      75.2     5000.
  END FTABLE129
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-
Member-> ***
<Name>   x <Name> x tem strg<-factor->strg <Name>   x   x        <Name>
x x ***
*** Met Seg GOOSE
WDM2    11 PREC     ENGL               SAME PERLND 101 112 EXTNL  PREC
WDM2    13 ATEM     ENGL               SAME PERLND 101 112 EXTNL  GATMP
WDM2    17 DEWP     ENGL               SAME PERLND 101 112 EXTNL  DTMPG
WDM2    14 WIND     ENGL               SAME PERLND 101 112 EXTNL  WINMOV
WDM2    15 SOLR     ENGL               SAME PERLND 101 112 EXTNL  SOLRAD
WDM2    16 PEVT     ENGL               SAME PERLND 101 112 EXTNL  PETINP
*** Met Seg GOOSE
WDM2    11 PREC     ENGL               SAME IMPLND 101 112 EXTNL  PREC
WDM2    13 ATEM     ENGL               SAME IMPLND 101 112 EXTNL  GATMP
WDM2    17 DEWP     ENGL               SAME IMPLND 101 112 EXTNL  DTMPG
WDM2    14 WIND     ENGL               SAME IMPLND 101 112 EXTNL  WINMOV
WDM2    15 SOLR     ENGL               SAME IMPLND 101 112 EXTNL  SOLRAD
WDM2    16 PEVT     ENGL               SAME IMPLND 101 112 EXTNL  PETINP
*** Met Seg GOOSE
WDM2    11 PREC     ENGL               SAME RCHRES  67 129 EXTNL  PREC
WDM2    13 ATEM     ENGL               SAME RCHRES  67 129 EXTNL  GATMP
WDM2    17 DEWP     ENGL               SAME RCHRES  67 129 EXTNL  DEWTMP
WDM2    14 WIND     ENGL               SAME RCHRES  67 129 EXTNL  WIND
WDM2    15 SOLR     ENGL               SAME RCHRES  67 129 EXTNL  SOLRAD
WDM2    18 CLOU     ENGL               SAME RCHRES  67 129 EXTNL  CLOUD
WDM2    12 EVAP     ENGL               SAME RCHRES  67 129 EXTNL  POTEV

WDM1  7072 FECA     ENGL               DIV  RCHRES  67     INFLOW IDQAL
WDM1  7073 FECA     ENGL               DIV  RCHRES  69     INFLOW IDQAL
WDM1  7074 FECA     ENGL               DIV  RCHRES  70     INFLOW IDQAL
WDM1  7075 FECA     ENGL               DIV  RCHRES  72     INFLOW IDQAL
WDM1  7076 FECA     ENGL               DIV  RCHRES  73     INFLOW IDQAL
WDM1  7087 FECA     ENGL               DIV  RCHRES  86     INFLOW IDQAL
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WDM1  7077 FECA     ENGL              DIV  RCHRES  75      INFLOW IDQAL
WDM1  7078 FECA     ENGL              DIV  RCHRES  76      INFLOW IDQAL
WDM1  7001 FLOW     ENGL        0.0826SAME RCHRES  76      INFLOW IVOL
WDM1  7002 FECA     ENGL              DIV  RCHRES  76      INFLOW IDQAL
WDM1  7079 FECA     ENGL              DIV  RCHRES  77      INFLOW IDQAL
WDM1  7090 FECA     ENGL              DIV  RCHRES  89      INFLOW IDQAL
WDM1  7080 FECA     ENGL              DIV  RCHRES  79      INFLOW IDQAL
WDM1  7089 FECA     ENGL              DIV  RCHRES  88      INFLOW IDQAL
WDM1  7007 FLOW     ENGL        0.0826SAME RCHRES  88      INFLOW IVOL
WDM1  7008 FECA     ENGL              DIV  RCHRES  88      INFLOW IDQAL
WDM1  7082 FECA     ENGL              DIV  RCHRES  81      INFLOW IDQAL
WDM1  7092 FECA     ENGL              DIV  RCHRES  91      INFLOW IDQAL
WDM1  7084 FECA     ENGL              DIV  RCHRES  83      INFLOW IDQAL
WDM1  7083 FECA     ENGL              DIV  RCHRES  82      INFLOW IDQAL
WDM1  7093 FECA     ENGL              DIV  RCHRES  93      INFLOW IDQAL
WDM1  7088 FECA     ENGL              DIV  RCHRES  87      INFLOW IDQAL
WDM1  7094 FECA     ENGL              DIV  RCHRES  95      INFLOW IDQAL
WDM1  7099 FECA     ENGL              DIV  RCHRES 100      INFLOW IDQAL
WDM1  7086 FECA     ENGL              DIV  RCHRES  85      INFLOW IDQAL
WDM1  7098 FECA     ENGL              DIV  RCHRES  99      INFLOW IDQAL
WDM1  7095 FECA     ENGL              DIV  RCHRES  96      INFLOW IDQAL
WDM1  7096 FECA     ENGL              DIV  RCHRES  97      INFLOW IDQAL
WDM1  7097 FECA     ENGL              DIV  RCHRES  98      INFLOW IDQAL
WDM1  7081 FECA     ENGL              DIV  RCHRES  80      INFLOW IDQAL
WDM1  7100 FECA     ENGL              DIV  RCHRES 101      INFLOW IDQAL
WDM1  7103 FECA     ENGL              DIV  RCHRES 105      INFLOW IDQAL
WDM1  7011 FLOW     ENGL        0.0826SAME RCHRES 105      INFLOW IVOL
WDM1  7012 FECA     ENGL              DIV  RCHRES 105      INFLOW IDQAL
WDM1  7104 FECA     ENGL              DIV  RCHRES 106      INFLOW IDQAL
WDM1  7003 FLOW     ENGL        0.0826SAME RCHRES 106      INFLOW IVOL
WDM1  7004 FECA     ENGL              DIV  RCHRES 106      INFLOW IDQAL
WDM1  7106 FECA     ENGL              DIV  RCHRES 108      INFLOW IDQAL
WDM1  7005 FLOW     ENGL        0.0826SAME RCHRES 108      INFLOW IVOL
WDM1  7006 FECA     ENGL              DIV  RCHRES 108      INFLOW IDQAL
WDM1  7107 FECA     ENGL              DIV  RCHRES 109      INFLOW IDQAL
WDM1  7101 FECA     ENGL              DIV  RCHRES 102      INFLOW IDQAL
WDM1  7108 FECA     ENGL              DIV  RCHRES 110      INFLOW IDQAL
WDM1  7102 FECA     ENGL              DIV  RCHRES 104      INFLOW IDQAL
WDM1  7110 FECA     ENGL              DIV  RCHRES 112      INFLOW IDQAL
WDM1  7085 FECA     ENGL              DIV  RCHRES  84      INFLOW IDQAL
WDM1  7112 FECA     ENGL              DIV  RCHRES 114      INFLOW IDQAL
WDM1  7114 FECA     ENGL              DIV  RCHRES 116      INFLOW IDQAL
WDM1  7115 FECA     ENGL              DIV  RCHRES 117      INFLOW IDQAL
WDM1  7116 FECA     ENGL              DIV  RCHRES 118      INFLOW IDQAL
WDM1  7117 FECA     ENGL              DIV  RCHRES 119      INFLOW IDQAL
WDM1  7118 FECA     ENGL              DIV  RCHRES 120      INFLOW IDQAL
WDM1  7119 FECA     ENGL              DIV  RCHRES 121      INFLOW IDQAL
WDM1  7120 FECA     ENGL              DIV  RCHRES 122      INFLOW IDQAL
WDM1  7121 FECA     ENGL              DIV  RCHRES 123      INFLOW IDQAL
WDM1  7122 FECA     ENGL              DIV  RCHRES 124      INFLOW IDQAL
WDM1  7123 FECA     ENGL              DIV  RCHRES 125      INFLOW IDQAL
WDM1  7009 FLOW     ENGL        0.0826SAME RCHRES 125      INFLOW IVOL
WDM1  7010 FECA     ENGL              DIV  RCHRES 125      INFLOW IDQAL
WDM1  7091 FECA     ENGL              DIV  RCHRES  90      INFLOW IDQAL
WDM1  7124 FECA     ENGL              DIV  RCHRES 126      INFLOW IDQAL
WDM1  7125 FECA     ENGL              DIV  RCHRES 127      INFLOW IDQAL
WDM1  7105 FECA     ENGL              DIV  RCHRES 107      INFLOW IDQAL
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WDM1  7109 FECA     ENGL              DIV  RCHRES 111     INFLOW IDQAL
WDM1  7111 FECA     ENGL              DIV  RCHRES 113     INFLOW IDQAL
WDM1  7113 FECA     ENGL              DIV  RCHRES 115     INFLOW IDQAL
WDM1  7126 FECA     ENGL              DIV  RCHRES 129     INFLOW IDQAL
END EXT SOURCES

SCHEMATIC
<-Volume->                  <--Area-->     <-Volume->  <ML#> ***
<sb>
<Name>   x                  <-factor->     <Name>   x        ***
x x
IMPLND 101                        12.9     RCHRES  67      1
PERLND 101                      245.17     RCHRES  67      2
IMPLND 102                        0.98     RCHRES  67      1
PERLND 102                        4.47     RCHRES  67      2
IMPLND 103                        0.03     RCHRES  67      1
PERLND 103                        0.07     RCHRES  67      2
IMPLND 104                        5.98     RCHRES  67      1
PERLND 104                       43.88     RCHRES  67      2
IMPLND 105                        1.21     RCHRES  67      1
PERLND 105                       59.08     RCHRES  67      2
IMPLND 112                        4.29     RCHRES  67      1
PERLND 112                        3.51     RCHRES  67      2
IMPLND 106                        3.37     RCHRES  67      1
PERLND 106                      164.97     RCHRES  67      2
IMPLND 108                        2.88     RCHRES  67      1
PERLND 108                         7.4     RCHRES  67      2
IMPLND 109                       43.65     RCHRES  67      1
PERLND 109                       35.71     RCHRES  67      2
IMPLND 110                           0     RCHRES  67      1
PERLND 110                           0     RCHRES  67      2
IMPLND 105                        0.07     RCHRES  71      1
PERLND 105                         3.6     RCHRES  71      2
IMPLND 106                        0.27     RCHRES  71      1
PERLND 106                       13.06     RCHRES  71      2
IMPLND 101                         1.4     RCHRES  69      1
PERLND 101                       26.66     RCHRES  69      2
IMPLND 102                       24.72     RCHRES  69      1
PERLND 102                      112.61     RCHRES  69      2
IMPLND 103                        0.91     RCHRES  69      1
PERLND 103                        2.12     RCHRES  69      2
IMPLND 104                        6.73     RCHRES  69      1
PERLND 104                       49.38     RCHRES  69      2
IMPLND 105                        0.76     RCHRES  69      1
PERLND 105                       37.45     RCHRES  69      2
IMPLND 106                         6.8     RCHRES  69      1
PERLND 106                      333.14     RCHRES  69      2
IMPLND 107                        0.13     RCHRES  69      1
PERLND 107                        2.53     RCHRES  69      2
IMPLND 110                        0.01     RCHRES  69      1
PERLND 110                        0.01     RCHRES  69      2
IMPLND 101                         8.1     RCHRES  70      1
PERLND 101                      153.94     RCHRES  70      2
IMPLND 102                        0.24     RCHRES  70      1
PERLND 102                         1.1     RCHRES  70      2
IMPLND 103                        0.06     RCHRES  70      1
PERLND 103                        0.14     RCHRES  70      2
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IMPLND 104	3.57	RCHRES	70	1
PERLND 104	26.19	RCHRES	70	2
IMPLND 105	5.75	RCHRES	70	1
PERLND 105	281.61	RCHRES	70	2
IMPLND 106	2.78	RCHRES	70	1
PERLND 106	135.96	RCHRES	70	2
IMPLND 109	22.64	RCHRES	70	1
PERLND 109	18.52	RCHRES	70	2
IMPLND 101	4.62	RCHRES	72	1
PERLND 101	87.71	RCHRES	72	2
IMPLND 104	1.72	RCHRES	72	1
PERLND 104	12.61	RCHRES	72	2
IMPLND 105	6.74	RCHRES	72	1
PERLND 105	330.53	RCHRES	72	2
IMPLND 106	4.08	RCHRES	72	1
PERLND 106	199.96	RCHRES	72	2
IMPLND 109	10.65	RCHRES	72	1
PERLND 109	8.72	RCHRES	72	2
IMPLND 101	3.01	RCHRES	73	1
PERLND 101	57.16	RCHRES	73	2
IMPLND 102	3.34	RCHRES	73	1
PERLND 102	15.21	RCHRES	73	2
IMPLND 103	0.2	RCHRES	73	1
PERLND 103	0.46	RCHRES	73	2
IMPLND 104	9.01	RCHRES	73	1
PERLND 104	66.05	RCHRES	73	2
IMPLND 105	0.12	RCHRES	73	1
PERLND 105	5.99	RCHRES	73	2
IMPLND 106	8.05	RCHRES	73	1
PERLND 106	394.38	RCHRES	73	2
IMPLND 107	4.07	RCHRES	73	1
PERLND 107	77.4	RCHRES	73	2
IMPLND 109	14.94	RCHRES	73	1
PERLND 109	12.22	RCHRES	73	2
IMPLND 110	0	RCHRES	73	1
PERLND 110	0	RCHRES	73	2
IMPLND 101	3.14	RCHRES	86	1
PERLND 101	59.71	RCHRES	86	2
IMPLND 102	0.19	RCHRES	86	1
PERLND 102	0.87	RCHRES	86	2
IMPLND 104	1.03	RCHRES	86	1
PERLND 104	7.58	RCHRES	86	2
IMPLND 105	1.8	RCHRES	86	1
PERLND 105	88.22	RCHRES	86	2
IMPLND 106	3.29	RCHRES	86	1
PERLND 106	160.96	RCHRES	86	2
IMPLND 109	2.55	RCHRES	86	1
PERLND 109	2.09	RCHRES	86	2
RCHRES 69		RCHRES	86	3
IMPLND 101	17.19	RCHRES	75	1
PERLND 101	326.62	RCHRES	75	2
IMPLND 102	6.86	RCHRES	75	1
PERLND 102	31.25	RCHRES	75	2
IMPLND 103	5.9	RCHRES	75	1
PERLND 103	13.76	RCHRES	75	2
IMPLND 104	5.94	RCHRES	75	1
PERLND 104	43.59	RCHRES	75	2

IMPLND	112	8.13	RCHRES	75	1
PERLND	112	6.65	RCHRES	75	2
IMPLND	106	3.49	RCHRES	75	1
PERLND	106	170.81	RCHRES	75	2
IMPLND	108	2.31	RCHRES	75	1
PERLND	108	5.93	RCHRES	75	2
IMPLND	109	28.23	RCHRES	75	1
PERLND	109	23.1	RCHRES	75	2
IMPLND	110	0.24	RCHRES	75	1
PERLND	110	0.19	RCHRES	75	2
IMPLND	101	10.04	RCHRES	76	1
PERLND	101	190.76	RCHRES	76	2
IMPLND	102	7.05	RCHRES	76	1
PERLND	102	32.12	RCHRES	76	2
IMPLND	103	0.03	RCHRES	76	1
PERLND	103	0.08	RCHRES	76	2
IMPLND	104	10.21	RCHRES	76	1
PERLND	104	74.87	RCHRES	76	2
IMPLND	105	1.14	RCHRES	76	1
PERLND	105	55.65	RCHRES	76	2
IMPLND	112	9.15	RCHRES	76	1
PERLND	112	7.49	RCHRES	76	2
IMPLND	106	4.47	RCHRES	76	1
PERLND	106	218.8	RCHRES	76	2
IMPLND	108	10.45	RCHRES	76	1
PERLND	108	26.87	RCHRES	76	2
IMPLND	109	21.99	RCHRES	76	1
PERLND	109	17.99	RCHRES	76	2
IMPLND	110	1.31	RCHRES	76	1
PERLND	110	1.07	RCHRES	76	2
IMPLND	101	11.65	RCHRES	77	1
PERLND	101	221.45	RCHRES	77	2
IMPLND	102	5.56	RCHRES	77	1
PERLND	102	25.34	RCHRES	77	2
IMPLND	103	0.13	RCHRES	77	1
PERLND	103	0.31	RCHRES	77	2
IMPLND	104	10.98	RCHRES	77	1
PERLND	104	80.56	RCHRES	77	2
IMPLND	105	1.46	RCHRES	77	1
PERLND	105	71.54	RCHRES	77	2
IMPLND	112	2.88	RCHRES	77	1
PERLND	112	2.36	RCHRES	77	2
IMPLND	106	4.32	RCHRES	77	1
PERLND	106	211.65	RCHRES	77	2
IMPLND	108	2.73	RCHRES	77	1
PERLND	108	7.01	RCHRES	77	2
IMPLND	109	23.59	RCHRES	77	1
PERLND	109	19.3	RCHRES	77	2
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PERLND	110	0	RCHRES	77	2
IMPLND	101	1.2	RCHRES	89	1
PERLND	101	22.76	RCHRES	89	2
IMPLND	102		RCHRES	89	1
PERLND	102	4.54	RCHRES	89	2
IMPLND	103	0.03	RCHRES	89	1
PERLND	103	0.06	RCHRES	89	2
IMPLND	104	1.16	RCHRES	89	1

PERLND 104	8.55	RCHRES	89	2
IMPLND 105	1.33	RCHRES	89	1
PERLND 105	65.22	RCHRES	89	2
IMPLND 106	6.91	RCHRES	89	1
PERLND 106	338.33	RCHRES	89	2
IMPLND 107	1.65	RCHRES	89	1
PERLND 107	31.35	RCHRES	89	2
IMPLND 108	0.01	RCHRES	89	1
PERLND 108	0.04	RCHRES	89	2
IMPLND 109	43.04	RCHRES	89	1
PERLND 109	35.22	RCHRES	89	2
IMPLND 110	0.01	RCHRES	89	1
PERLND 110	0.01	RCHRES	89	2
RCHRES 67		RCHRES	89	3
IMPLND 101	13.96	RCHRES	79	1
PERLND 101	265.29	RCHRES	79	2
IMPLND 102	0.31	RCHRES	79	1
PERLND 102	1.39	RCHRES	79	2
IMPLND 104	2.93	RCHRES	79	1
PERLND 104	21.5	RCHRES	79	2
IMPLND 105	1.3	RCHRES	79	1
PERLND 105	63.83	RCHRES	79	2
IMPLND 106	5.88	RCHRES	79	1
PERLND 106	287.86	RCHRES	79	2
IMPLND 111	5.2	RCHRES	79	1
PERLND 111	13.38	RCHRES	79	2
IMPLND 109	13.23	RCHRES	79	1
PERLND 109	10.83	RCHRES	79	2
IMPLND 110	0.08	RCHRES	79	1
PERLND 110	0.07	RCHRES	79	2
IMPLND 101	5.76	RCHRES	88	1
PERLND 101	109.36	RCHRES	88	2
IMPLND 102	8.06	RCHRES	88	1
PERLND 102	36.7	RCHRES	88	2
IMPLND 103	2.51	RCHRES	88	1
PERLND 103	5.85	RCHRES	88	2
IMPLND 104	9.64	RCHRES	88	1
PERLND 104	70.68	RCHRES	88	2
IMPLND 105	3.35	RCHRES	88	1
PERLND 105	164.31	RCHRES	88	2
IMPLND 112	12.62	RCHRES	88	1
PERLND 112	10.33	RCHRES	88	2
IMPLND 106	11.86	RCHRES	88	1
PERLND 106	581.13	RCHRES	88	2
IMPLND 107	3.75	RCHRES	88	1
PERLND 107	71.32	RCHRES	88	2
IMPLND 109	40.09	RCHRES	88	1
PERLND 109	32.8	RCHRES	88	2
IMPLND 110	0.6	RCHRES	88	1
PERLND 110	0.49	RCHRES	88	2
IMPLND 101	3	RCHRES	81	1
PERLND 101	56.92	RCHRES	81	2
IMPLND 104	1.94	RCHRES	81	1
PERLND 104	14.24	RCHRES	81	2
IMPLND 105	6.13	RCHRES	81	1
PERLND 105	300.26	RCHRES	81	2
IMPLND 106	7.31	RCHRES	81	1

PERLND 106	358.2	RCHRES	81	2
IMPLND 109	7.49	RCHRES	81	1
PERLND 109	6.13	RCHRES	81	2
IMPLND 101	0.63	RCHRES	91	1
PERLND 101	11.97	RCHRES	91	2
IMPLND 104	0.83	RCHRES	91	1
PERLND 104	6.11	RCHRES	91	2
IMPLND 105	2.96	RCHRES	91	1
PERLND 105	145.05	RCHRES	91	2
IMPLND 112	0.75	RCHRES	91	1
PERLND 112	0.61	RCHRES	91	2
IMPLND 106	2.61	RCHRES	91	1
PERLND 106	127.84	RCHRES	91	2
IMPLND 111	0.77	RCHRES	91	1
PERLND 111	1.98	RCHRES	91	2
IMPLND 109	3.04	RCHRES	91	1
PERLND 109	2.48	RCHRES	91	2
RCHRES 86		RCHRES	91	3
IMPLND 101	8.36	RCHRES	83	1
PERLND 101	158.77	RCHRES	83	2
IMPLND 102	0.28	RCHRES	83	1
PERLND 102	1.29	RCHRES	83	2
IMPLND 103	0.34	RCHRES	83	1
PERLND 103	0.8	RCHRES	83	2
IMPLND 104	4.2	RCHRES	83	1
PERLND 104	30.76	RCHRES	83	2
IMPLND 105	5.34	RCHRES	83	1
PERLND 105	261.89	RCHRES	83	2
IMPLND 106	6.24	RCHRES	83	1
PERLND 106	305.97	RCHRES	83	2
IMPLND 111	1.01	RCHRES	83	1
PERLND 111	2.61	RCHRES	83	2
IMPLND 109	18.3	RCHRES	83	1
PERLND 109	14.97	RCHRES	83	2
IMPLND 104	0.14	RCHRES	82	1
PERLND 104	1.04	RCHRES	82	2
IMPLND 105	1.83	RCHRES	82	1
PERLND 105	89.76	RCHRES	82	2
IMPLND 106	0.42	RCHRES	82	1
PERLND 106	20.47	RCHRES	82	2
IMPLND 109	0.15	RCHRES	82	1
PERLND 109	0.12	RCHRES	82	2
RCHRES 72		RCHRES	82	3
IMPLND 101	7.4	RCHRES	93	1
PERLND 101	140.55	RCHRES	93	2
IMPLND 102	8.01	RCHRES	93	1
PERLND 102	36.48	RCHRES	93	2
IMPLND 104	9.28	RCHRES	93	1
PERLND 104	68.03	RCHRES	93	2
IMPLND 112	0.49	RCHRES	93	1
PERLND 112	0.4	RCHRES	93	2
IMPLND 106	6.26	RCHRES	93	1
PERLND 106	306.58	RCHRES	93	2
IMPLND 109	22.01	RCHRES	93	1
PERLND 109	18.01	RCHRES	93	2
IMPLND 110	0.02	RCHRES	93	1
PERLND 110	0.02	RCHRES	93	2

RCHRES 75		RCHRES 93	3
IMPLND 105	0.17	RCHRES 92	1
PERLND 105	8.09	RCHRES 92	2
IMPLND 106	0.01	RCHRES 92	1
PERLND 106	0.3	RCHRES 92	2
RCHRES 91		RCHRES 92	3
IMPLND 101	0.67	RCHRES 87	1
PERLND 101	12.74	RCHRES 87	2
IMPLND 104	0.24	RCHRES 87	1
PERLND 104	1.74	RCHRES 87	2
IMPLND 105	2.21	RCHRES 87	1
PERLND 105	108.49	RCHRES 87	2
IMPLND 106	3.58	RCHRES 87	1
PERLND 106	175.64	RCHRES 87	2
IMPLND 109	0.09	RCHRES 87	1
PERLND 109	0.07	RCHRES 87	2
RCHRES 83		RCHRES 87	3
IMPLND 101	1.88	RCHRES 95	1
PERLND 101	35.7	RCHRES 95	2
IMPLND 102	0.83	RCHRES 95	1
PERLND 102	3.79	RCHRES 95	2
IMPLND 104	7.63	RCHRES 95	1
PERLND 104	55.96	RCHRES 95	2
IMPLND 105	1.01	RCHRES 95	1
PERLND 105	49.63	RCHRES 95	2
IMPLND 112	3.46	RCHRES 95	1
PERLND 112	2.83	RCHRES 95	2
IMPLND 106	4.91	RCHRES 95	1
PERLND 106	240.53	RCHRES 95	2
IMPLND 107	0.25	RCHRES 95	1
PERLND 107	4.83	RCHRES 95	2
IMPLND 109	12.86	RCHRES 95	1
PERLND 109	10.52	RCHRES 95	2
IMPLND 110	0.85	RCHRES 95	1
PERLND 110	0.7	RCHRES 95	2
RCHRES 88		RCHRES 95	3
IMPLND 106	0.06	RCHRES 78	1
PERLND 106	2.84	RCHRES 78	2
IMPLND 108	0.49	RCHRES 78	1
PERLND 108	1.25	RCHRES 78	2
IMPLND 109	0.02	RCHRES 78	1
PERLND 109	0.01	RCHRES 78	2
IMPLND 110	0	RCHRES 78	1
PERLND 110	0	RCHRES 78	2
RCHRES 76		RCHRES 78	3
IMPLND 101	2.17	RCHRES 100	1
PERLND 101	41.3	RCHRES 100	2
IMPLND 102	0.5	RCHRES 100	1
PERLND 102	2.28	RCHRES 100	2
IMPLND 104	3.55	RCHRES 100	1
PERLND 104	26.03	RCHRES 100	2
IMPLND 106	1.57	RCHRES 100	1
PERLND 106	76.67	RCHRES 100	2
IMPLND 107	0.21	RCHRES 100	1
PERLND 107	3.95	RCHRES 100	2
IMPLND 108	0	RCHRES 100	1
PERLND 108	0	RCHRES 100	2

IMPLND	109	19.73	RCHRES 100	1
PERLND	109	16.15	RCHRES 100	2
IMPLND	110	16.18	RCHRES 100	1
PERLND	110	13.24	RCHRES 100	2
RCHRES	89		RCHRES 100	3
RCHRES	78		RCHRES 100	3
IMPLND	101	2.35	RCHRES 85	1
PERLND	101	44.7	RCHRES 85	2
IMPLND	102	0.79	RCHRES 85	1
PERLND	102	3.58	RCHRES 85	2
IMPLND	104	1.94	RCHRES 85	1
PERLND	104	14.2	RCHRES 85	2
IMPLND	105	0.79	RCHRES 85	1
PERLND	105	38.84	RCHRES 85	2
IMPLND	106	1.85	RCHRES 85	1
PERLND	106	90.42	RCHRES 85	2
IMPLND	109	5.06	RCHRES 85	1
PERLND	109	4.14	RCHRES 85	2
IMPLND	110	0	RCHRES 85	1
PERLND	110	0	RCHRES 85	2
RCHRES	77		RCHRES 85	3
IMPLND	101	2.99	RCHRES 99	1
PERLND	101	56.9	RCHRES 99	2
IMPLND	104	0.74	RCHRES 99	1
PERLND	104	5.46	RCHRES 99	2
IMPLND	105	1.25	RCHRES 99	1
PERLND	105	61.15	RCHRES 99	2
IMPLND	106	6.32	RCHRES 99	1
PERLND	106	309.89	RCHRES 99	2
IMPLND	109	8.01	RCHRES 99	1
PERLND	109	6.55	RCHRES 99	2
IMPLND	110	0.07	RCHRES 99	1
PERLND	110	0.05	RCHRES 99	2
RCHRES	95		RCHRES 99	3
IMPLND	101	2.48	RCHRES 96	1
PERLND	101	47.21	RCHRES 96	2
IMPLND	102	3.07	RCHRES 96	1
PERLND	102	13.98	RCHRES 96	2
IMPLND	103	0.27	RCHRES 96	1
PERLND	103	0.62	RCHRES 96	2
IMPLND	104	2.19	RCHRES 96	1
PERLND	104	16.06	RCHRES 96	2
IMPLND	105	2.74	RCHRES 96	1
PERLND	105	134.34	RCHRES 96	2
IMPLND	106	4.7	RCHRES 96	1
PERLND	106	230.26	RCHRES 96	2
IMPLND	107	0.24	RCHRES 96	1
PERLND	107	4.63	RCHRES 96	2
IMPLND	109	10.88	RCHRES 96	1
PERLND	109	8.9	RCHRES 96	2
IMPLND	101	0.69	RCHRES 97	1
PERLND	101	13.16	RCHRES 97	2
IMPLND	104	0.04	RCHRES 97	1
PERLND	104	0.29	RCHRES 97	2
IMPLND	105	0.36	RCHRES 97	1
PERLND	105	17.76	RCHRES 97	2
IMPLND	106	2.06	RCHRES 97	1

PERLND 106	100.73	RCHRES	97	2
IMPLND 109	1.32	RCHRES	97	1
PERLND 109	1.08	RCHRES	97	2
RCHRES 96		RCHRES	97	3
IMPLND 101	0.58	RCHRES	98	1
PERLND 101	11.04	RCHRES	98	2
IMPLND 104	0.44	RCHRES	98	1
PERLND 104	3.22	RCHRES	98	2
IMPLND 105	0.51	RCHRES	98	1
PERLND 105	25.19	RCHRES	98	2
IMPLND 106	2.28	RCHRES	98	1
PERLND 106	111.47	RCHRES	98	2
RCHRES 97		RCHRES	98	3
IMPLND 101	0	RCHRES	94	1
PERLND 101	0.04	RCHRES	94	2
IMPLND 102	1.72	RCHRES	94	1
PERLND 102	7.83	RCHRES	94	2
IMPLND 104	2.08	RCHRES	94	1
PERLND 104	15.22	RCHRES	94	2
IMPLND 106	0.85	RCHRES	94	1
PERLND 106	41.61	RCHRES	94	2
IMPLND 109	4.32	RCHRES	94	1
PERLND 109	3.54	RCHRES	94	2
RCHRES 93		RCHRES	94	3
IMPLND 101	0.61	RCHRES	80	1
PERLND 101	11.51	RCHRES	80	2
IMPLND 106	0.37	RCHRES	80	1
PERLND 106	17.93	RCHRES	80	2
IMPLND 109	0.78	RCHRES	80	1
PERLND 109	0.64	RCHRES	80	2
RCHRES 79		RCHRES	80	3
IMPLND 101	1.17	RCHRES	101	1
PERLND 101	22.27	RCHRES	101	2
IMPLND 102	1.85	RCHRES	101	1
PERLND 102	8.44	RCHRES	101	2
IMPLND 103	0.18	RCHRES	101	1
PERLND 103	0.42	RCHRES	101	2
IMPLND 104	0.88	RCHRES	101	1
PERLND 104	6.46	RCHRES	101	2
IMPLND 105	0.17	RCHRES	101	1
PERLND 105	8.55	RCHRES	101	2
IMPLND 106	3.06	RCHRES	101	1
PERLND 106	149.97	RCHRES	101	2
IMPLND 107	1.33	RCHRES	101	1
PERLND 107	25.27	RCHRES	101	2
IMPLND 109	17.91	RCHRES	101	1
PERLND 109	14.65	RCHRES	101	2
IMPLND 110	0.12	RCHRES	101	1
PERLND 110	0.09	RCHRES	101	2
RCHRES 85		RCHRES	101	3
RCHRES 94		RCHRES	101	3
IMPLND 101	0.05	RCHRES	103	1
PERLND 101	0.95	RCHRES	103	2
IMPLND 102	17.58	RCHRES	103	1
PERLND 102	80.1	RCHRES	103	2
IMPLND 103	0.33	RCHRES	103	1
PERLND 103	0.78	RCHRES	103	2

IMPLND 104	9.51	RCHRES 103	1
PERLND 104	69.71	RCHRES 103	2
IMPLND 106	0.69	RCHRES 103	1
PERLND 106	33.59	RCHRES 103	2
IMPLND 107	0.23	RCHRES 103	1
PERLND 107	4.41	RCHRES 103	2
IMPLND 109	18.17	RCHRES 103	1
PERLND 109	14.87	RCHRES 103	2
IMPLND 110	0.28	RCHRES 103	1
PERLND 110	0.23	RCHRES 103	2
RCHRES 100		RCHRES 103	3
RCHRES 101		RCHRES 103	3
IMPLND 101	0.05	RCHRES 105	1
PERLND 101	0.93	RCHRES 105	2
IMPLND 105	0.29	RCHRES 105	1
PERLND 105	14.42	RCHRES 105	2
IMPLND 106	5.14	RCHRES 105	1
PERLND 106	252.12	RCHRES 105	2
IMPLND 107	0.5	RCHRES 105	1
PERLND 107	9.52	RCHRES 105	2
IMPLND 109	46.94	RCHRES 105	1
PERLND 109	38.4	RCHRES 105	2
IMPLND 110	0.05	RCHRES 105	1
PERLND 110	0.04	RCHRES 105	2
RCHRES 103		RCHRES 105	3
IMPLND 101	0.5	RCHRES 106	1
PERLND 101	9.59	RCHRES 106	2
IMPLND 102	18.45	RCHRES 106	1
PERLND 102	84.04	RCHRES 106	2
IMPLND 103	1.13	RCHRES 106	1
PERLND 103	2.64	RCHRES 106	2
IMPLND 104	7.39	RCHRES 106	1
PERLND 104	54.17	RCHRES 106	2
IMPLND 106	7.1	RCHRES 106	1
PERLND 106	348.08	RCHRES 106	2
IMPLND 107	0.23	RCHRES 106	1
PERLND 107	4.45	RCHRES 106	2
IMPLND 109	19.09	RCHRES 106	1
PERLND 109	15.62	RCHRES 106	2
IMPLND 110	0.26	RCHRES 106	1
PERLND 110	0.21	RCHRES 106	2
RCHRES 105		RCHRES 106	3
IMPLND 102	3.35	RCHRES 108	1
PERLND 102	15.27	RCHRES 108	2
IMPLND 103	3.92	RCHRES 108	1
PERLND 103	9.16	RCHRES 108	2
IMPLND 104	2.86	RCHRES 108	1
PERLND 104	21	RCHRES 108	2
IMPLND 106	10.67	RCHRES 108	1
PERLND 106	522.88	RCHRES 108	2
IMPLND 109	8.25	RCHRES 108	1
PERLND 109	6.75	RCHRES 108	2
RCHRES 106		RCHRES 108	3
IMPLND 102	7.26	RCHRES 109	1
PERLND 102	33.06	RCHRES 109	2
IMPLND 103	0.08	RCHRES 109	1
PERLND 103	0.2	RCHRES 109	2

IMPLND 104	5.55	RCHRES 109	1
PERLND 104	40.74	RCHRES 109	2
IMPLND 106	4.21	RCHRES 109	1
PERLND 106	206.38	RCHRES 109	2
IMPLND 109	13.12	RCHRES 109	1
PERLND 109	10.74	RCHRES 109	2
RCHRES 108		RCHRES 109	3
IMPLND 101	3.07	RCHRES 102	1
PERLND 101	58.29	RCHRES 102	2
IMPLND 103	0.03	RCHRES 102	1
PERLND 103	0.07	RCHRES 102	2
IMPLND 104	3.12	RCHRES 102	1
PERLND 104	22.86	RCHRES 102	2
IMPLND 105	1.86	RCHRES 102	1
PERLND 105	91.2	RCHRES 102	2
IMPLND 106	8.48	RCHRES 102	1
PERLND 106	415.46	RCHRES 102	2
IMPLND 111	4.08	RCHRES 102	1
PERLND 111	10.48	RCHRES 102	2
IMPLND 109	10.35	RCHRES 102	1
PERLND 109	8.47	RCHRES 102	2
IMPLND 110	0.07	RCHRES 102	1
PERLND 110	0.06	RCHRES 102	2
RCHRES 99		RCHRES 102	3
RCHRES 98		RCHRES 102	3
IMPLND 101	0.02	RCHRES 110	1
PERLND 101	0.36	RCHRES 110	2
IMPLND 102	6.65	RCHRES 110	1
PERLND 102	30.28	RCHRES 110	2
IMPLND 104	3	RCHRES 110	1
PERLND 104	22.02	RCHRES 110	2
IMPLND 105	0.59	RCHRES 110	1
PERLND 105	28.84	RCHRES 110	2
IMPLND 106	3.73	RCHRES 110	1
PERLND 106	182.78	RCHRES 110	2
IMPLND 109	8.71	RCHRES 110	1
PERLND 109	7.13	RCHRES 110	2
RCHRES 109		RCHRES 110	3
IMPLND 101	0.05	RCHRES 104	1
PERLND 101	0.94	RCHRES 104	2
IMPLND 105	1.66	RCHRES 104	1
PERLND 105	81.41	RCHRES 104	2
IMPLND 106	2.47	RCHRES 104	1
PERLND 106	121.22	RCHRES 104	2
RCHRES 102		RCHRES 104	3
IMPLND 101	4.08	RCHRES 112	1
PERLND 101	77.47	RCHRES 112	2
IMPLND 102	0.03	RCHRES 112	1
PERLND 102	0.11	RCHRES 112	2
IMPLND 103	0.02	RCHRES 112	1
PERLND 103	0.04	RCHRES 112	2
IMPLND 104	1.46	RCHRES 112	1
PERLND 104	10.7	RCHRES 112	2
IMPLND 105	1.9	RCHRES 112	1
PERLND 105	93.05	RCHRES 112	2
IMPLND 106	5.41	RCHRES 112	1
PERLND 106	265.08	RCHRES 112	2

IMPLND 109	5.26	RCHRES 112	1
PERLND 109	4.3	RCHRES 112	2
RCHRES 110		RCHRES 112	3
IMPLND 101	0.27	RCHRES 84	1
PERLND 101	5.2	RCHRES 84	2
IMPLND 105	0.48	RCHRES 84	1
PERLND 105	23.34	RCHRES 84	2
IMPLND 106	1.26	RCHRES 84	1
PERLND 106	61.54	RCHRES 84	2
IMPLND 109	1.92	RCHRES 84	1
PERLND 109	1.57	RCHRES 84	2
RCHRES 81		RCHRES 84	3
IMPLND 101	2.98	RCHRES 114	1
PERLND 101	56.69	RCHRES 114	2
IMPLND 102	0.3	RCHRES 114	1
PERLND 102	1.37	RCHRES 114	2
IMPLND 103	0.02	RCHRES 114	1
PERLND 103	0.04	RCHRES 114	2
IMPLND 104	5.37	RCHRES 114	1
PERLND 104	39.37	RCHRES 114	2
IMPLND 105	1.18	RCHRES 114	1
PERLND 105	58.09	RCHRES 114	2
IMPLND 106	8.94	RCHRES 114	1
PERLND 106	438.1	RCHRES 114	2
IMPLND 111	0	RCHRES 114	1
PERLND 111	0	RCHRES 114	2
IMPLND 109	10.12	RCHRES 114	1
PERLND 109	8.28	RCHRES 114	2
RCHRES 112		RCHRES 114	3
IMPLND 101	0.81	RCHRES 116	1
PERLND 101	15.39	RCHRES 116	2
IMPLND 103	0.01	RCHRES 116	1
PERLND 103	0.03	RCHRES 116	2
IMPLND 104	1.78	RCHRES 116	1
PERLND 104	13.03	RCHRES 116	2
IMPLND 105	0.69	RCHRES 116	1
PERLND 105	34.06	RCHRES 116	2
IMPLND 106	2.79	RCHRES 116	1
PERLND 106	136.85	RCHRES 116	2
IMPLND 111	12.39	RCHRES 116	1
PERLND 111	31.85	RCHRES 116	2
IMPLND 109	2.21	RCHRES 116	1
PERLND 109	1.81	RCHRES 116	2
RCHRES 114		RCHRES 116	3
IMPLND 101	3.11	RCHRES 117	1
PERLND 101	59.16	RCHRES 117	2
IMPLND 102	0.06	RCHRES 117	1
PERLND 102	0.29	RCHRES 117	2
IMPLND 103	0.13	RCHRES 117	1
PERLND 103	0.3	RCHRES 117	2
IMPLND 104	3.38	RCHRES 117	1
PERLND 104	24.81	RCHRES 117	2
IMPLND 105	4.24	RCHRES 117	1
PERLND 105	207.8	RCHRES 117	2
IMPLND 112	0.94	RCHRES 117	1
PERLND 112	0.77	RCHRES 117	2
IMPLND 106	4.39	RCHRES 117	1

PERLND 106	214.95	RCHRES 117	2
IMPLND 111	0	RCHRES 117	1
PERLND 111	0.01	RCHRES 117	2
IMPLND 109	14.15	RCHRES 117	1
PERLND 109	11.58	RCHRES 117	2
RCHRES 92		RCHRES 117	3
RCHRES 116		RCHRES 117	3
IMPLND 101	5.34	RCHRES 118	1
PERLND 101	101.44	RCHRES 118	2
IMPLND 103	0	RCHRES 118	1
PERLND 103	0.01	RCHRES 118	2
IMPLND 104	4.75	RCHRES 118	1
PERLND 104	34.85	RCHRES 118	2
IMPLND 105	3.57	RCHRES 118	1
PERLND 105	174.92	RCHRES 118	2
IMPLND 106	4.65	RCHRES 118	1
PERLND 106	227.97	RCHRES 118	2
IMPLND 109	13.78	RCHRES 118	1
PERLND 109	11.27	RCHRES 118	2
RCHRES 117		RCHRES 118	3
IMPLND 101	0.5	RCHRES 74	1
PERLND 101	9.53	RCHRES 74	2
IMPLND 104	0	RCHRES 74	1
PERLND 104	0.03	RCHRES 74	2
IMPLND 106	0.1	RCHRES 74	1
PERLND 106	5.03	RCHRES 74	2
IMPLND 109	0.75	RCHRES 74	1
PERLND 109	0.61	RCHRES 74	2
RCHRES 70		RCHRES 74	3
IMPLND 101	1.52	RCHRES 119	1
PERLND 101	28.93	RCHRES 119	2
IMPLND 104	0.48	RCHRES 119	1
PERLND 104	3.52	RCHRES 119	2
IMPLND 105	0.28	RCHRES 119	1
PERLND 105	13.65	RCHRES 119	2
IMPLND 106	3.74	RCHRES 119	1
PERLND 106	183.16	RCHRES 119	2
IMPLND 109	2.75	RCHRES 119	1
PERLND 109	2.25	RCHRES 119	2
RCHRES 118		RCHRES 119	3
IMPLND 101	4.41	RCHRES 120	1
PERLND 101	83.8	RCHRES 120	2
IMPLND 103	0.03	RCHRES 120	1
PERLND 103	0.08	RCHRES 120	2
IMPLND 104	2.46	RCHRES 120	1
PERLND 104	18.02	RCHRES 120	2
IMPLND 105	5.72	RCHRES 120	1
PERLND 105	280.11	RCHRES 120	2
IMPLND 106	4.26	RCHRES 120	1
PERLND 106	208.58	RCHRES 120	2
IMPLND 109	8.16	RCHRES 120	1
PERLND 109	6.68	RCHRES 120	2
RCHRES 119		RCHRES 120	3
IMPLND 101	1.49	RCHRES 121	1
PERLND 101	28.3	RCHRES 121	2
IMPLND 104	0.11	RCHRES 121	1
PERLND 104	0.82	RCHRES 121	2

IMPLND 105	7.16	RCHRES 121	1
PERLND 105	351.09	RCHRES 121	2
IMPLND 106	1.17	RCHRES 121	1
PERLND 106	57.58	RCHRES 121	2
IMPLND 109	6.07	RCHRES 121	1
PERLND 109	4.96	RCHRES 121	2
RCHRES 82		RCHRES 121	3
RCHRES 120		RCHRES 121	3
IMPLND 101	6.45	RCHRES 122	1
PERLND 101	122.52	RCHRES 122	2
IMPLND 102	0.14	RCHRES 122	1
PERLND 102	0.66	RCHRES 122	2
IMPLND 104	9.01	RCHRES 122	1
PERLND 104	66.07	RCHRES 122	2
IMPLND 105	5.89	RCHRES 122	1
PERLND 105	288.46	RCHRES 122	2
IMPLND 106	1.54	RCHRES 122	1
PERLND 106	75.39	RCHRES 122	2
IMPLND 109	13.57	RCHRES 122	1
PERLND 109	11.1	RCHRES 122	2
RCHRES 121		RCHRES 122	3
IMPLND 101	4.04	RCHRES 123	1
PERLND 101	76.71	RCHRES 123	2
IMPLND 104	3.15	RCHRES 123	1
PERLND 104	23.09	RCHRES 123	2
IMPLND 105	3.99	RCHRES 123	1
PERLND 105	195.41	RCHRES 123	2
IMPLND 106	3.97	RCHRES 123	1
PERLND 106	194.38	RCHRES 123	2
IMPLND 111	3.54	RCHRES 123	1
PERLND 111	9.1	RCHRES 123	2
IMPLND 109	7.41	RCHRES 123	1
PERLND 109	6.06	RCHRES 123	2
RCHRES 122		RCHRES 123	3
IMPLND 101	1.09	RCHRES 124	1
PERLND 101	20.76	RCHRES 124	2
IMPLND 104	0.51	RCHRES 124	1
PERLND 104	3.78	RCHRES 124	2
IMPLND 105	3.16	RCHRES 124	1
PERLND 105	154.94	RCHRES 124	2
IMPLND 106	1.99	RCHRES 124	1
PERLND 106	97.64	RCHRES 124	2
IMPLND 111	2.63	RCHRES 124	1
PERLND 111	6.77	RCHRES 124	2
IMPLND 109	4.87	RCHRES 124	1
PERLND 109	3.98	RCHRES 124	2
RCHRES 123		RCHRES 124	3
IMPLND 101	6.15	RCHRES 125	1
PERLND 101	116.89	RCHRES 125	2
IMPLND 104	0.28	RCHRES 125	1
PERLND 104	2.03	RCHRES 125	2
IMPLND 105	3	RCHRES 125	1
PERLND 105	147.21	RCHRES 125	2
IMPLND 106	4.85	RCHRES 125	1
PERLND 106	237.68	RCHRES 125	2
IMPLND 111	1.95	RCHRES 125	1
PERLND 111	5.01	RCHRES 125	2

IMPLND 109	8.01	RCHRES 125		1
PERLND 109	6.55	RCHRES 125		2
RCHRES 74		RCHRES 125		3
RCHRES 124		RCHRES 125		3
IMPLND 101	1.11	RCHRES 90		1
PERLND 101	21.03	RCHRES 90		2
IMPLND 102	10.58	RCHRES 90		1
PERLND 102	48.19	RCHRES 90		2
IMPLND 103	0.37	RCHRES 90		1
PERLND 103	0.86	RCHRES 90		2
IMPLND 104	5.36	RCHRES 90		1
PERLND 104	39.28	RCHRES 90		2
IMPLND 105	0.84	RCHRES 90		1
PERLND 105	41.29	RCHRES 90		2
IMPLND 106	7.69	RCHRES 90		1
PERLND 106	376.93	RCHRES 90		2
IMPLND 107	1.52	RCHRES 90		1
PERLND 107	28.87	RCHRES 90		2
IMPLND 109	16.71	RCHRES 90		1
PERLND 109	13.67	RCHRES 90		2
IMPLND 110	0.01	RCHRES 90		1
PERLND 110	0.01	RCHRES 90		2
RCHRES 73		RCHRES 90		3
IMPLND 101	2.17	RCHRES 126		1
PERLND 101	41.25	RCHRES 126		2
IMPLND 104	0.7	RCHRES 126		1
PERLND 104	5.12	RCHRES 126		2
IMPLND 105	5.17	RCHRES 126		1
PERLND 105	253.28	RCHRES 126		2
IMPLND 106	2.52	RCHRES 126		1
PERLND 106	123.43	RCHRES 126		2
IMPLND 111	0.17	RCHRES 126		1
PERLND 111	0.43	RCHRES 126		2
IMPLND 109	12.49	RCHRES 126		1
PERLND 109	10.22	RCHRES 126		2
RCHRES 125		RCHRES 126		3
IMPLND 101	1.73	RCHRES 127		1
PERLND 101	32.82	RCHRES 127		2
IMPLND 104	0.67	RCHRES 127		1
PERLND 104	4.89	RCHRES 127		2
IMPLND 105	4.75	RCHRES 127		1
PERLND 105	232.85	RCHRES 127		2
IMPLND 106	5.77	RCHRES 127		1
PERLND 106	282.61	RCHRES 127		2
IMPLND 109	2.61	RCHRES 127		1
PERLND 109	2.13	RCHRES 127		2
RCHRES 126		RCHRES 127		3
IMPLND 106	0.01	RCHRES 128		1
PERLND 106	0.47	RCHRES 128		2
RCHRES 84		RCHRES 128		3
RCHRES 127		RCHRES 128		3
IMPLND 101	5.64	RCHRES 107		1
PERLND 101	107.18	RCHRES 107		2
IMPLND 102	0.12	RCHRES 107		1
PERLND 102	0.54	RCHRES 107		2
IMPLND 104	0.12	RCHRES 107		1
PERLND 104	0.88	RCHRES 107		2

IMPLND 105	0.33	RCHRES 107	1
PERLND 105	16.24	RCHRES 107	2
IMPLND 106	4.24	RCHRES 107	1
PERLND 106	207.91	RCHRES 107	2
IMPLND 109	2.66	RCHRES 107	1
PERLND 109	2.17	RCHRES 107	2
RCHRES 87		RCHRES 107	3
RCHRES 104		RCHRES 107	3
IMPLND 101	5.75	RCHRES 111	1
PERLND 101	109.19	RCHRES 111	2
IMPLND 102	0.06	RCHRES 111	1
PERLND 102	0.26	RCHRES 111	2
IMPLND 104	2.89	RCHRES 111	1
PERLND 104	21.22	RCHRES 111	2
IMPLND 105	1.09	RCHRES 111	1
PERLND 105	53.5	RCHRES 111	2
IMPLND 106	7.62	RCHRES 111	1
PERLND 106	373.18	RCHRES 111	2
IMPLND 109	14.49	RCHRES 111	1
PERLND 109	11.85	RCHRES 111	2
RCHRES 80		RCHRES 111	3
RCHRES 107		RCHRES 111	3
IMPLND 101	3.82	RCHRES 113	1
PERLND 101	72.49	RCHRES 113	2
IMPLND 104	0.2	RCHRES 113	1
PERLND 104	1.45	RCHRES 113	2
IMPLND 105	6.62	RCHRES 113	1
PERLND 105	324.44	RCHRES 113	2
IMPLND 106	4.45	RCHRES 113	1
PERLND 106	217.93	RCHRES 113	2
IMPLND 109	4.73	RCHRES 113	1
PERLND 109	3.87	RCHRES 113	2
RCHRES 111		RCHRES 113	3
IMPLND 101	0.08	RCHRES 115	1
PERLND 101	1.44	RCHRES 115	2
IMPLND 104	0.44	RCHRES 115	1
PERLND 104	3.21	RCHRES 115	2
IMPLND 105	2.58	RCHRES 115	1
PERLND 105	126.45	RCHRES 115	2
IMPLND 106	1.14	RCHRES 115	1
PERLND 106	55.7	RCHRES 115	2
IMPLND 109	3.49	RCHRES 115	1
PERLND 109	2.85	RCHRES 115	2
RCHRES 113		RCHRES 115	3
IMPLND 101	1.07	RCHRES 129	1
PERLND 101	20.28	RCHRES 129	2
IMPLND 102	0.05	RCHRES 129	1
PERLND 102	0.22	RCHRES 129	2
IMPLND 104	0.84	RCHRES 129	1
PERLND 104	6.16	RCHRES 129	2
IMPLND 105	4.06	RCHRES 129	1
PERLND 105	198.78	RCHRES 129	2
IMPLND 106	6.96	RCHRES 129	1
PERLND 106	340.98	RCHRES 129	2
IMPLND 109	11.28	RCHRES 129	1
PERLND 109	9.23	RCHRES 129	2
RCHRES 128		RCHRES 129	3

```
RCHRES 115                                  RCHRES 129      3
END SCHEMATIC

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys
Aggr Amd ***
<Name>   x        <Name> x x<-factor->strg <Name>   x <Name>qf  tem
strg strg***
RCHRES 105 HYDR   RO     1 1          AVER WDM1  1002 FLOW   1 ENGL
AGGR REPL
RCHRES 105 GQUAL  DQAL   1 1          AVER WDM1  1152 DQAL   1 ENGL
AGGR REPL
END EXT TARGETS

MASS-LINK

  MASS-LINK        2
<-Volume-> <-Grp> <-Member-><--Mult-->     <-Target vols> <-Grp> <-
Member->  ***
<Name>            <Name> x x<-factor->     <Name>                <Name>
x x  ***
*** Factor converts acre-in to acre-ft _1/12_
PERLND     PWATER PERO       0.0833333     RCHRES         INFLOW IVOL
PERLND     PQUAL  POQUAL 1                 RCHRES         INFLOW IDQAL
1
  END MASS-LINK    2

  MASS-LINK        1
<-Volume-> <-Grp> <-Member-><--Mult-->     <-Target vols> <-Grp> <-
Member->  ***
<Name>            <Name> x x<-factor->     <Name>                <Name>
x x  ***
IMPLND     IWATER SURO      0.08333333     RCHRES         INFLOW IVOL
IMPLND     IQUAL  SOQUAL 1                 RCHRES         INFLOW IDQAL
1
  END MASS-LINK    1

  MASS-LINK        3
<-Volume-> <-Grp> <-Member-><--Mult-->     <-Target vols> <-Grp> <-
Member->  ***
<Name>            <Name> x x<-factor->     <Name>                <Name>
x x  ***
RCHRES     ROFLOW                          RCHRES         INFLOW
  END MASS-LINK    3

  MASS-LINK        4
<-Volume-> <-Grp> <-Member-><--Mult-->     <-Target vols> <-Grp> <-
Member->  ***
<Name>            <Name> x x<-factor->     <Name>                <Name>
x x  ***
BMPRAC     ROFLOW                          RCHRES         INFLOW
  END MASS-LINK    4

  MASS-LINK        5
<-Volume-> <-Grp> <-Member-><--Mult-->     <-Target vols> <-Grp> <-
Member->  ***
```

```
<Name>            <Name> x x<-factor->     <Name>                <Name>
x x  ***
IMPLND     IWATER SURO      0.08333333     BMPRAC         INFLOW IVOL
IMPLND     IQUAL  SOQUAL 1                 BMPRAC         INFLOW IDQAL
1
  END MASS-LINK    5

  MASS-LINK        6
<-Volume-> <-Grp> <-Member-><--Mult-->     <-Target vols> <-Grp> <-
Member->  ***
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Appendix C-1: Public Notice

Michael F. Easley, Governor

William G. Ross Jr., Secretary
North Carolina Department of Environment and Natural Resources

Alan W. Klimek, P.E. Director
Division of Water Quality

Now Available Upon Request

Fecal Coliform
Total Maximum Daily Load
Goose Creek
Public Review Draft – February 2005

Is now available upon request from the North Carolina Division of Water Quality. This TMDL study was prepared as a requirement of the Federal Water Pollution Control Act, Section 303(d). The study identifies the sources of the pollutants, determines allowable loads to surface waters, and suggests pollutant allocations.

TO OBTAIN A FREE COPY OF THE TMDL REPORTS:

Please contact Ms. Robin Markham (919) 733-5083, extension 558 or write to:
Adugna Kebede
Water Quality Planning Branch
NC Division of Water Quality
1617 Mail Service Center
Raleigh, NC 27699-1617

The draft TMDL is also located on the following website: http://h2o.enr.state.nc.us/tmdl. Interested parties are invited to comment on the draft TMDL study by March 15, 2005. Comments concerning the report should be directed to the Division of Water Quality at the above address.

One NorthCarolina Naturally

North Carolina Division of Water Quality/Planning Branch 1617 Mail Service Center Raleigh, NC 27699-1617 Phone (919) 733-5083
512 North Salisbury St. Raleigh, NC 27604 FAX (919) 715-5637

Customer Service 1-877-623-6748 Internet: h2o.enr.state.nc.us An Equal Opportunity/Affirmative Action Employer

Appendix C-2: Affidavit of Publication from The Charlotte Observer Public Notification

The Knight Publishing Co., Inc.
Charlotte, NC
Affidavit of Publication

North Carolina } ss
Mecklenburg County }

THE CHARLOTTE OBSERVER

CHAR-MECK STORM WATER SERVICES
VIVIAN LOVE
700 N TRYON ST
CHARLOTTE NC 28202

PUBLIC NOTICE
State of North Carolina
Division of Water Quality
Mecklenburg County
Water Quality Program (MCWQP)
Mecklenburg County
Water Quality

Availability of the Fecal Coliform Total Maximum Daily Load (TMDL) for Goose Creek

Copies of the TMDL may be obtained by calling Robin Markham at (919) 733-5083 ext. 558 or on the internet at http://h2o.enr.state.nc.us/tmdl. Written comments regarding the TMDL will be accepted until March 18th, 2005. Please mail comments to NCDWQ Planning Branch, attn: Adugna Kebede, 1617 Mail Service Center, Raleigh, NC 27699
LP5364668

REFERENCE: 30002143
5364668 Public Notice

Before the undersigned, a Notary Public of said County and State, duly authorized to administer oaths affirmations, etc., personally appeared, being duly sworn or affirmed according to law, doth depose and say that he/she is a representative of the Knight Publishing Company a corporation organized and doing business under the laws of the State of Delaware, and publishing a newspaper known as The Charlotte Observer in the city of Charlotte, County of Mecklenburg and State of North Carolina and that as such he/she is familiar with the books, records, files and business of said Corporation and by reference to the files of said publication the attached advertisement was inserted. The following is correctly copied from the books and files of the aforesaid Corporation and Publication.

PUBLISHED ON: 02/16

AD SPACE: 25 LINE
FILED ON: 02/23/05

NAME: ____________ TITLE: Acct. Clerk
DATE: FEB 2 3 2005

In Testimony Whereof I have hereunto set my hand and affixed my seal, the day and year aforesaid.

Notary: ____________ My Commission Expires: __/__/__

My Commission Expires May 27, 2006

Appendix C-3: Goose Creek TMDL Stakeholder Meeting Minutes

Goose Creek TMDL Public Meeting Minutes

Meeting Date: Wednesday, March 16, 2005
Meeting Time: 10:00 a.m. to 12:00 a.m.
Meeting Location: Mint Hill Town Hall Meeting Chamber located at 7151 Matthews-Mint Hill Road

Purpose of Public Meeting:
To discuss the findings of the Goose Creek TMDL and receive comments and input from attendees.

Attendees:
Barry Gullet – Charlotte Mecklenburg Utilities
Rick Roti – Sierra Club
Tom Augspurger – U.S. Fish and Wildlife Services
Mark Fowlkes – N.C. Wildlife Resources Commission
Jenny Harrison – N.C. Wildlife Resources Commission
Richard Farmer – Mecklenburg County Water Quality Program
David Kroening – Mecklenburg County Water Quality Program
Dr. Craig Allan – UNC-Charlotte
Jerry Simpson – Union County Cooperative Extension Director
Amy Helms - Union County Storm Water Engineer
Adugna Kebede – North Carolina Division of Water Quality (DWQ)

Agenda:

Time	Topic	Speaker
10:00 to 10:30	Source Assessment and Monitoring	Richard Farmer
10:30 to 11:00	Modeling Approach	David Kroening
11:00 to 11:30	Allocations and Source Reductions	David Kroening
11:30 to 12:00	Group Discussion	

Richard Farmer of the Mecklenburg County Water Quality Program (MCWQP) started off with a PowerPoint presentation describing the point and non-point sources of fecal coliform bacteria in the Goose Creek watershed. Phase I monitoring sites and associated data were then presented to the group. Phase II monitoring data, which included specific land use monitoring sites, was also presented. The Phase II land use monitoring locations include:

- a tributary to Goose Creek that is downstream of a residential community that utilizes individual waste water systems;
- a separate tributary to Goose Creek which is located downstream of a horse farm;

- Goose Creek at Bain School Road upstream of a cattle farm;
- Goose Creek at Lawyers Rd. located downstream of the cattle farm; and
- Goose Creek at Highway 218 located downstream of a chicken farm.

The Bacterial Source Tracking (BST) component of the monitoring effort was also discussed. BST is a monitoring technique used to distinguish animal form human sources. The BST monitoring sites include:

- Goose Creek at Flour Mill Rd.;
- Goose Creek at Howey Bottoms Rd.;
- Goose Creek at the Tucker Farm;
- Duck Creek at Hopewell Church Rd.; and
- Duck Creek at Mill Grove Rd.

BST monitoring showed that of the isolates sampled 48% were from livestock, 25% were from human sources and that 27% were from wildlife.

David Kroening of MCWQP followed Richard with a presentation covering Sections 3 and 4 from the Draft TMDL document. David explained that Win HSPF was used to simulate fecal coliform, flow and temperature in the Goose Creek Watershed. When available, local data was used to populate model parameters. Calibration graphs, land-use maps and model output were presented to the stakeholders. A source reduction strategy consisting of a 92.5% reduction in fecal coliform from MS4 areas, septic systems, ground water and non-point source runoff was described.

Comments from the attendees at the meeting were as follows:
Rick Roti – Mr. Roti expressed a concern that the model incorporated current land uses and impervious areas but did not address build out in the watershed. He was concerned that there was no projection for future development as part of the TMDL and how this could affect the Carolina heelsplitter. Mr. Roti was concerned that there is no State water quality standard for suspended solids and felt that one should be implemented. He stated that the TMDL should be met as a condition of the Phase II Storm Water Permit. Mr. Roti commented that there should be more development controls within the watershed and that he is concerned about changes to the watershed due to increased development. Mr. Roti stated that he does not like the fact that there is not a requirement for an implementation strategy and that DWQ should mandate that jurisdictions work together to address water quality issues.
Tom Auspurger – Mr. Auspurger stated fecal coliform bacteria is only part of the problem and that reducing fecal coliform levels alone would not address the biological integrity of the stream. He stated that there are greater stressors to biological integrity such as sediment and nutrients and that if these pollutants were addressed, a reduction in fecal coliform may also be realized. Mr. Auspurger was concerned that the lowest 5% of flows were not included in the model due to drought conditions. He feels that these conditions need to be addressed so that real conditions are not ignored.
Adugna Kebede – Mr. Kebede stated that all comments that wish to be considered for input into the TMDL be provided to him at (919) 733-5083 ext. 515.

The meeting adjourned at approximately 12:00 p.m.