

## **Export of Phosphorus from Great Swamp to Passaic River**

### **I. Purpose and Background**

The Passaic River at Millington Gorge (PA2) is the headwater boundary of the flow and water quality model developed for the Non-Tidal Passaic River Basin TMDL Study, and exhibits relatively high phosphorus concentrations. The Passaic River at Millington Gorge is also the outlet of the Great Swamp watershed in Morris and Somerset Counties. The average phosphorus concentration based on the sampling performed in 2003 by Omni Environmental (Omni) was 0.13 mg/l total phosphorus, which is consistent with earlier data collected by NJDEP in the 1990s when that station was included in the Ambient Surface Water Monitoring Network (ASMN). NJDEP requested this study in order to better characterize the Passaic River headwater phosphorus condition at the outlet of Great Swamp as well as the phosphorus inputs to the Great Swamp. In other words, how do tributary and point source phosphorus imports to Great Swamp compare with the export of phosphorus to the Passaic River? The study was not designed to quantify processes within the swamp itself, but rather to make use of existing data to quantify phosphorus loads entering and exiting the swamp through the Passaic River.

The Great Swamp Watershed Association (GSWA) and Ten Towns Great Swamp Watershed Management Committee (TTC) have a high quality long-term dataset, made available to Omni in January 2006, at the outlet of Great Swamp (the Passaic River at Millington Gorge). It reveals no relationship with flow that might indicate point source influence, but instead shows a strong seasonal trend. For this reason, bimonthly average concentrations for total phosphorus were used along with actual measured concentrations to develop a seasonally varying boundary condition for total phosphorus at the Passaic River headwater boundary. The predictive strength of this seasonal variation based on bimonthly average total phosphorus concentrations is remarkable, as discussed in Section IV. The strong seasonal trend, along with observations of very high nonpoint source concentrations in the Great Swamp in streams that are not downstream of any sewage treatment plant (STP) discharge, suggest that the Passaic River headwater quality may be dominated by wetland dynamics.

## **II. Great Swamp Watershed Characterization**

Several datasets were combined to provide a characterization of the phosphorus conditions throughout the Great Swamp watershed. GSWA and TTC have collaborated to develop an extensive dataset that includes the major tributaries to Great Swamp as well as the export to Passaic River. These data were collected by trained volunteers using prescribed quality assurance procedures under the direction of a professional technical consultant, and samples were analyzed by a NJDEP-certified laboratory<sup>1</sup> for phosphorus and the other constituents. Further information on the GSWA and TTC stream monitoring program, as well as the data results, are available at <http://www.greatswamp.org/StreamMon.htm>). In addition to the GSWA dataset, Omni has data from the TMDL monitoring program as well as long term quarterly data from Black Brook that were collected on behalf of the Township of Chatham under a NJDEP-approved Quality Assurance Sampling Plan. Finally, monthly reporting data submitted to NJDEP from July 2000 through April 2005 from Morris-Woodland STP and Chatham-Main STP were assembled. All these data were compiled within a single database in order to perform this study, and are provided in Attachment 1 as well as electronically in Appendix M of the Phase II Final Report for the Non-Tidal Passaic River Basin TMDL Study. Figure GS-1 shows the sampling locations and point sources within the Great Swamp watershed.

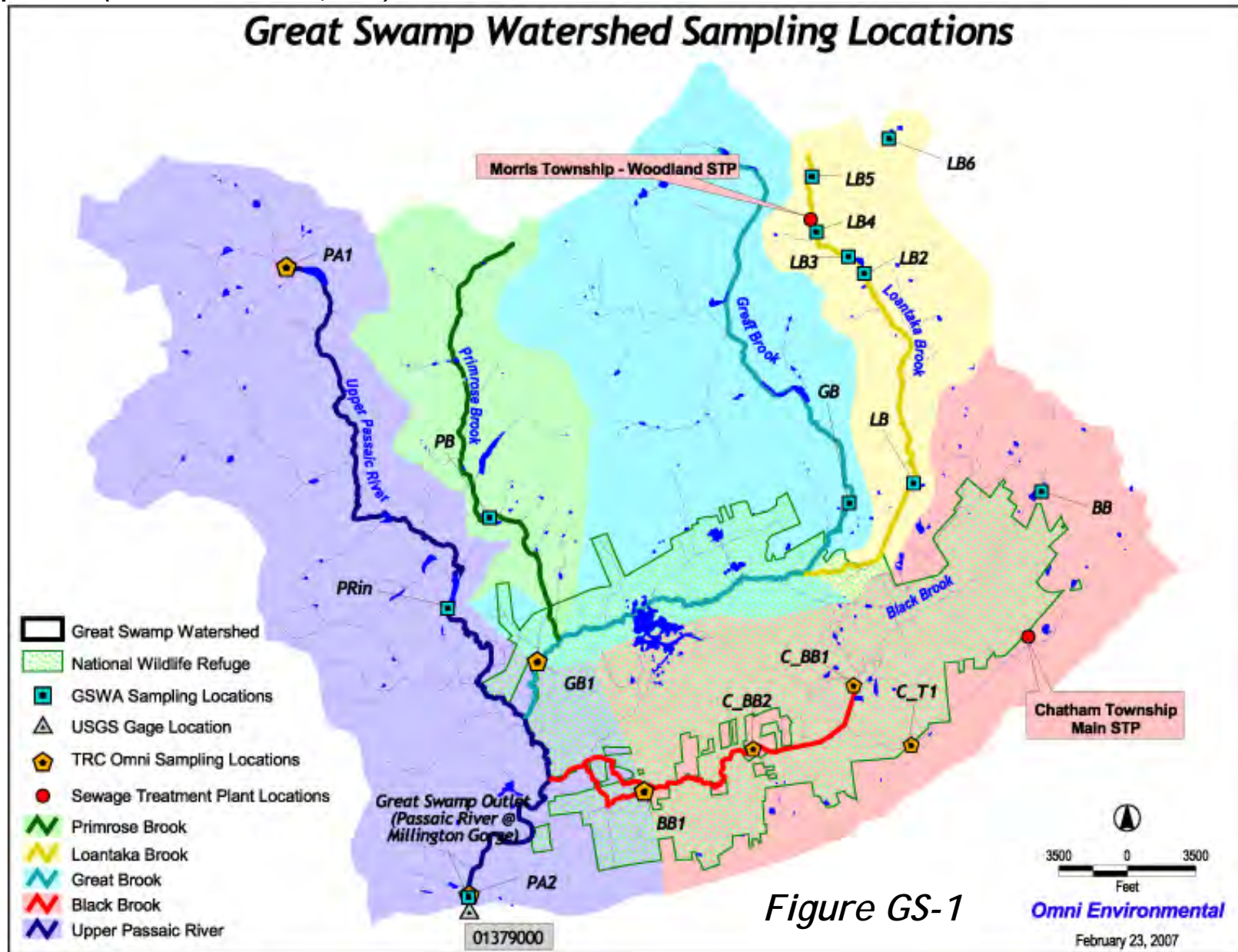
There are five subwatersheds that drain to Great Swamp: the Passaic River headwaters, Primrose Brook, Great Brook, Loantaka Brook, and Black Brook. The Morris-Woodland STP discharges to Loantaka Brook well upstream of the point where it enters Great Swamp. The Chatham-Main STP discharges to a tributary to Black Brook at a location just outside the boundary of the National Wildlife Refuge. Black Brook and Great Brook combine to form the Passaic River within the Great Swamp.

### **A. Great Swamp**

The area of the Great Swamp is not defined precisely. The heart of Great Swamp is the Great Swamp National Wildlife Refuge, shown on Figure GS-1. However, there are extensive wetlands that are part of the Great Swamp, but that lie outside the National

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<sup>1</sup> Environmental Compliance Monitoring, Inc in Hillsborough, NJ (NJDEP Certification #18630)



Wildlife Refuge. Furthermore, there is very little wetland area upstream of the GSWA<sup>2</sup> sampling stations (PRin, PB, GB, LB, and BB). Therefore, the Great Swamp can be considered the portion of the Great Swamp watershed downstream of the GSWA station locations on the Passaic River (PRin), Primrose Brook (PB), Great Brook (GB), Loantaka Brook (LB), and Black Brook (BB). Figure GS-2 provides an idealization of the Great Swamp watershed showing inlet subwatersheds, point sources, and the outlet location. Inlet subwatersheds were defined as the drainage areas of the GSWA sampling locations listed above.

Using this definition, the following stream sampling stations are located within the swamp itself: the Black Brook upstream of the tributary into which Chatham-Main STP discharges (C\_BB1), the tributary into which Chatham-Main STP discharges (C\_T1), the Black Brook downstream of the tributary into which Chatham-Main STP discharges (C\_BB2), the mainstem Black Brook (BB1), and the mainstem Great Brook (GB1). Figure GS-3 shows the average total phosphorus concentrations at stations in the subwatersheds upstream of Great Swamp (LB2, LB3, LB4, LB5, LB6, PA1), the inlets to Great Swamp (PRin, PB, GB, LB, and BB), stations within Great Swamp (C\_BB1, C\_T1, C\_BB2, BB1, GB1), and the outlet (PRout/PA2). Growing season was defined as May through September for this analysis.

Notice that very high phosphorus concentrations are going into Great Swamp, and that the inlet concentrations are higher during the growing season. The phosphorus conditions at the various inlets to the Great Swamp will be examined in more detail in the ensuing section. Within the Great Swamp, phosphorus concentrations are even higher than the inlet concentration during the growing season, and lower than the inlet concentration during the non-growing season. The fact that stream phosphorus concentrations within the Great Swamp are higher during the growing season is likely the cause of the seasonal pattern observed at the outlet, namely that phosphorus concentration is higher in the summer than the winter.

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<sup>2</sup> These sites are referenced as GSWA sites because they are included in the dataset housed by GSWA. They are in fact TTC sites that are sampled by GSWA volunteers under the management of TTC's technical consultant.

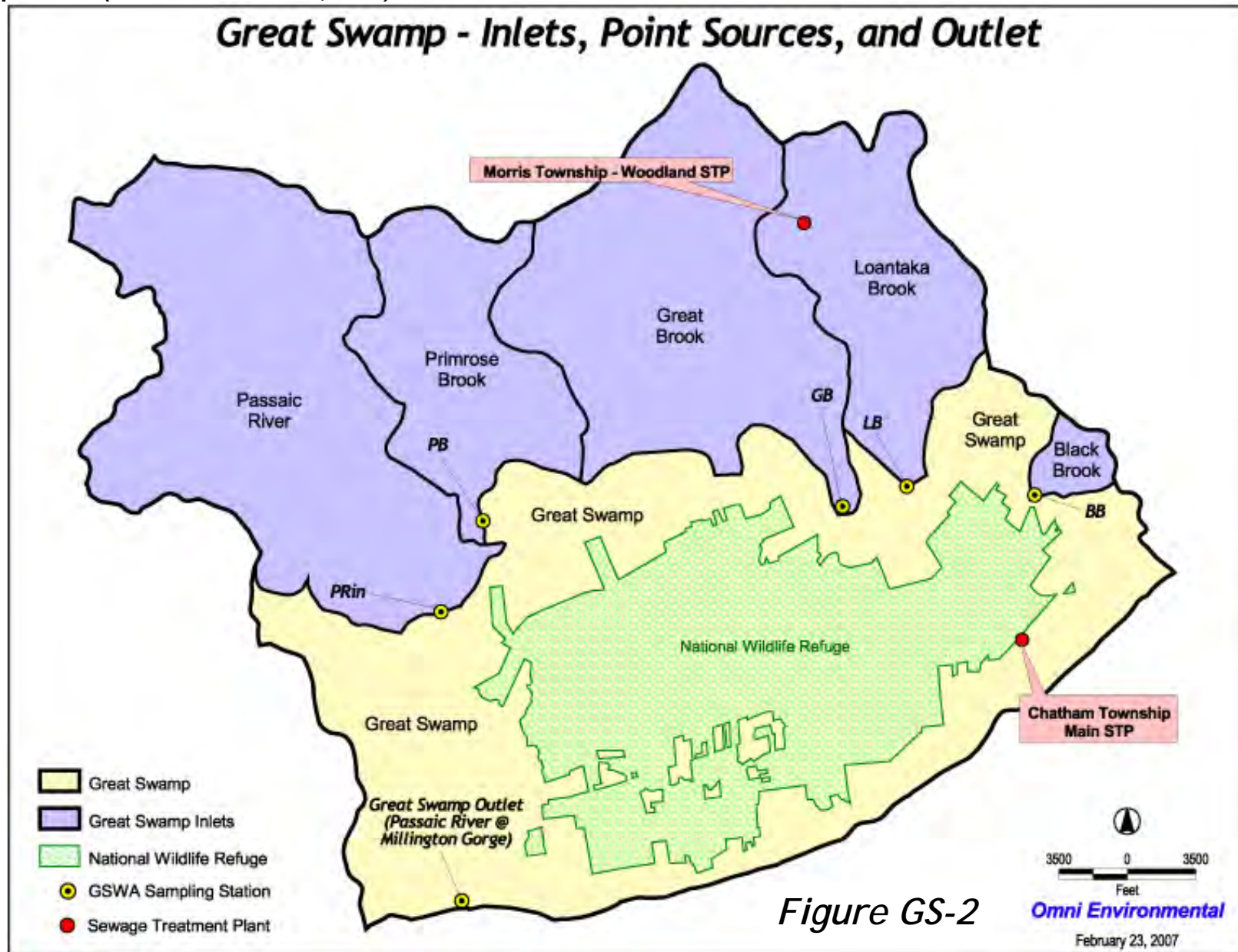
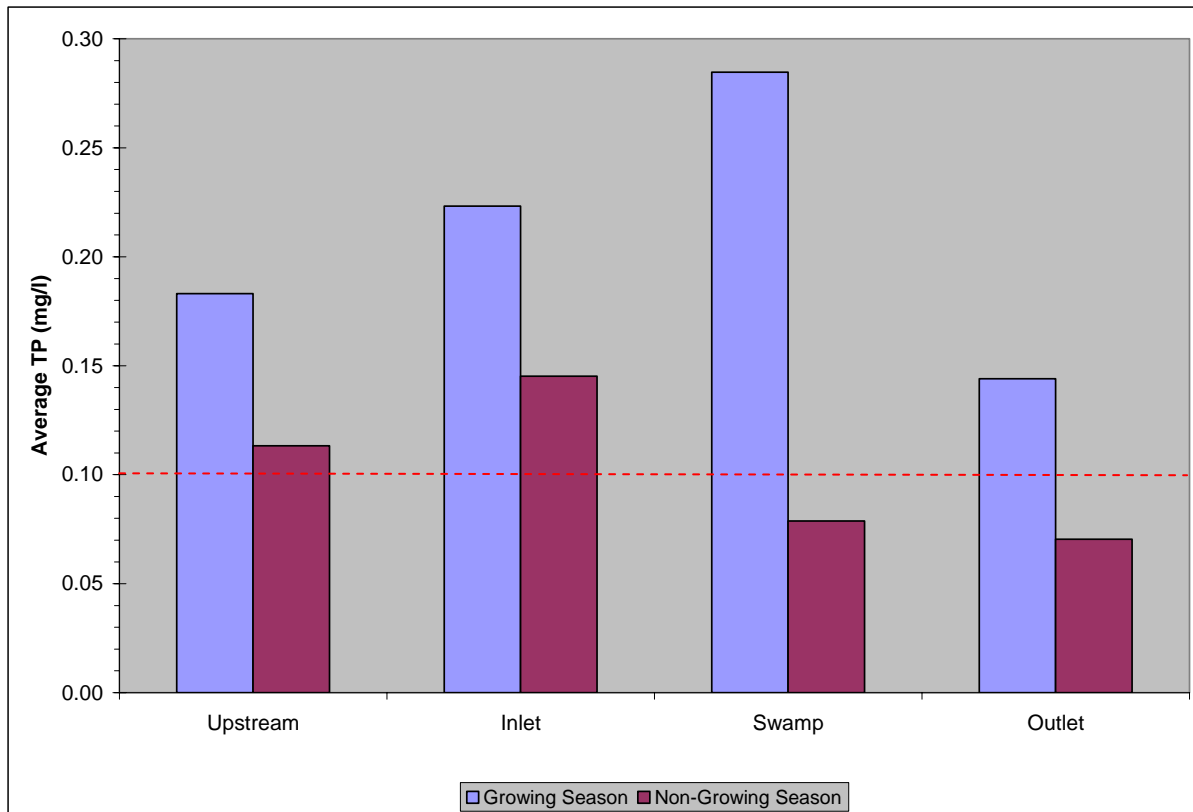


Figure GS-3: Average Phosphorus Concentrations in Great Swamp Watershed



One possible explanation for this pattern (i.e. higher phosphorus levels during the summer) is that natural levels of dissolved oxygen within the Great Swamp are extremely low during the summer (Phase I Report, TRC Omni, 2004). As a result, iron in the sediments will reduce to its ferrous form and release phosphorus into the water column. Iron levels in Great Brook and Black Brook within Great Swamp were generally high, varying from about 0.5 to 3.0 mg/l (Phase I Report, TRC Omni, 2004). Higher levels were observed in the summer than winter. Also, it should be noted that sediment interactions are very important within the Great Swamp. Based on experience of Omni staff who have sampled several locations in Great Swamp for many years, the substrates of streams in the Great Swamp are comprised of soft and deep black muck extending several feet down from the stream bottom, making sampling difficult and hazardous. This deep muck, a natural condition present throughout much of the Great Swamp, likely represents a major oxygen demand, phosphorus bank, and interflow connection.

Sediment interactions within the Great Swamp appear to be much more important to the overall phosphorus balance than plant uptake, since the Great Swamp is providing a source of phosphorus during the summer when uptake is highest (see Section IV). If productivity within the swamp were controlling phosphorus exports, then one would expect phosphorus leaving the swamp to be lowest during the growing season when uptake (and retention) within the swamp is highest. While investigating processes within the swamp is beyond the scope of this analysis, this discussion provides plausible contributing factors for the observed seasonal pattern of phosphorus in the Great Swamp.

Figure GS-4 shows the average phosphorus concentrations observed within Great Swamp itself. Stations C\_BB1 and C\_T1 were sampled 10 times from May to November of 2002. C\_BB2 was sampled 22 times from May 2002 to August 2005. Stations BB1 and GB1 were sampled 12 times from June to November of 2003. Note that station C\_BB1 is upstream of any point source influence, and exhibits phosphorus concentrations higher than the treated effluent from either of the STPs that discharge within the Great Swamp watershed. Extremely high concentrations (0.7 and 2.4 mg/l) were observed in August of 2002 at station C\_BB1. Figure GS-4 also shows the very large contrast between phosphorus concentrations during the growing season versus the non-growing season. Both are high, but the concentrations are highest during the growing season. Again, this points to the sediment interactions overwhelming any impact from uptake (which would tend to decrease concentrations during the growing season). Stations BB1 and GB1 are remarkably similar to one another in phosphorus concentration, despite receiving inputs from completely different inlet subwatersheds; they are located in the Black Brook and Great Brook, respectively, near the point where each combines with the Passaic River within the Great Swamp. Given the myriad of interconnected streams within the Great Swamp (Figure GS-5), it is very likely that Black Brook and Great Brook not completely independent within the swamp itself. In fact, precise definitions of upstream and downstream may not have much meaning within the Great Swamp. The inlets and outlet of the swamp, however, are well-defined hydrologically, and each exhibits distinct water quality characteristics, as described below. The fact that the inlets and outlet are distinct, but locations within the swamp are

not, supports the basic idealization shown in Figure GS-2 on which the loading analysis was based.

**Figure GS-4: Average Phosphorus Concentrations within Great Swamp**

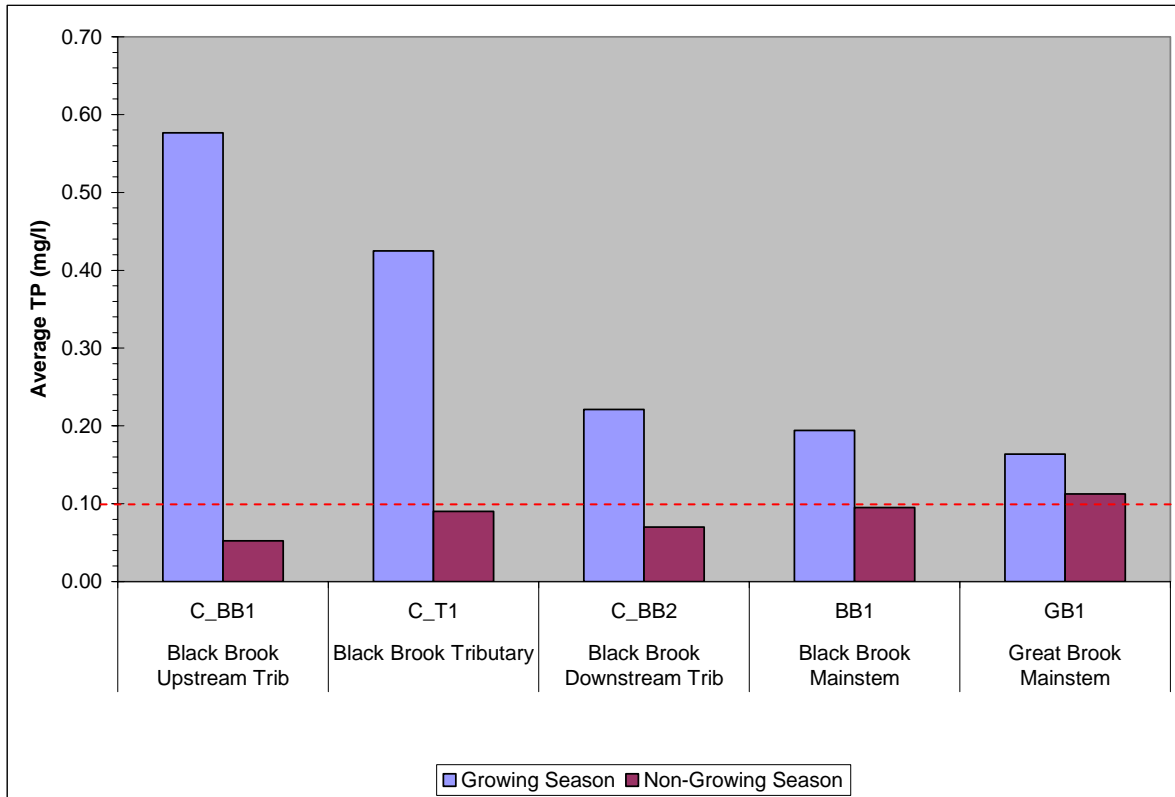
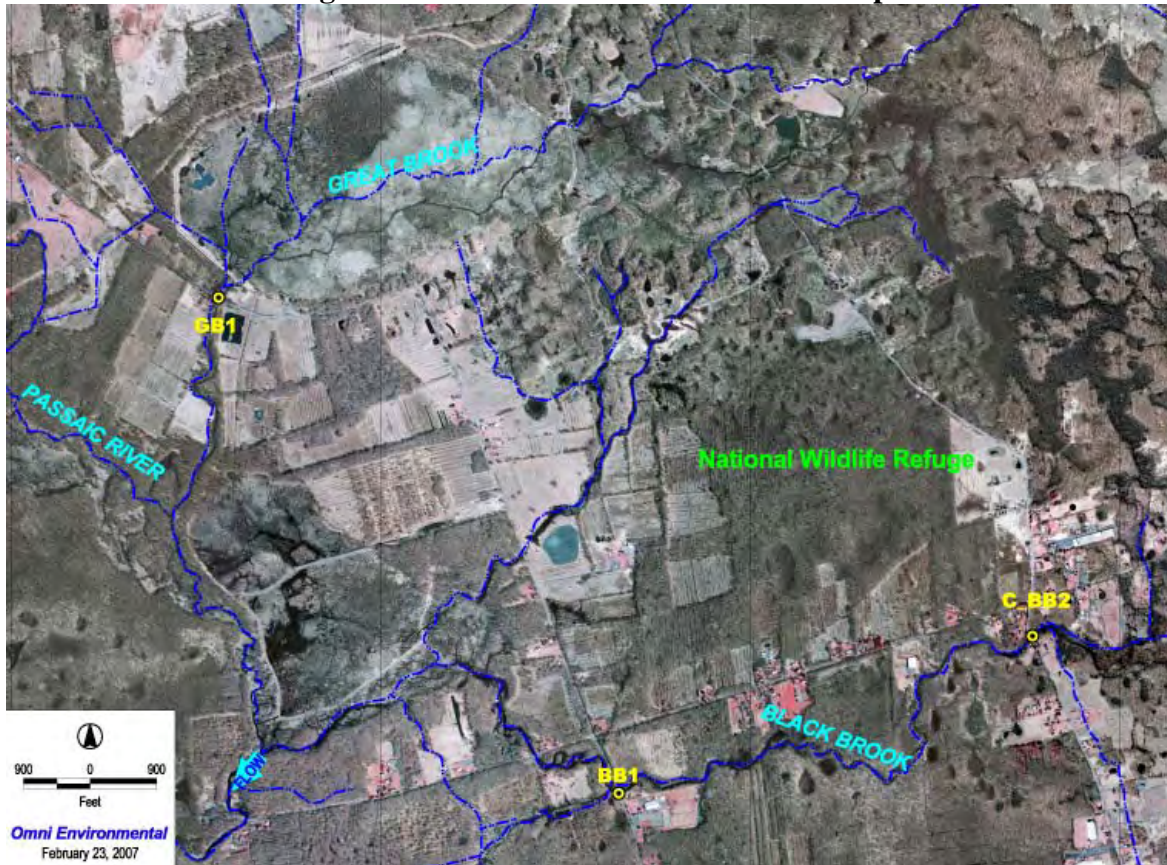


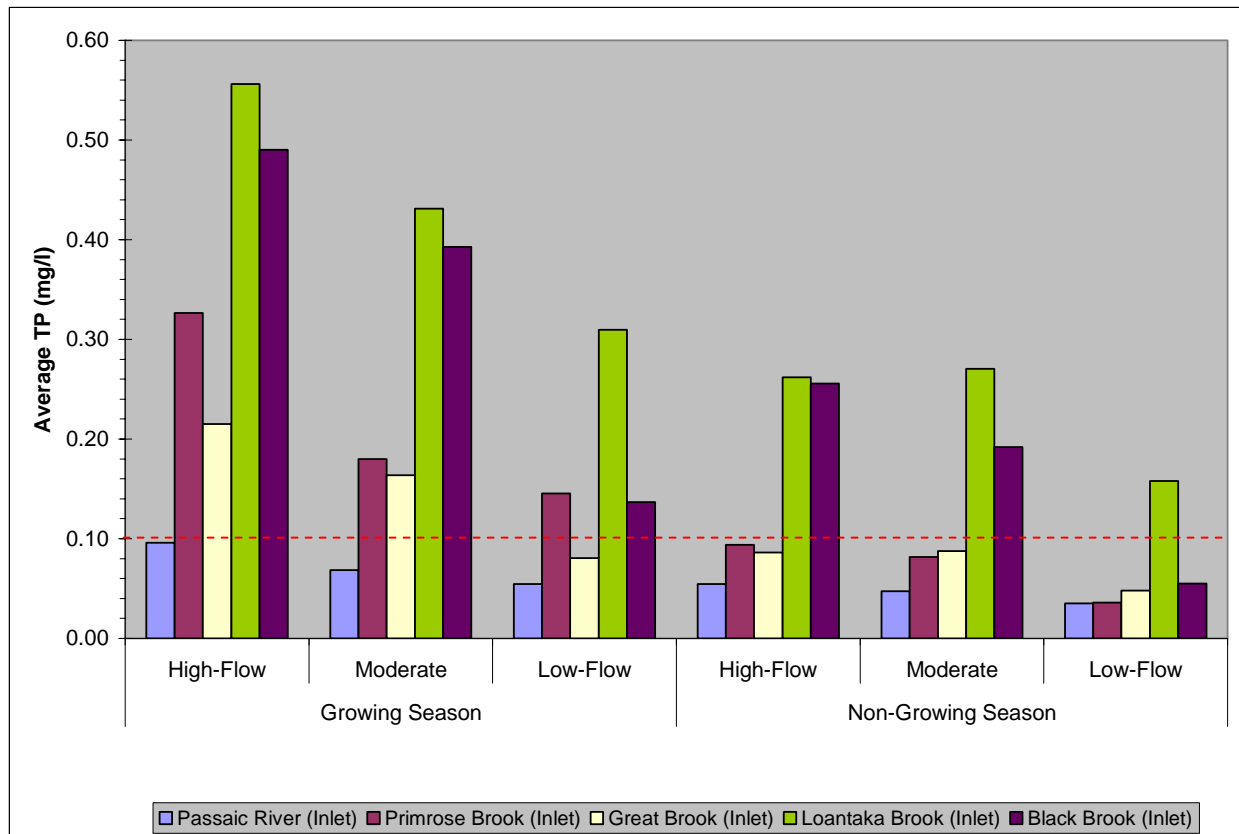
Figure GS-5: Aerial Photo of Great Swamp



### **B. Great Swamp Inlets**

As shown in Figure GS-2, there are five subwatersheds that drain to the Great Swamp: Passaic River upstream of GSWA station PRin; Primrose Brook upstream of GSWA station PB; Great Brook upstream of GSWA station GB; Loantaka Brook upstream of GSWA station LB; and Black Brook upstream of GSWA station BB. Figure GS-6 shows the average phosphorus concentrations at the five inlets to the Great Swamp. General flow conditions were defined using the daily records from the USGS flow gage at the Passaic River at Millington (01379000), the outlet of the Great Swamp. Samples taken when flows at the gage were over the 25<sup>th</sup> Percentile flow (defined by USGS to be 113cfs) were designated High-Flow; samples taken when flows at the gage were below the 70<sup>th</sup> Percentile flow (defined by USGS to be 23cfs) were designated Low-Flow. Figure GS-6 reveals strong differences between growing season and non-growing season, among various flow conditions, and among the five inlets.

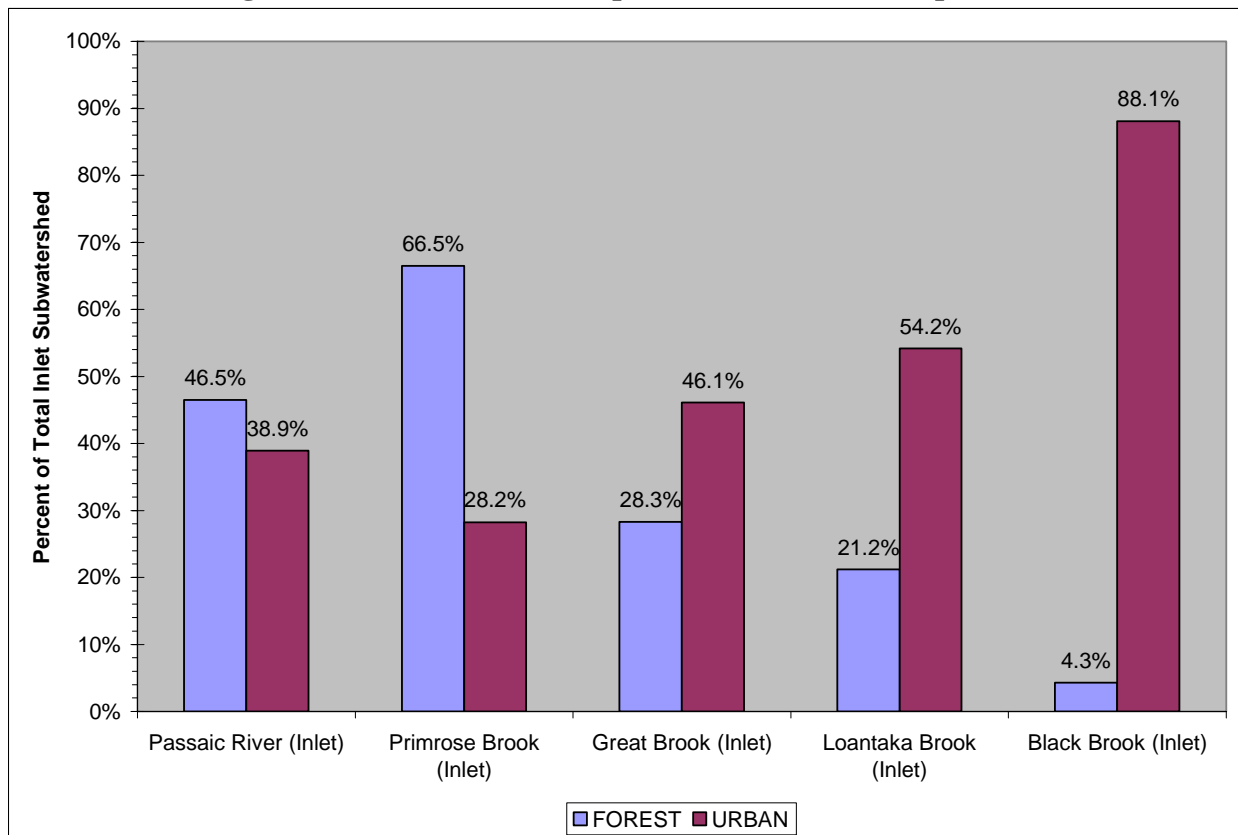
Figure GS-6: Average Phosphorus Concentrations at Inlets to Great Swamp



Distinguishing between natural and anthropogenic sources within the inlets to the Great Swamp is difficult. High-flow concentrations are higher in concentration than low-flow concentrations, even in Loantaka Brook, which includes the Morris-Woodland STP discharge. Growing season concentrations are higher than non-growing season concentrations; this may reflect seasonally varying baseflow concentrations, migratory waterfowl contributions, and/or seasonal urban sources such as lawn fertilization. However, lawn fertilization is not likely to explain all (or even most) of the difference, since lawn fertilization is also applied in the early Spring and late Fall during the non-growing season (as defined in this analysis). The fact that Loantaka Brook remains high in concentration during low flow periods can certainly be attributed to the fact that Morris-Woodland STP discharges to it. Furthermore, Black Brook drains Chatham and is highly urbanized. Figure GS-7 shows the percent forest and percent urban land use areas within the subwatersheds of the various inlets to the Great Swamp (according to

NJDEP's 1995 land use coverage). Urbanization can explain some of the high phosphorus sources, but an important component unrelated to urbanization remains. The Passaic River inlet, despite being 39% urban, is very low in phosphorus compared to the other inlets. Furthermore, Primrose Brook is over 66% forested and yet exhibits average phosphorus concentrations of 0.14 mg/l. Similarly, the Loantaka Brook headwater (GSWA station LB6) furthest upstream of Morris-Woodland STP exhibits an average phosphorus concentration of 0.17 mg/l, with a summer high reaching 0.38 mg/l. Clearly, there are very high sources of phosphorus being delivered to Great Swamp even upstream of point sources and unrelated to urbanized areas. Defining the exact nature of these sources and investigating the degree to which they are naturally occurring, is beyond the scope of this analysis.

Figure GS-7: Land Use Composition of Great Swamp Inlets



### **III. Hydrology of the Great Swamp**

In order to characterize phosphorus loads into and out of the Great Swamp over time, flows must be estimated at all inlets and the outlet. Flow at the outlet is available from the USGS stream flow gage at that location (01379000). Flows at the inlets were often measured by GSWA during their sampling. In order to be able to predict flows at the inlets during days that were not sampled, attempts were made to relate flows at the inlets to gaged flow at the outlet. Traditional drainage area ratio methods could not be used, because the inlet flows as a percentage of the outlet flow varied greatly over time. In fact, the variation of inlet flows as a percentage of the outlet flow varies with the outlet flow; the lower the outlet flow, the higher the inlet flow as a percentage of the outlet flow. Individual inlet flows were frequently larger than the outlet flow during low-flow conditions.

This relationship between inlet flows as a percentage of outlet flow and the outlet flow turns out to be very strong when described using a power function for each inlet. Figures GS-8 to GS-12 show the power functions and strengths for each subwatershed inlet. These are remarkably strong flow correlations. During low-flow conditions, much more water is flowing into the Great Swamp than flowing out. In fact, each of the inlet flows alone is greater than the outlet flow during low-flow conditions. The Great Swamp during low-flow conditions is storing and/or losing (e.g., through evapotranspiration) vast quantities of water. As flow conditions increase, more and more of the inlet flow is being passed through to the outlet. Under high-flow conditions, there is much more water flowing out of the Great Swamp than is flowing in at that time. The additional water released during high flow periods, in addition to being the water stored during low flow periods, may also originate from water sources within the swamp such as groundwater discharge.

It is important to understand that this evaluation is not a water balance for the Great Swamp, nor is one required for the scope of the analysis. Recall from the idealization in Figure GS-2 that the Great Swamp is essentially being treated like a black box. The objective of the loading analysis is to quantify loads entering the Great Swamp at the inlets and exiting via the Passaic River at Millington. A water balance would attempt to account for the difference between the water entering and the water exiting the Great Swamp by quantifying water loads such as groundwater discharge and losses such as evapotranspiration. This analysis instead

focused simply on quantifying the loads entering the swamp through its inlets and exiting through the outlet. Using the power functions shown in Figures GS-8 to GS-12, the flows at the inlets can be calculated directly from the flow at the outlet, which is measured continuously by USGS. Moreover, the strength of these relationships is excellent, providing an accurate empirical means of predicting flows at the five inlets as a function of gaged flow at the outlet. R-squared correlations vary from 0.53 to 0.96, with the weighted average (by mean flow) R-squared correlation for all inlets being 0.83.

**Figure GS-8: Flow at Passaic River Inlet as a Percentage of Outlet Flow**

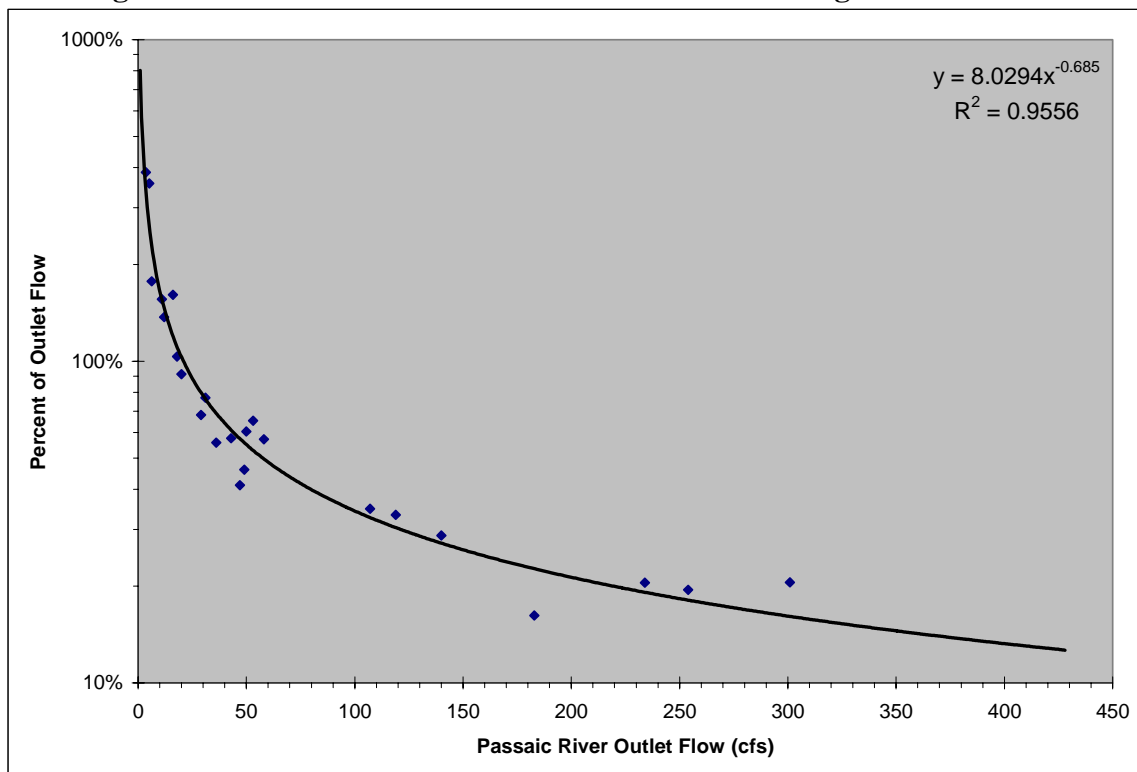


Figure GS-9: Flow at Primrose Brook Inlet as a Percentage of Outlet Flow

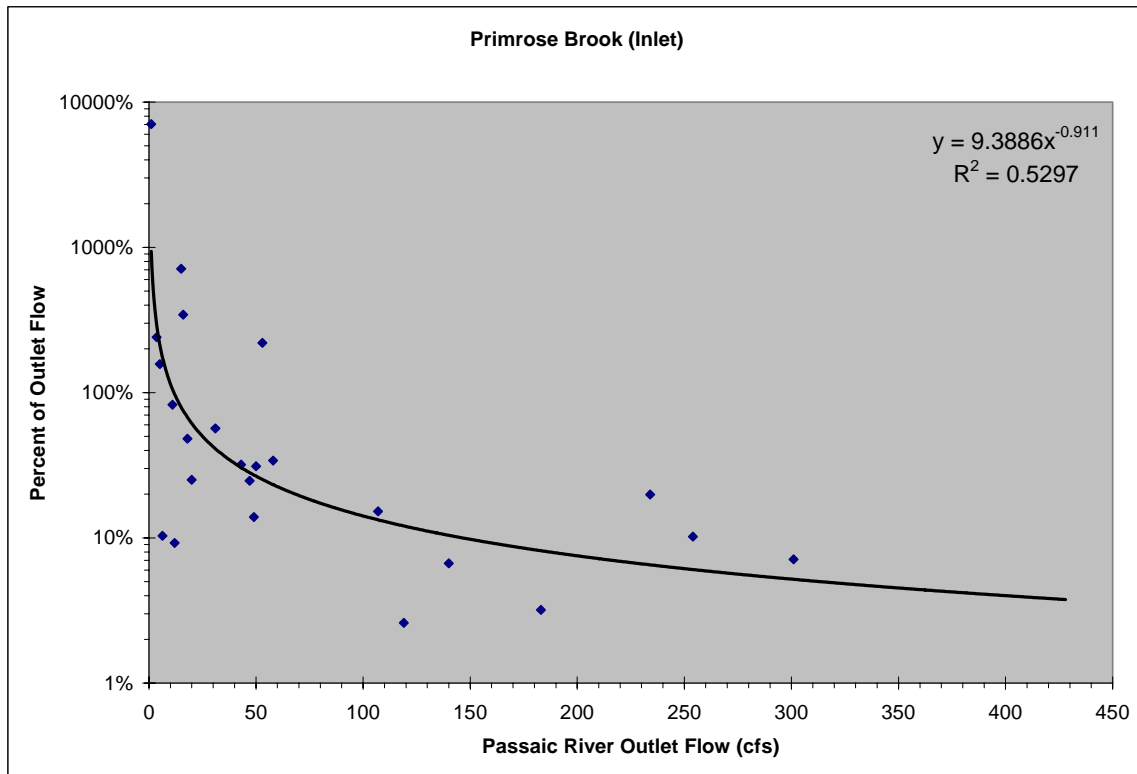


Figure GS-10: Flow at Great Brook Inlet as a Percentage of Outlet Flow

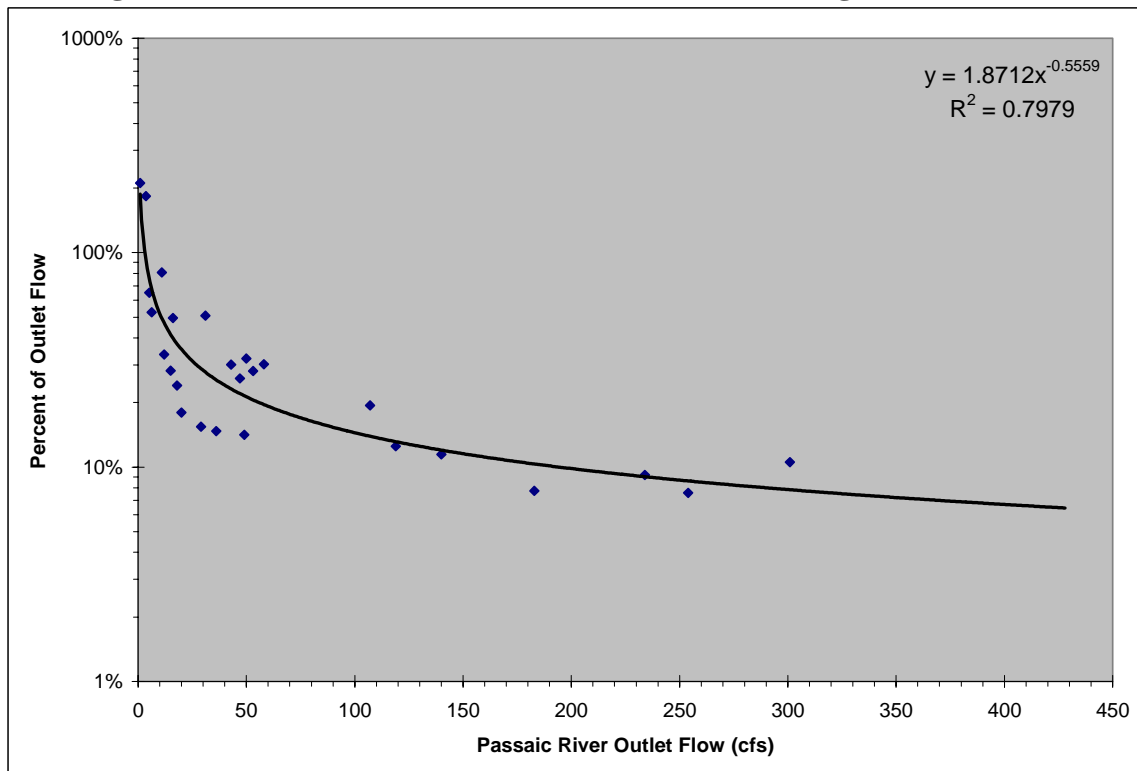


Figure GS-11: Flow at Loantaka Brook Inlet as a Percentage of Outlet Flow

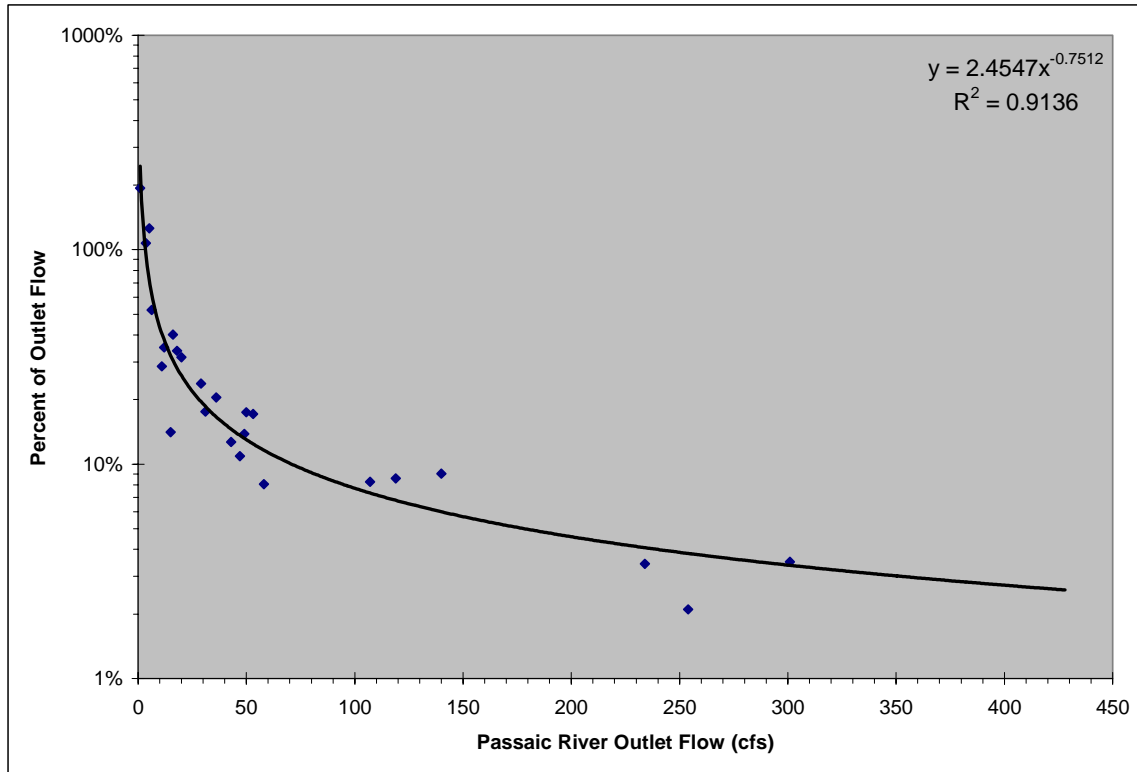
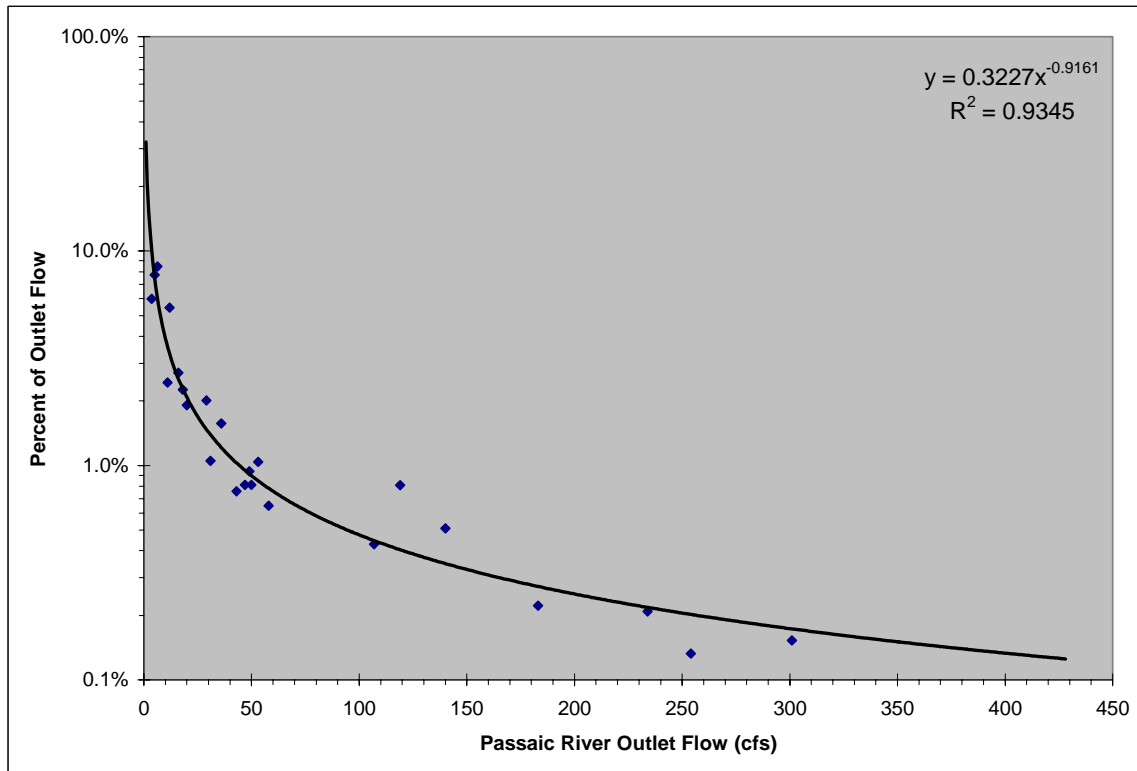


Figure GS-12: Flow at Black Brook Inlet as a Percentage of Outlet Flow



#### **IV. Characterization of Loads**

Given the hydrologic and pollutant loading characteristics of the Great Swamp, it makes sense to evaluate annual loads over multiple years. Looking at annual loads integrates the seasonal storage and release mechanism that are occurring and allows a direct comparison between the loads entering and exiting the Great Swamp. Loads for all subwatershed inlets and the two STP point sources were therefore calculated on a daily time scale for a seven-year period from 1999 through 2005, and then summed up annually.

Daily flows for each subwatershed inlet were calculated based on the outlet flow using the power functions described previously. Daily average flows for the Morris-Woodland STP and the Chatham-Main STP were based on the average of the flows available for each month. For most months, only monthly Discharge Monitoring Report (DMR) data were used. For months for which no flow data were available, the average flows of 2.066 cfs and 1.126 cfs were used for the Morris-Woodland and Chatham-Main STPs, respectively. Daily flow records at the USGS stream flow gage (01379000) were used to characterize flow at the Great Swamp outlet.

Total phosphorus concentrations for each day at the subwatershed inlets were assumed to vary by growing season and general flow condition as shown previously in Figure GS-6 and in Table GS-1 below. Daily total phosphorus concentrations of treated effluent from Morris-Woodland STP and Chatham-Main STP were based on the average of the effluent concentrations available for each month. For most months, monthly DMR data were used. For months for which no data were available, the average effluent phosphorus concentrations for summer and winter were used, as shown in Table GS-2 below. Total phosphorus concentrations at the Great Swamp outlet (Passaic River at Millington Gorge) were assumed to vary on a bi-monthly basis according to the averages shown in Table GS-3. Each of these assumptions was carefully selected based on the amount of data available and the trends observed.

**Table GS-1: Average Inlet Phosphorus Concentrations**

Season	Flow Condition	Passaic River Inlet	Primrose Brook Inlet	Great Brook Inlet	Loantaka Brook Inlet	Black Brook Inlet
Growing Season	High-Flow	0.096	0.327	0.215	0.556	0.490
	Moderate	0.069	0.180	0.164	0.431	0.393
	Low-Flow	0.055	0.145	0.081	0.309	0.137
Non-Growing Season	High-Flow	0.055	0.094	0.086	0.262	0.256
	Moderate	0.047	0.082	0.088	0.270	0.192
	Low-Flow	0.035	0.036	0.048	0.158	0.055

**Table GS-2: Average Effluent Phosphorus Concentrations**

Summer / Winter	Morris-Woodland STP	Chatham-Main STP
Summer	0.541	0.470
Winter	0.493	0.287

**Table GS-3: Average Outlet Phosphorus Concentrations<sup>3</sup>**

Bi-Month	Passaic River (Outlet)
Dec-Jan	0.064
Feb-March	0.040
April-May	0.090
June-July	0.141
Aug-Sept	0.166
Oct-Nov	0.078

In order to assess the performance of the resultant empirical model of daily total phosphorus concentrations at each of the five inlets as well as the outlet, model predictions were compared with actual measurements. The following goodness-of-fit statistics were calculated for each inlet and the outlet and are provided in Table GS-4:

Mean Error: the average residual (predicted minus observed);

<sup>3</sup> The average bi-monthly concentrations at the outlet were based on GSWA data; data collected by Omni during the TMDL monitoring program were used as an independent validation of the resultant model for the Great Swamp outlet (Passaic River headwater boundary).

% Mean Error: the Mean Error divided by the average observed concentration;

Mean Absolute Error: the average absolute residual (absolute value of predicted minus observed); and

Root Mean Squared Error: the square root of the average squared residual,

$$RMSE = \sqrt{\frac{\sum (Predicted - Observed)^2}{N}},$$

where N = the number of observations.

Since the main purpose of the model is to characterize loads in and out of the Great Swamp over time rather than daily concentrations, the Mean Error and Percent Mean Error are the most important statistics. If the Mean Error is zero, then overpredictions of daily concentrations are exactly balanced by underpredictions. This is important, since daily loads are summed up over time to characterize seasonal and annual loads. The Percent Mean Errors are under 2%. Statistics for the outlet were calculated separately for the GSWA data used to estimate the bimonthly concentration averages, and the Omni TMDL sampling data were used for model validation. These statistics show a remarkably good fit for each of the inlets as well as the outlet.

In order to determine whether the residual errors were skewed one way or another under different flow conditions, Figures GS-13 through GS-18 show the residual errors plotted against the gaged flow at the outlet. The Great Swamp inlets from the Passaic River and Great Brook comprise approximately two-thirds of the flow into the Great Swamp and exhibit very low residual errors (i.e., good fit), as does the Passaic River at the Great Swamp outlet. The higher residual values at the inlets from Black Brook and Primrose Brook reflect the greater variation in phosphorus concentrations observed at those locations, apparently the result of intermittent sources. Even those inlets with higher residual errors, however, exhibit no bias with respect to flow that would confound the load calculations. For instance, if the model were overpredicting phosphorus concentration during low stream flow conditions, but underpredicting phosphorus concentration during higher stream flow conditions, load predictions would be grossly in error even though the Mean Error might look very good. The fact that the residual errors are balanced positive and negative and are not skewed with respect to stream flow conditions reflects the

overall fitness of the predicted concentrations for performing load calculations. The goodness-of-fit statistics and residual versus flow graphs clearly demonstrate that the empirical model of phosphorus concentrations is very strong across a full range of flow conditions.

**Table GS-4: Goodness-of-Fit Statistics for Empirical TP Concentration Model**

Great Swamp Boundary		Mean Error	% Mean Error	Mean Absolute Error	Root Mean Squared Error
Passaic River (Inlet)		0.000	0.00%	0.021	0.026
Primrose Brook (Inlet)		0.000	0.30%	0.113	0.155
Great Brook (Inlet)		-0.001	-1.22%	0.046	0.064
Loantaka Brook (Inlet)		0.003	1.04%	0.128	0.167
Black Brook (Inlet)		0.000	0.00%	0.147	0.180
Passaic River (Outlet)	Calibration (GSWA)	0.000	-0.29%	0.023	0.029
	Validation (Omni)	-0.005	-3.68%	0.035	0.046
	All Outlet Data	-0.001	-1.17%	0.025	0.033

**Figure GS-13: Residual TP Error at Passaic River Inlet Versus Outlet Flow**

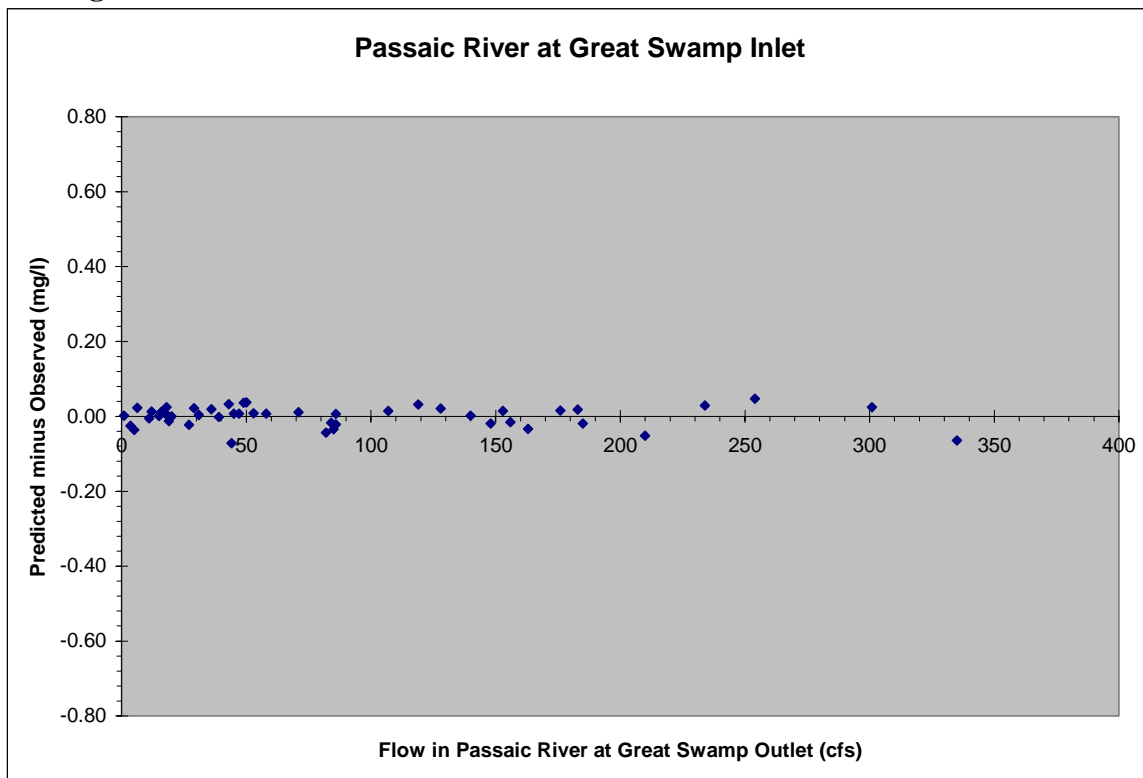


Figure GS-14: Residual TP Error at Primrose Brook Inlet Versus Outlet Flow

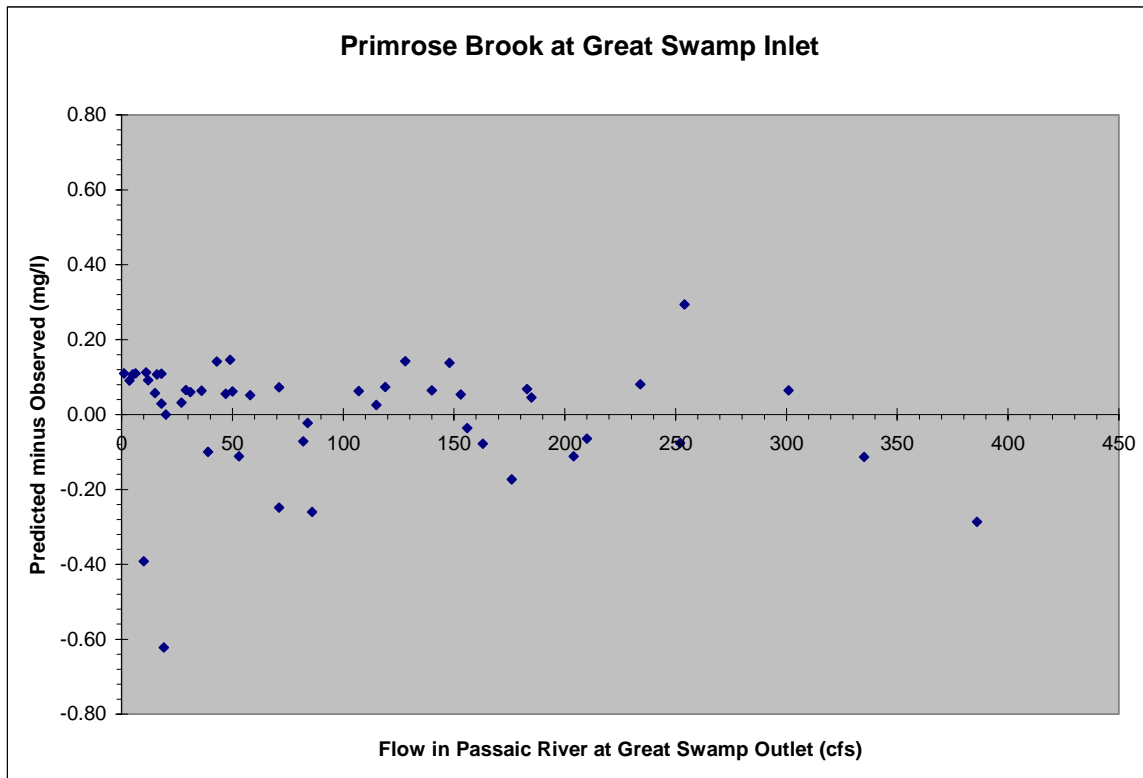


Figure GS-15: Residual TP Error at Great Brook Inlet Versus Outlet Flow

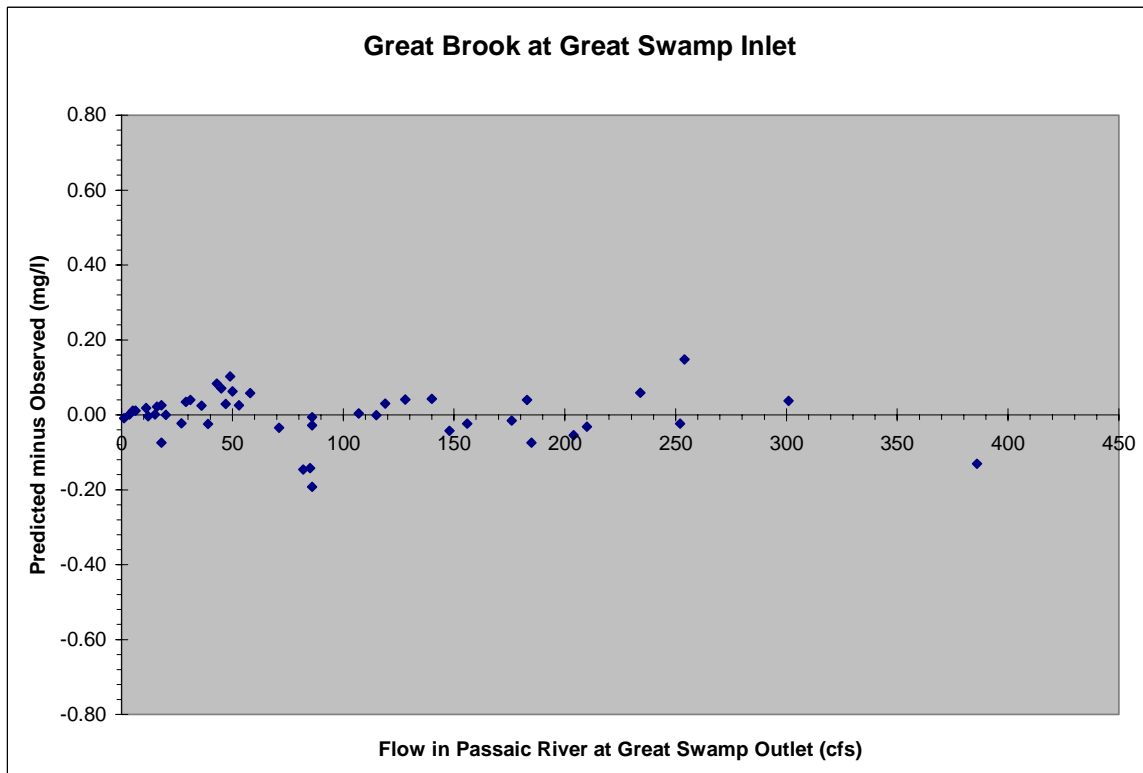


Figure GS-16: Residual TP Error at Loantaka Brook Inlet Versus Outlet Flow

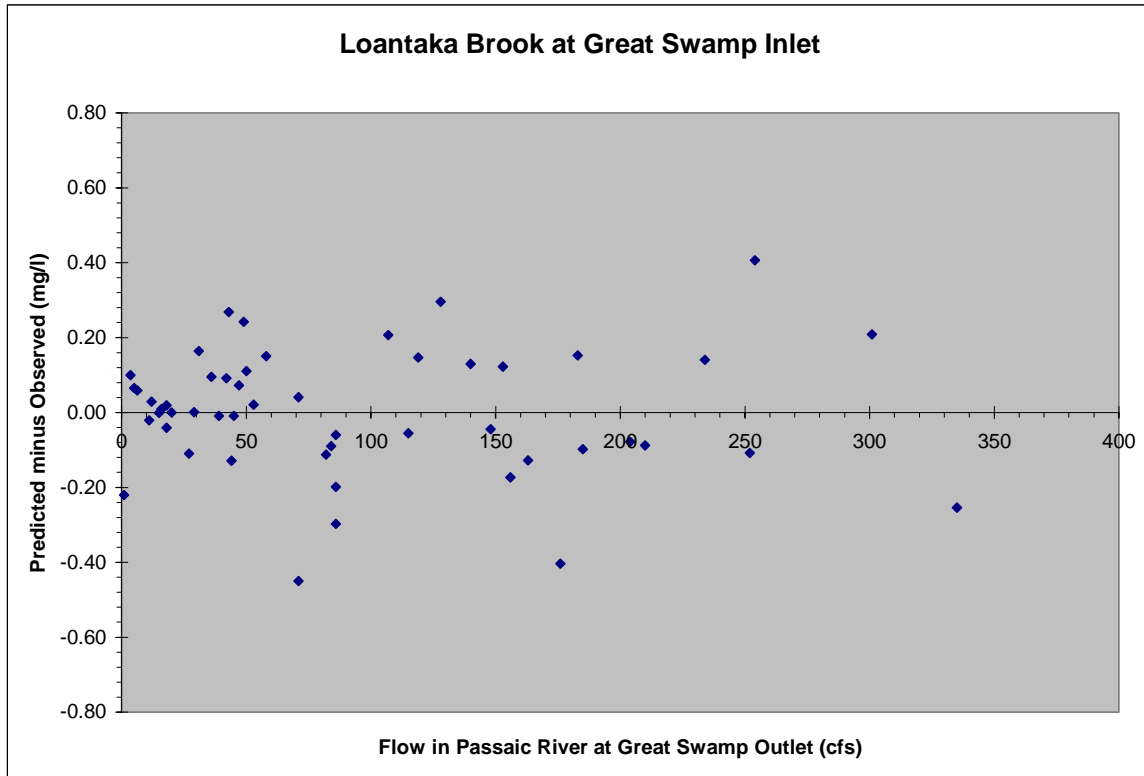


Figure GS-17: Residual TP Error at Black Brook Inlet Versus Outlet Flow

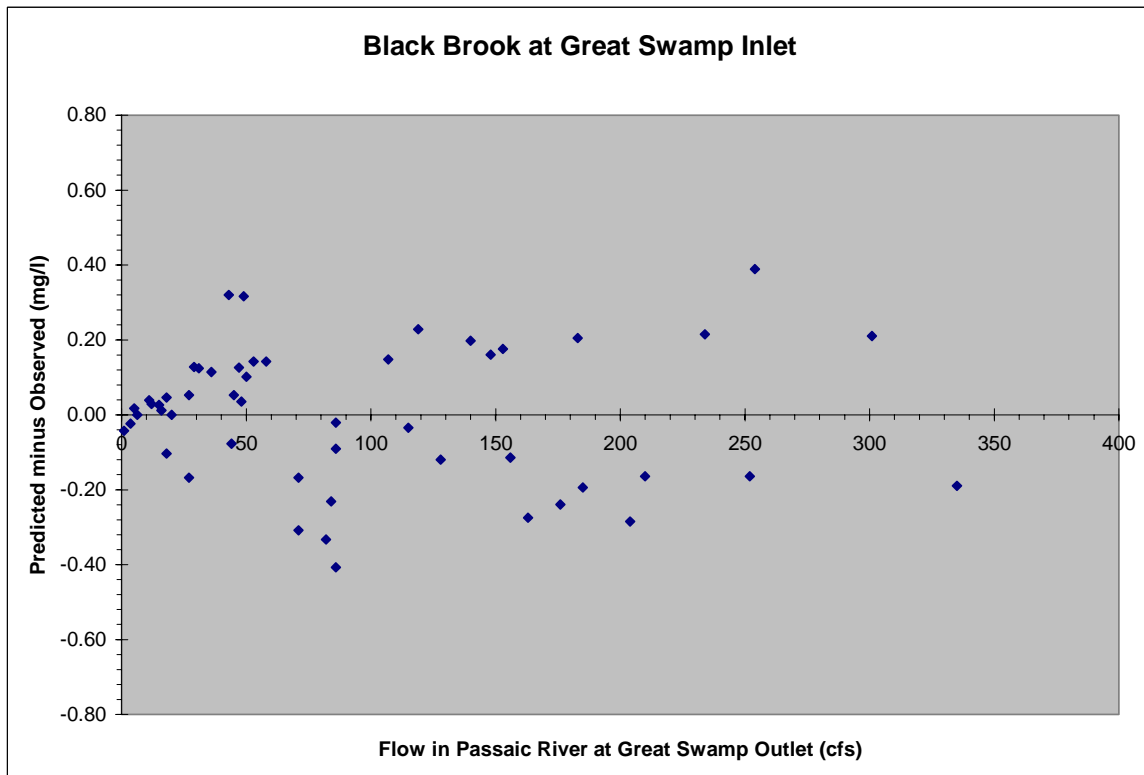
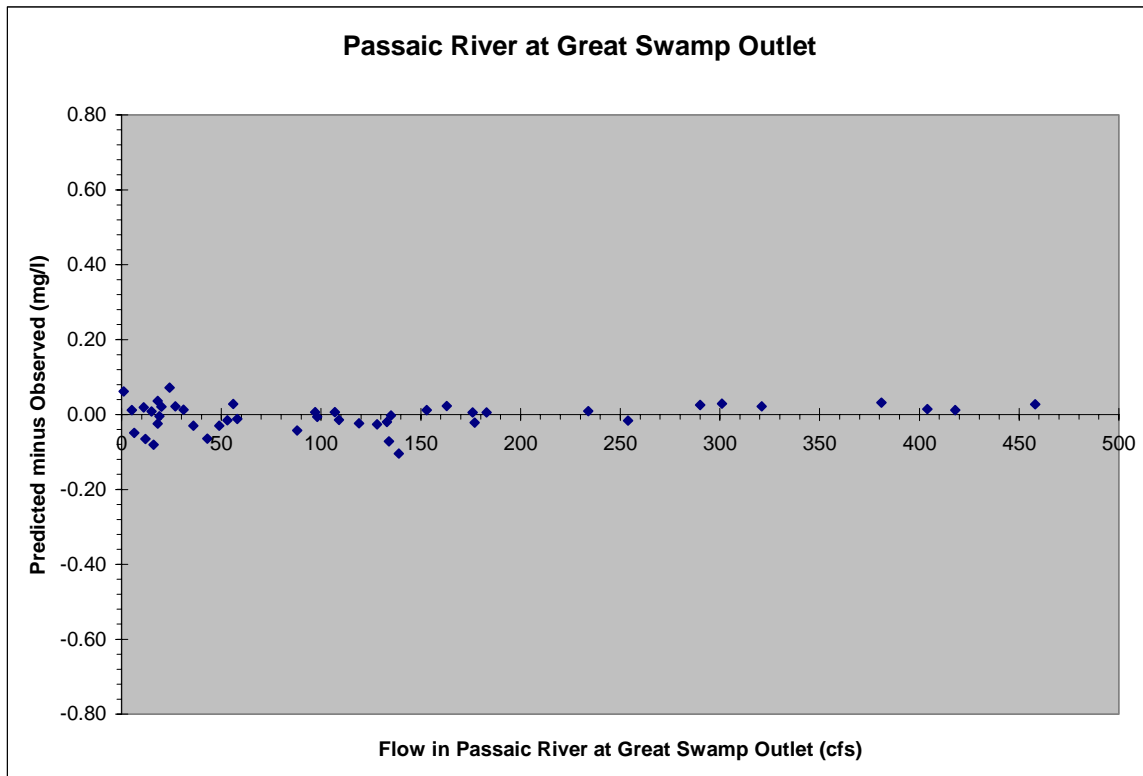
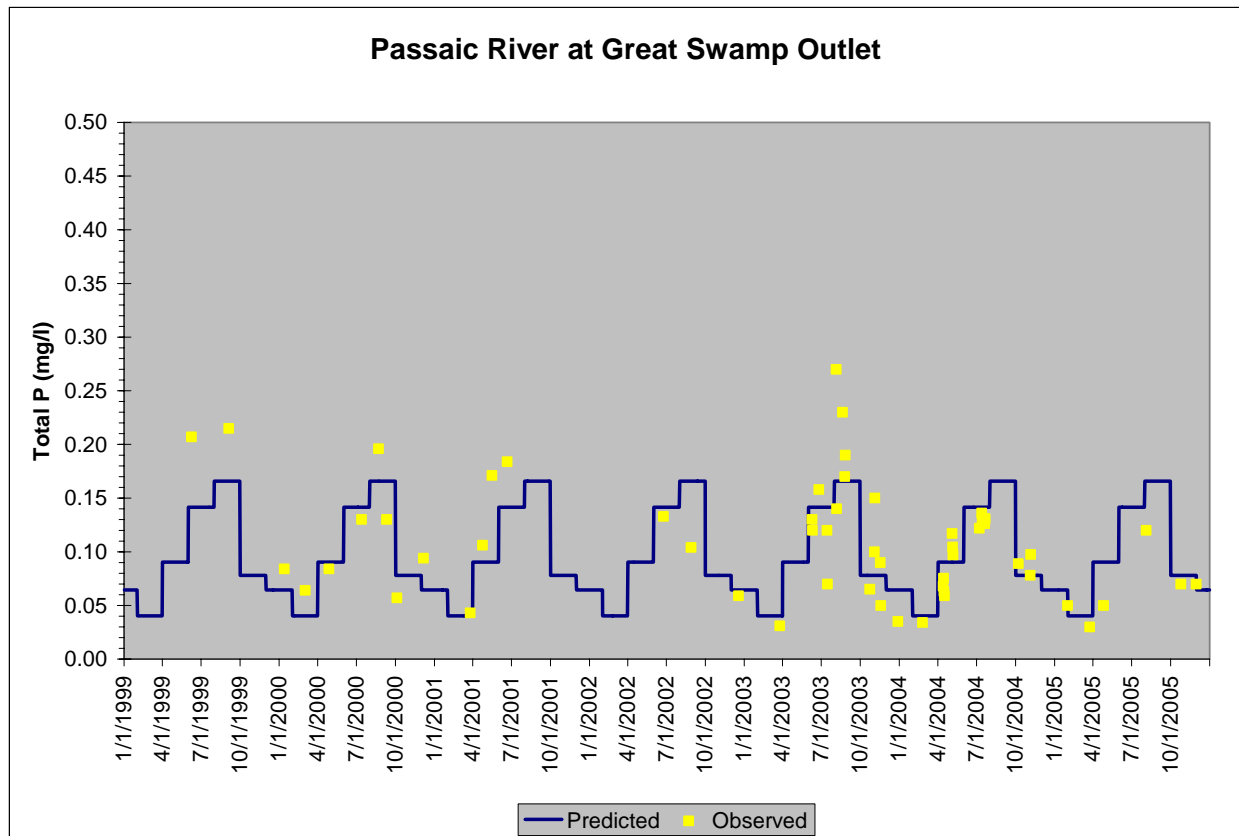


Figure GS-18: Residual TP Error at Passaic River Outlet Versus Flow



Since the Great Swamp outlet is also the Passaic River headwater boundary, the total phosphorus concentrations predicted using the empirical model described above at this location were also used to develop the headwater boundary condition for the Passaic TMDL model. Figure GS-19 shows the predicted and observed total phosphorus concentrations over time, demonstrating an excellent fit. The predicted seasonally varying total phosphorus concentrations based on bimonthly concentrations were used along with actual measured concentrations to develop a seasonally-varying boundary condition for total phosphorus at the Passaic River headwater boundary. The empirical model developed herein provides a very solid basis for the headwater boundary condition used for the Passaic TMDL model.

Figure GS-19: Predicted Versus Observed TP at Passaic River at Great Swamp Outlet



As described above, powerful empirical tools were developed to calculate both stream flow rates and total phosphorus concentrations at the inlets and outlet of the Great Swamp. The only inputs required include gaged flow rate at the outlet (Passaic River at Millington) and the month of the year. Based on these two inputs, flows and total phosphorus concentrations can be calculated at each of the five inlets as well as the outlet of Great Swamp. Given the strength of the empirical relationships observed in the system, this empirically based model calculates loads in and out of the Great Swamp with a relatively high degree of certainty.

Phosphorus loads in and out of Great Swamp were calculated on a daily time scale over a seven-year period from 1999 through 2005. The load from the Morris-Woodland STP was subtracted out of the load from the Loantaka Brook inlet in order to account for point and nonpoint source loads independently. No attenuation was assumed from Morris-Woodland STP to the Loantaka Brook inlet location (approximately 3.2 miles), making the estimation of load from Morris-Woodland STP conservative. However, the total load from both Morris-Woodland

STP and Loantaka Brook is based on measured data; only the portion of that load attributed to Morris-Woodland STP can be considered conservative. The Chatham-Main STP discharges within the Great Swamp as defined in this analysis; that load is calculated directly.

Figure GS-20 shows the composition of phosphorus loads to Great Swamp over the seven-year period analyzed. Figure GS-21 shows the annual loads in and out of the Great Swamp from 1999 to 2005, along with the average annual loads. During dry years like 2001 and 2002, Great Swamp functions like a sink; more phosphorus enters Great Swamp than leaves it. On the other hand, during wet years like 2003, Great Swamp acts like a source; much more phosphorus leaves the Great Swamp than enters it. It is important to recall that this analysis is not a water or phosphorus balance; it merely calculates loads entering and exiting the Great Swamp. There are important processes within the Swamp that very likely affect the balance of both water and phosphorus, such as groundwater discharge.

**Figure GS-20: Composition of Phosphorus Loads to Great Swamp**

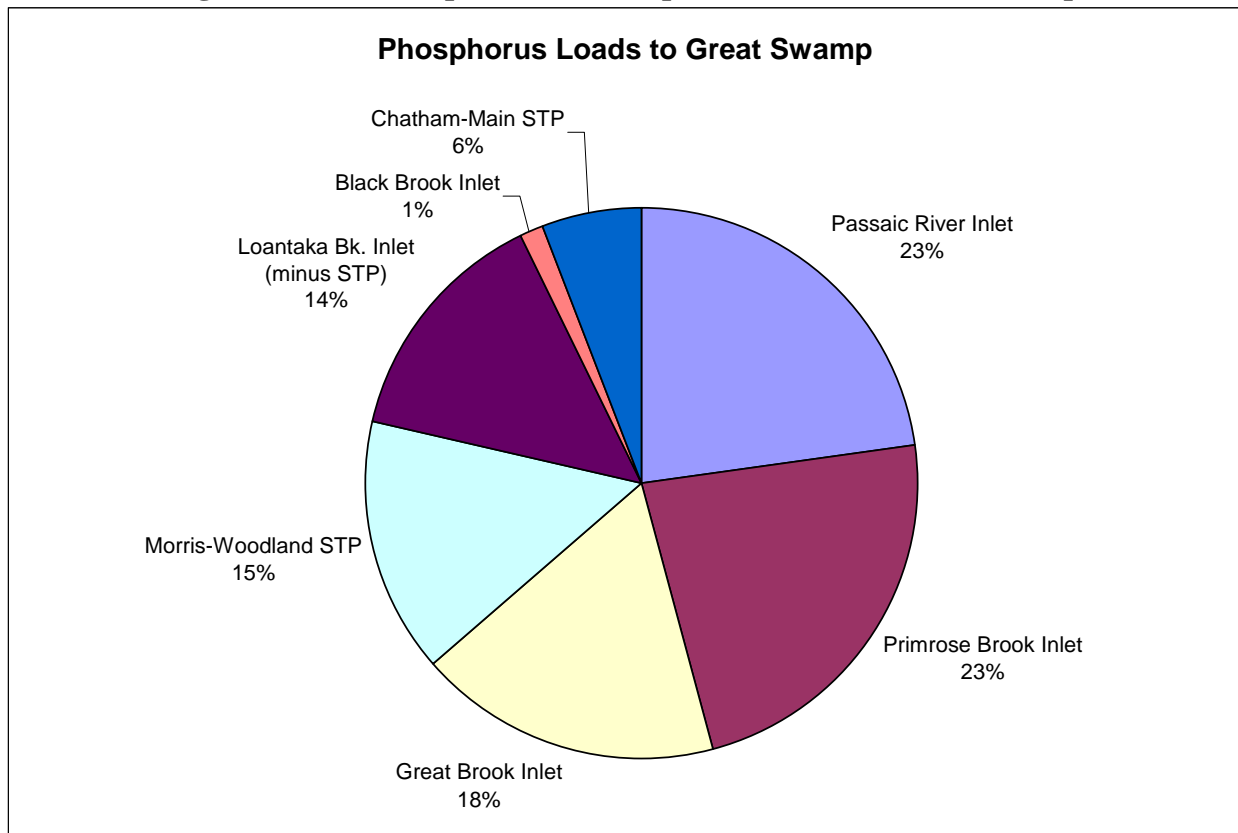
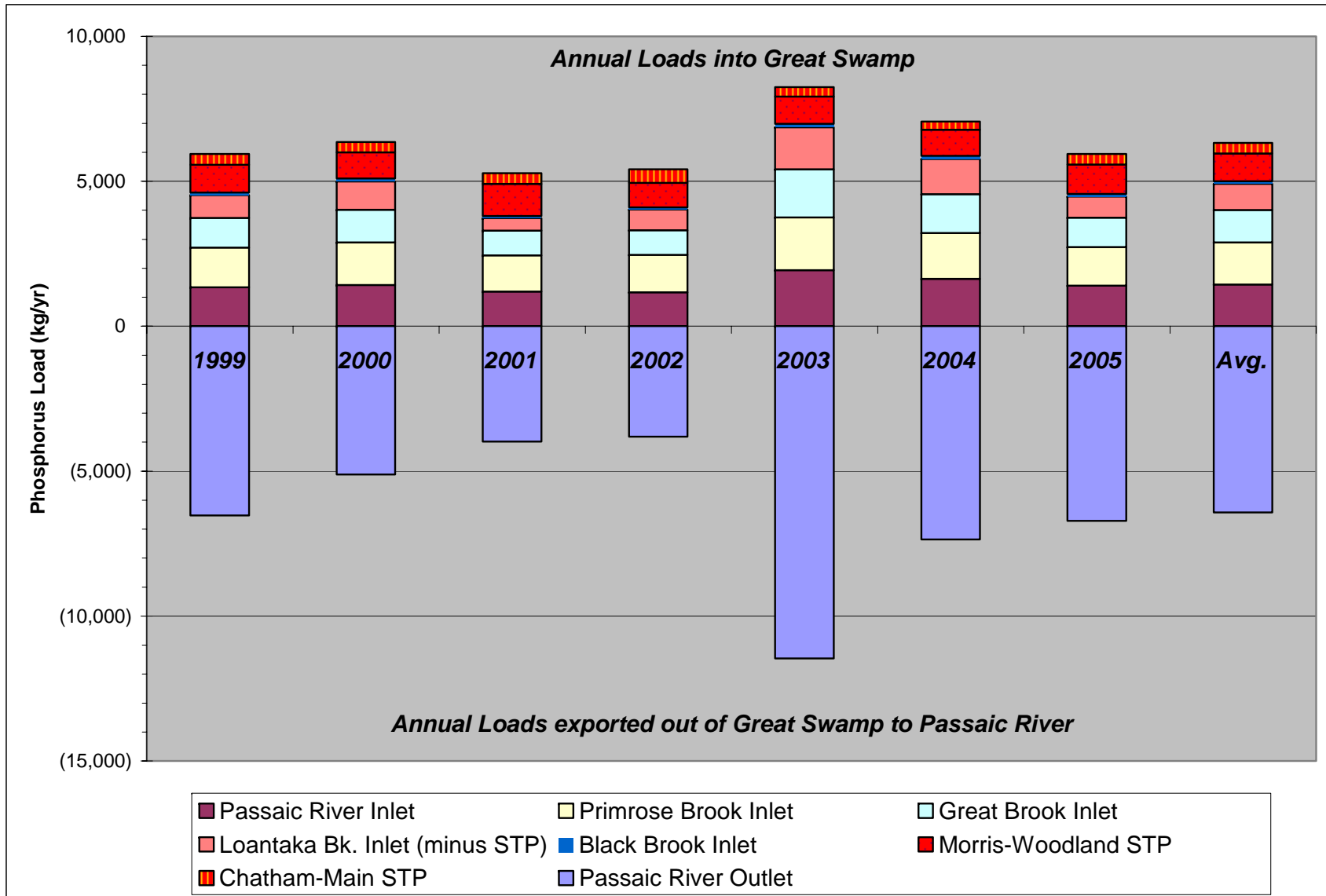


Figure GS-21: Annual Phosphorus Load Summary for Great Swamp (1999 – 2005)



**V. STP Loads**

It is not known whether decreases in phosphorus loads to Great Swamp would change the phosphorus condition at the outlet. Nevertheless, since the loads entering Great Swamp are similar in magnitude to the loads exported from Great Swamp to the Passaic River, it is justified to establish limits to prevent future loads from increasing.

Both the Morris-Woodland and Chatham-Main STPs remove phosphorus in order to satisfy effluent limitations of 1.0 mg/l total phosphorus. Table GS-5 provides average effluent phosphorus concentrations and flows for both STPs based on the effluent data analyzed (July 2000 to April 2005), along with permitted effluent phosphorus concentrations and flows.

**Table GS-5: Actual and Permitted Effluent Phosphorus Concentrations and Flows**

Actual / Permitted	Effluent Flow / Concentration	Morris-Woodland	Chatham-Main
Actual	Concentration (mg/l TP)	0.517	0.383
	Flow (cfs)	2.07	1.13
Permitted	Maximum Concentration (mg/l TP)	1.0	1.0
	LTA Concentration (mg/l TP) <sup>1</sup>	0.526	0.483
	Flow (cfs)	3.094 (2 MGD)	1.547 (1 MGD)

Figure GS-22 compares the average annual phosphorus loads from each of the STPs to the annual loads associated with two scenarios:

- 0.4 mg/l at Permitted Flow – effluent concentration of 0.4 mg/l discharging at the permitted effluent flow; and
- Permitted Flow and Concentration<sup>4</sup> – permitted effluent concentration (LTA based on monthly limit of 1.0 mg/l total phosphorus) discharging at the permitted effluent flow.

It is important to understand how the loads associated with these STP scenarios compare with the overall loads imported to the Great Swamp. Figure GS-23 shows the average annual phosphorus load imported to Great Swamp for each of the STP loading scenarios. Nonpoint

<sup>4</sup> For long-term loading calculations, the permitted average monthly effluent concentrations were translated into permitted long-term averages (LTA) based on assumed coefficient of variation of 0.6 and the number of samples per month at each facility.

source loads from the subwatershed inlets are distinguished from the point source loads in the graph. If one assumes that the incremental load associated with Permitted Flows and Concentrations is not attenuated at all from the point of discharge to the outlet of the Great Swamp, the load would translate into an average concentration increase of 0.01 mg/l in the Passaic River at the outlet of the Great Swamp. On the other hand, LTA effluent concentrations of 0.4 mg/l total phosphorus would hold the phosphorus loads imported to Great Swamp very near their current levels even when the treatment plants are discharging at their permitted flows. In fact, the average total phosphorus load imported to Great Swamp would remain less than 5% more than the average total phosphorus load currently exported from Great Swamp to the Passaic River. It is therefore technically justified to impose effluent limits of 0.4 mg/l LTA total phosphorus on the STPs in the Great Swamp watershed in order to prevent potential increases to the phosphorus loads and concentrations exported from the Great Swamp to the Passaic River.

**Figure GS-22: Average Annual STP Loads Associated with Effluent Loading Scenarios**

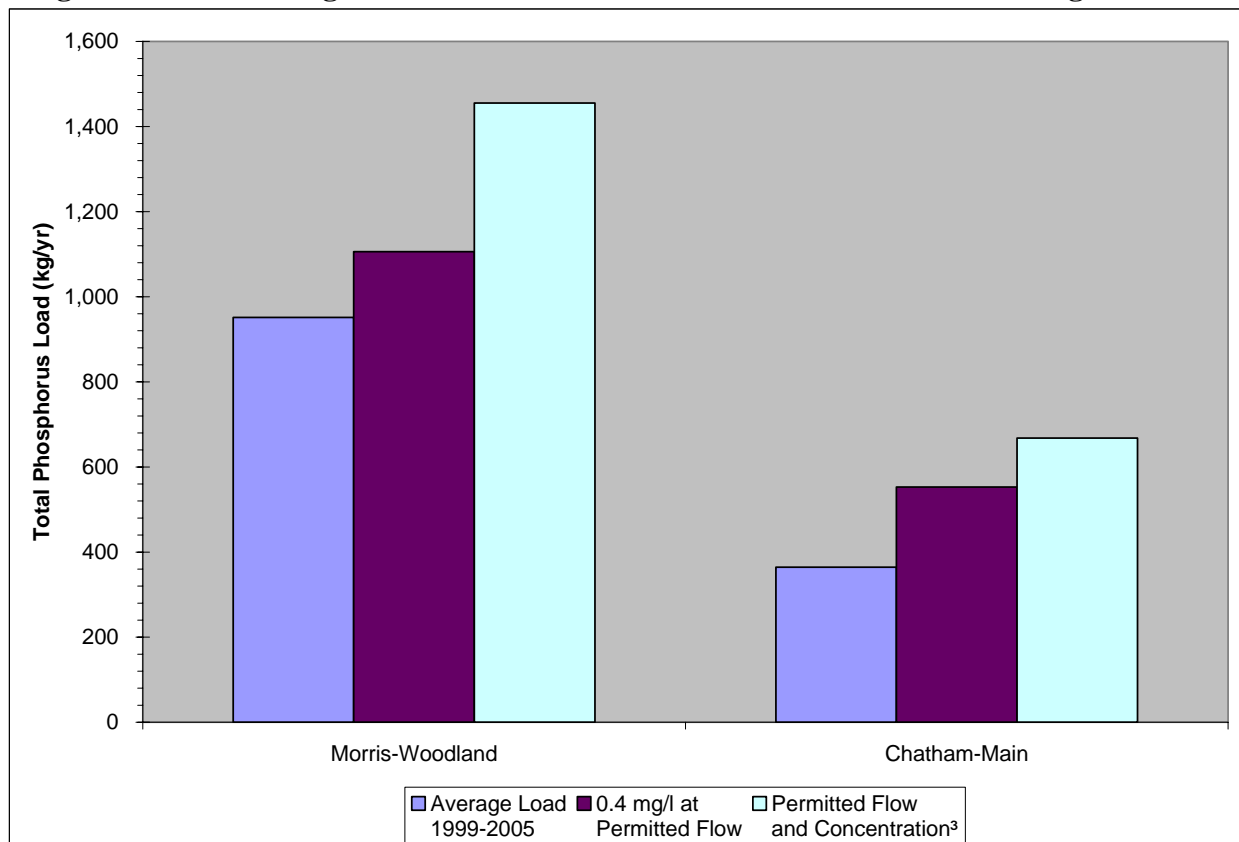
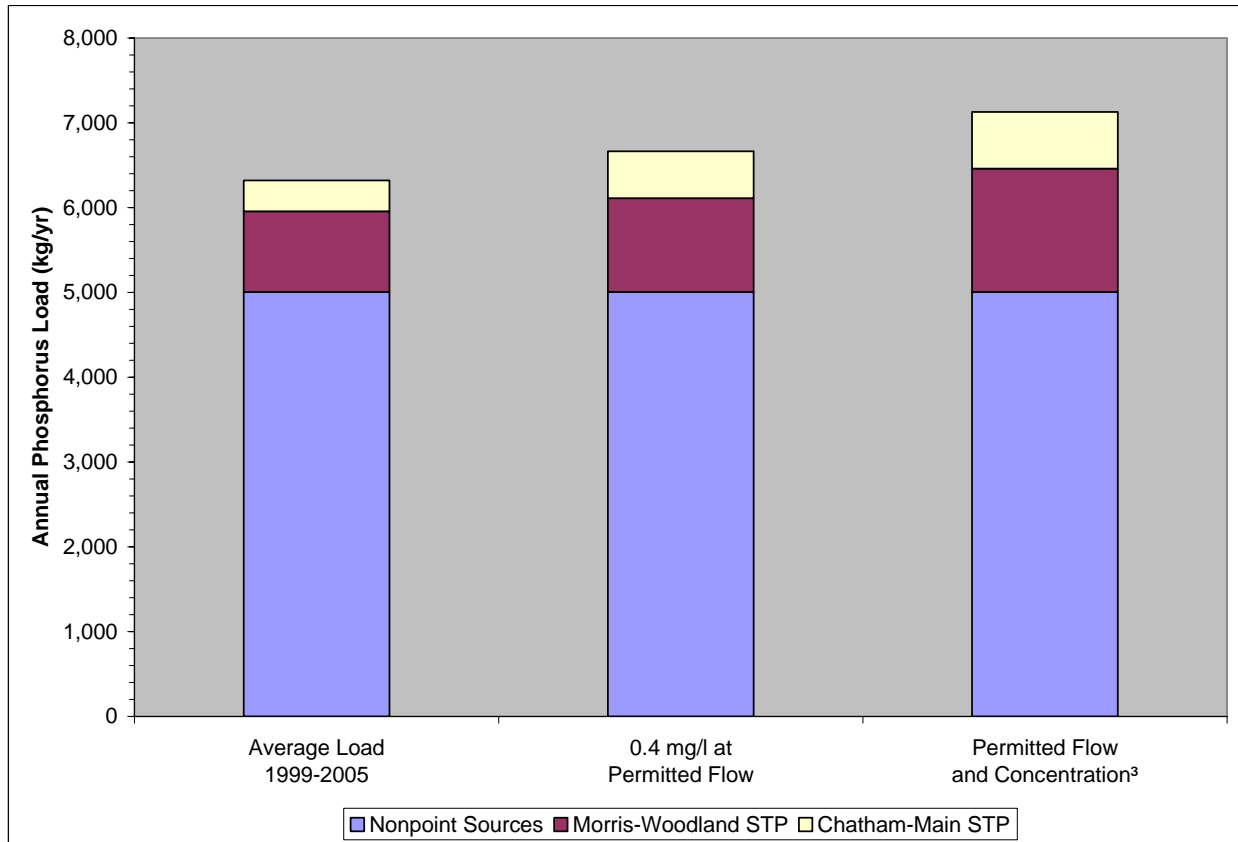


Figure GS-23: Overall Loads to Great Swamp Associated with Effluent Loading Scenarios



## **VI. Conclusion**

Total phosphorus concentrations at the inlets to the Great Swamp vary by growing season and general flow condition, and total phosphorus concentrations at the Great Swamp outlet (Passaic River at Millington Gorge) vary on a seasonal basis. Furthermore, the relationships between flows at the inlets to the Great Swamp as a percentage of outlet flow and the outlet flow itself turn out to be very strong when described using a power function for each inlet. As a result, powerful empirical tools were developed to calculate both flow rates and total phosphorus concentrations at the inlets and outlet of the Great Swamp. The only inputs required include gaged flow rate at the outlet and the month of the year. Based on these two inputs, flows and total phosphorus concentrations were calculated at each of the five inlets as well as the outlet of Great Swamp.

Given the strength of the empirical relationships observed in the system, both the hydrology and phosphorus concentrations at the inlets and outlet of the Great Swamp are remarkably predictable, albeit in ways that are counterintuitive. Over the seven-year period analyzed, the total load leaving Great Swamp was almost the same as the load entering Great Swamp. The year-to-year pattern suggests that Great Swamp experiences substantial year-to-year variation in the degree to which it functions as a phosphorus source or a phosphorus sink according to hydrologic and seasonal patterns. The highest phosphorus loads are exported from Great Swamp during summer high flow events, when high phosphorus concentrations get flushed into the Passaic River. The fact that phosphorus concentrations within the swamp and exported from the swamp are highest during the summer when uptake is highest suggest that the sediment dynamics in the wetlands are driving the phosphorus conditions rather than plant uptake.

The outlet of Great Swamp (Passaic River at Millington Gorge) exhibits seasonally varying phosphorus concentrations, from a low of 0.04 mg/l in February to a high of 0.166 mg/l in August. During the summer when phosphorus concentrations at the outlet (and within the Great Swamp) are highest, especially during critical dry summers, the Great Swamp is functioning like a sink; more phosphorus is entering the swamp than leaving during those periods. Baseflow concentrations in the Passaic River, Primrose Brook, and Great Brook inlets can be estimated by averaging their concentrations during low-flow conditions when nonpoint

sources would have minimal impact. The average low-flow phosphorus concentration at these three inlets is 0.097 mg/l during the growing season and 0.04 mg/l during the non-growing season. This can be considered a conservative estimate of background contribution; in reality, a portion of the phosphorus carried in stormwater is likely due to background sources as well. The sediment interactions within Great Swamp receive phosphorus load over time and deliver it to the outlet with higher concentrations during the growing season and lower concentrations during the non-growing season.

Since the loads entering Great Swamp are similar in magnitude to the loads exported from Great Swamp to the Passaic River, it is technically justified to impose effluent limits of 0.4 mg/l LTA total phosphorus on the STPs within the Great Swamp. While a direct link between loads imported and loads exported from Great Swamp could not be established based on existing information, 0.4 mg/l LTA effluent concentrations will prevent the phosphorus loads entering the Great Swamp from increasing such that the loads and concentrations exported to the Passaic River might potentially increase as well.

This research was limited by the available information and the scope of the analysis. The intent was to synthesize available datasets and to make the best possible characterization of loads based on existing data. The fact that the loads into and out of the Great Swamp can be empirically modeled with a reasonable degree of certainty was a surprising and helpful outcome. As a result, the study provided a seasonally varying boundary condition for phosphorus concentration at the Passaic River headwater (the outlet of Great Swamp) that was used to enhance the Non-Tidal Passaic River Basin TMDL Study. In addition, the study characterized the phosphorus loads from the two major treatment plants in the context of all the other loads into the Great Swamp as well as the load exported out of the Great swamp into the Passaic River, providing the technical basis to recommend effluent limits of 0.4 mg/l LTA total phosphorus for these facilities.

However, additional study is needed to better understand the sources of the phosphorus loads that are currently imported to the Great Swamp, as well as the processes within the Great Swamp that affect phosphorus storage and release. A detailed study of the sources of phosphorus currently imported to the Great Swamp through its inlets would isolate the natural background component from the anthropogenic sources, and provide a better determination of

how much of the inlet phosphorus load can be reduced through phosphorus reduction measures. Furthermore, a detailed water budget and phosphorus budget would be necessary to better understand how phosphorus reductions at the inlets would translate into phosphorus reductions exported through the outlet to the Passaic River. Additional studies as described would require considerable additional data and information. This study provided a detailed characterization of phosphorus loads based solely on existing information.

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
Inlet	Black Brook (Inlet)	BB	GSWA	2/13/1999	0.9	0.213	0.048
Inlet	Black Brook (Inlet)	BB	GSWA	5/20/1999	0.8	0.483	0.037
Inlet	Black Brook (Inlet)	BB	GSWA	6/8/1999	0.7	0.108	0.048
Inlet	Black Brook (Inlet)	BB	GSWA	9/4/1999	0.5	0.137	0.082
Inlet	Black Brook (Inlet)	BB	GSWA	10/10/1999	0.6	0.157	0.080
Inlet	Black Brook (Inlet)	BB	GSWA	11/3/1999	0.9	0.525	0.254
Inlet	Black Brook (Inlet)	BB	GSWA	3/2/2000	1.0	0.027	0.007
Inlet	Black Brook (Inlet)	BB	GSWA	3/18/2000	1.0	0.420	0.039
Inlet	Black Brook (Inlet)	BB	GSWA	4/25/2000	0.7	0.058	0.033
Inlet	Black Brook (Inlet)	BB	GSWA	5/11/2000	0.7	0.470	0.108
Inlet	Black Brook (Inlet)	BB	GSWA	6/22/2000	0.6	0.340	0.060
Inlet	Black Brook (Inlet)	BB	GSWA	7/13/2000	0.4	0.119	0.072
Inlet	Black Brook (Inlet)	BB	GSWA	7/27/2000	2.6	0.330	0.095
Inlet	Black Brook (Inlet)	BB	GSWA	8/22/2000	0.5	0.076	0.044
Inlet	Black Brook (Inlet)	BB	GSWA	9/10/2000	0.4	0.090	0.040
Inlet	Black Brook (Inlet)	BB	GSWA	9/26/2000	1.5	0.340	0.058
Inlet	Black Brook (Inlet)	BB	GSWA	10/4/2000	0.4	0.055	0.032
Inlet	Black Brook (Inlet)	BB	GSWA	11/10/2000	1.3	0.500	0.198
Inlet	Black Brook (Inlet)	BB	GSWA	11/19/2000	0.6	0.064	0.045
Inlet	Black Brook (Inlet)	BB	GSWA	12/6/2000	0.6	0.078	0.025
Inlet	Black Brook (Inlet)	BB	GSWA	12/17/2000	9.1	0.450	0.081
Inlet	Black Brook (Inlet)	BB	GSWA	1/31/2001	1.3	0.290	0.043
Inlet	Black Brook (Inlet)	BB	GSWA	3/22/2001	1.5	0.420	0.049
Inlet	Black Brook (Inlet)	BB	GSWA	4/24/2001	0.5	0.050	0.019
Inlet	Black Brook (Inlet)	BB	GSWA	5/16/2001	0.4	0.125	0.017
Inlet	Black Brook (Inlet)	BB	GSWA	6/2/2001	5.5	0.680	0.090
Inlet	Black Brook (Inlet)	BB	GSWA	6/17/2001	1.9	0.800	0.144
Inlet	Black Brook (Inlet)	BB	GSWA	9/26/2001	0.4	0.240	0.054
Inlet	Black Brook (Inlet)	BB	GSWA	11/26/2001	0.4	0.360	0.168
Inlet	Black Brook (Inlet)	BB	GSWA	6/24/2002		0.110	0.061
Inlet	Black Brook (Inlet)	BB	GSWA	8/28/2002		0.179	0.122
Inlet	Black Brook (Inlet)	BB	GSWA	12/18/2002	0.4	0.051	0.020
Inlet	Black Brook (Inlet)	BB	GSWA	3/25/2003	0.5	0.041	0.009

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
Inlet	Black Brook (Inlet)	BB	GSWA	6/25/2003	0.3	0.101	0.064
Inlet	Black Brook (Inlet)	BB	GSWA	8/20/2003	0.3	0.072	0.001
Inlet	Black Brook (Inlet)	BB	GSWA	10/23/2003	0.3	0.068	0.040
Inlet	Black Brook (Inlet)	BB	GSWA	12/28/2003	0.5	0.045	0.022
Inlet	Black Brook (Inlet)	BB	GSWA	2/24/2004	0.5	0.044	0.012
Inlet	Black Brook (Inlet)	BB	GSWA	4/13/2004	1.0	0.530	0.080
Inlet	Black Brook (Inlet)	BB	GSWA	5/4/2004	0.5	0.610	0.037
Inlet	Black Brook (Inlet)	BB	GSWA	7/7/2004	0.3	0.098	0.057
Inlet	Black Brook (Inlet)	BB	GSWA	7/13/2004	0.9	0.730	0.104
Inlet	Black Brook (Inlet)	BB	GSWA	7/19/2004	0.7	0.560	0.082
Inlet	Black Brook (Inlet)	BB	GSWA	10/7/2004	0.4	0.066	0.001
Inlet	Black Brook (Inlet)	BB	GSWA	11/5/2004	0.6	0.423	0.235
Inlet	Black Brook (Inlet)	BB	GSWA	1/31/2005	0.4	0.090	0.045
Inlet	Black Brook (Inlet)	BB	GSWA	3/24/2005	0.9	0.080	0.001
Inlet	Black Brook (Inlet)	BB	GSWA	4/26/2005	0.4	0.050	0.027
Inlet	Black Brook (Inlet)	BB	GSWA	8/4/2005	0.2	0.160	0.090
Inlet	Black Brook (Inlet)	BB	GSWA	10/25/2005	1.5	0.370	0.110
Inlet	Black Brook (Inlet)	BB	GSWA	11/30/2005	2.2	0.540	0.078
Inlet	Great Brook (Inlet)	GB	GSWA	2/13/1999	14.0	0.116	0.024
Inlet	Great Brook (Inlet)	GB	GSWA	5/20/1999	7.5	0.356	0.011
Inlet	Great Brook (Inlet)	GB	GSWA	6/8/1999	4.0	0.084	0.032
Inlet	Great Brook (Inlet)	GB	GSWA	9/4/1999	3.3	0.070	0.025
Inlet	Great Brook (Inlet)	GB	GSWA	9/16/1999	112.5	0.346	0.060
Inlet	Great Brook (Inlet)	GB	GSWA	11/3/1999	47.2	0.234	0.061
Inlet	Great Brook (Inlet)	GB	GSWA	3/2/2000	14.9	0.056	0.008
Inlet	Great Brook (Inlet)	GB	GSWA	3/18/2000	25.1	0.118	0.020
Inlet	Great Brook (Inlet)	GB	GSWA	4/25/2000	16.0	0.043	0.023
Inlet	Great Brook (Inlet)	GB	GSWA	6/22/2000	10.6	0.093	0.010
Inlet	Great Brook (Inlet)	GB	GSWA	7/13/2000	3.3	0.070	0.020
Inlet	Great Brook (Inlet)	GB	GSWA	7/27/2000	135.0	0.258	0.040
Inlet	Great Brook (Inlet)	GB	GSWA	8/22/2000	6.9	0.061	0.025
Inlet	Great Brook (Inlet)	GB	GSWA	9/10/2000	4.3	0.055	0.031
Inlet	Great Brook (Inlet)	GB	GSWA	9/27/2000	6.9	0.188	0.026

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

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Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
Inlet	Great Brook (Inlet)	GB	GSWA	10/4/2000	3.6	0.048	0.022
Inlet	Great Brook (Inlet)	GB	GSWA	11/11/2000	11.6	0.230	0.062
Inlet	Great Brook (Inlet)	GB	GSWA	11/19/2000	4.5	0.053	0.035
Inlet	Great Brook (Inlet)	GB	GSWA	12/6/2000	5.3	0.063	0.030
Inlet	Great Brook (Inlet)	GB	GSWA	12/17/2000	212.7	0.160	0.053
Inlet	Great Brook (Inlet)	GB	GSWA	1/31/2001	37.5	0.087	0.024
Inlet	Great Brook (Inlet)	GB	GSWA	3/22/2001	55.7	0.110	0.019
Inlet	Great Brook (Inlet)	GB	GSWA	4/24/2001	14.9	0.062	0.011
Inlet	Great Brook (Inlet)	GB	GSWA	5/16/2001	7.9	0.059	0.029
Inlet	Great Brook (Inlet)	GB	GSWA	6/17/2001	111.7	0.170	0.034
Inlet	Great Brook (Inlet)	GB	GSWA	9/26/2001	7.7	0.155	0.004
Inlet	Great Brook (Inlet)	GB	GSWA	11/26/2001	6.6	0.110	0.007
Inlet	Great Brook (Inlet)	GB	GSWA	6/24/2002	4.2	0.080	0.045
Inlet	Great Brook (Inlet)	GB	GSWA	8/28/2002	2.1	0.090	0.026
Inlet	Great Brook (Inlet)	GB	GSWA	12/18/2002	14.2	0.046	0.022
Inlet	Great Brook (Inlet)	GB	GSWA	3/25/2003	21.5	0.027	0.006
Inlet	Great Brook (Inlet)	GB	GSWA	6/25/2003	19.3	0.067	0.040
Inlet	Great Brook (Inlet)	GB	GSWA	8/20/2003	12.9	0.080	0.005
Inlet	Great Brook (Inlet)	GB	GSWA	10/23/2003	15.8	0.048	0.026
Inlet	Great Brook (Inlet)	GB	GSWA	12/28/2003	31.7	0.049	0.026
Inlet	Great Brook (Inlet)	GB	GSWA	2/24/2004	20.8	0.084	0.012
Inlet	Great Brook (Inlet)	GB	GSWA	5/4/2004	27.4	0.174	0.032
Inlet	Great Brook (Inlet)	GB	GSWA	7/7/2004	8.9	0.062	0.033
Inlet	Great Brook (Inlet)	GB	GSWA	7/13/2004	139.7	0.230	0.044
Inlet	Great Brook (Inlet)	GB	GSWA	7/19/2004	22.8	0.198	0.037
Inlet	Great Brook (Inlet)	GB	GSWA	10/7/2004	12.2	0.059	0.001
Inlet	Great Brook (Inlet)	GB	GSWA	1/31/2005	16.0	0.020	0.016
Inlet	Great Brook (Inlet)	GB	GSWA	1/31/2005		0.030	0.017
Inlet	Great Brook (Inlet)	GB	GSWA	4/26/2005	17.5	0.030	0.019
Inlet	Great Brook (Inlet)	GB	GSWA	8/4/2005	6.6	0.080	0.037
Inlet	Great Brook (Inlet)	GB	GSWA	10/25/2005	76.0	0.110	0.035
Inlet	Great Brook (Inlet)	GB	GSWA	11/30/2005	221.8	0.140	0.019
Inlet	Loantaka Brook (Inlet)	LB	GSWA	2/13/1999	9.1	0.330	0.135

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
Inlet	Loantaka Brook (Inlet)	LB	GSWA	5/20/1999	8.9	0.729	0.057
Inlet	Loantaka Brook (Inlet)	LB	GSWA	6/8/1999	4.2	0.280	0.194
Inlet	Loantaka Brook (Inlet)	LB	GSWA	9/4/1999	3.3	0.250	0.206
Inlet	Loantaka Brook (Inlet)	LB	GSWA	9/30/1999	12.5	0.340	0.086
Inlet	Loantaka Brook (Inlet)	LB	GSWA	11/3/1999	18.6	0.383	0.115
Inlet	Loantaka Brook (Inlet)	LB	GSWA	3/2/2000	10.2	0.115	0.035
Inlet	Loantaka Brook (Inlet)	LB	GSWA	3/18/2000	14.3	0.350	0.046
Inlet	Loantaka Brook (Inlet)	LB	GSWA	4/25/2000	12.6	0.132	0.072
Inlet	Loantaka Brook (Inlet)	LB	GSWA	5/11/2000	8.9	0.560	0.210
Inlet	Loantaka Brook (Inlet)	LB	GSWA	6/22/2000	8.9	0.440	0.203
Inlet	Loantaka Brook (Inlet)	LB	GSWA	7/13/2000	6.4	0.244	0.226
Inlet	Loantaka Brook (Inlet)	LB	GSWA	7/27/2000	105.8	0.600	0.130
Inlet	Loantaka Brook (Inlet)	LB	GSWA	8/22/2000	6.8	0.189	0.068
Inlet	Loantaka Brook (Inlet)	LB	GSWA	9/10/2000	6.1	0.350	0.280
Inlet	Loantaka Brook (Inlet)	LB	GSWA	9/27/2000	7.4	0.440	0.078
Inlet	Loantaka Brook (Inlet)	LB	GSWA	10/4/2000	6.3	0.158	0.133
Inlet	Loantaka Brook (Inlet)	LB	GSWA	11/10/2000	34.9	0.720	0.218
Inlet	Loantaka Brook (Inlet)	LB	GSWA	11/19/2000	6.9	0.270	0.220
Inlet	Loantaka Brook (Inlet)	LB	GSWA	12/6/2000	7.4	0.175	0.092
Inlet	Loantaka Brook (Inlet)	LB	GSWA	12/17/2000	136.1	0.360	0.110
Inlet	Loantaka Brook (Inlet)	LB	GSWA	1/31/2001	26.4	0.317	0.071
Inlet	Loantaka Brook (Inlet)	LB	GSWA	3/22/2001	31.4	0.370	0.056
Inlet	Loantaka Brook (Inlet)	LB	GSWA	4/24/2001	9.1	0.250	0.102
Inlet	Loantaka Brook (Inlet)	LB	GSWA	5/16/2001	6.4	0.300	0.197
Inlet	Loantaka Brook (Inlet)	LB	GSWA	6/2/2001	119.4	0.810	0.090
Inlet	Loantaka Brook (Inlet)	LB	GSWA	6/17/2001	75.0	0.630	0.130
Inlet	Loantaka Brook (Inlet)	LB	GSWA	9/26/2001	7.4	0.290	0.131
Inlet	Loantaka Brook (Inlet)	LB	GSWA	11/26/2001	6.2	0.380	0.120
Inlet	Loantaka Brook (Inlet)	LB	GSWA	6/24/2002	2.1	0.310	0.260
Inlet	Loantaka Brook (Inlet)	LB	GSWA	8/28/2002	1.9	0.530	0.480
Inlet	Loantaka Brook (Inlet)	LB	GSWA	12/18/2002		0.110	0.049
Inlet	Loantaka Brook (Inlet)	LB	GSWA	3/25/2003	8.0	0.121	0.016
Inlet	Loantaka Brook (Inlet)	LB	GSWA	6/25/2003	5.3	0.150	0.102

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
Inlet	Loantaka Brook (Inlet)	LB	GSWA	8/20/2003	5.4	0.163	0.099
Inlet	Loantaka Brook (Inlet)	LB	GSWA	10/23/2003	5.4	0.106	0.071
Inlet	Loantaka Brook (Inlet)	LB	GSWA	12/28/2003	10.6	0.053	0.028
Inlet	Loantaka Brook (Inlet)	LB	GSWA	2/24/2004	8.9	0.064	0.018
Inlet	Loantaka Brook (Inlet)	LB	GSWA	4/13/2004	26.9	0.390	0.029
Inlet	Loantaka Brook (Inlet)	LB	GSWA	5/4/2004	9.8	0.260	0.036
Inlet	Loantaka Brook (Inlet)	LB	GSWA	7/7/2004	3.1	0.330	0.280
Inlet	Loantaka Brook (Inlet)	LB	GSWA	7/13/2004	29.9	0.960	0.101
Inlet	Loantaka Brook (Inlet)	LB	GSWA	7/19/2004	12.4	0.390	0.096
Inlet	Loantaka Brook (Inlet)	LB	GSWA	10/7/2004	5.1	0.198	0.164
Inlet	Loantaka Brook (Inlet)	LB	GSWA	11/5/2004	11.7	0.360	0.179
Inlet	Loantaka Brook (Inlet)	LB	GSWA	1/31/2005	8.7	0.160	0.081
Inlet	Loantaka Brook (Inlet)	LB	GSWA	3/24/2005	11.6	0.140	0.029
Inlet	Loantaka Brook (Inlet)	LB	GSWA	4/26/2005	4.7	0.120	0.098
Inlet	Loantaka Brook (Inlet)	LB	GSWA	8/4/2005	3.9	0.210	0.190
Inlet	Loantaka Brook (Inlet)	LB	GSWA	10/25/2005	60.1	0.420	0.046
Inlet	Loantaka Brook (Inlet)	LB	GSWA	10/25/2005		0.450	0.050
Inlet	Loantaka Brook (Inlet)	LB	GSWA	11/30/2005	53.8	0.340	0.043
Inlet	Passaic River (Inlet)	PRIN	GSWA	5/20/1999	35.3	0.062	0.009
Inlet	Passaic River (Inlet)	PRIN	GSWA	6/8/1999	16.5	0.042	0.015
Inlet	Passaic River (Inlet)	PRIN	GSWA	8/26/1999	18.2	0.067	0.006
Inlet	Passaic River (Inlet)	PRIN	GSWA	9/4/1999	11.2	0.032	0.012
Inlet	Passaic River (Inlet)	PRIN	GSWA	11/3/1999	44.3	0.091	0.009
Inlet	Passaic River (Inlet)	PRIN	GSWA	3/2/2000	39.6	0.023	0.007
Inlet	Passaic River (Inlet)	PRIN	GSWA	3/18/2000	47.9	0.106	0.013
Inlet	Passaic River (Inlet)	PRIN	GSWA	4/25/2000	40.2	0.053	0.011
Inlet	Passaic River (Inlet)	PRIN	GSWA	5/11/2000	36.5	0.140	0.017
Inlet	Passaic River (Inlet)	PRIN	GSWA	6/22/2000	37.1	0.061	0.014
Inlet	Passaic River (Inlet)	PRIN	GSWA	7/13/2000	18.2	0.091	0.027
Inlet	Passaic River (Inlet)	PRIN	GSWA	7/27/2000	179.6	0.115	0.020
Inlet	Passaic River (Inlet)	PRIN	GSWA	8/22/2000	22.6	0.032	0.015
Inlet	Passaic River (Inlet)	PRIN	GSWA	9/10/2000	18.6	0.030	0.010
Inlet	Passaic River (Inlet)	PRIN	GSWA	9/27/2000	29.7	0.070	0.012

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
Inlet	Passaic River (Inlet)	PRIN	GSWA	10/4/2000	18.2	0.035	0.011
Inlet	Passaic River (Inlet)	PRIN	GSWA	11/11/2000	32.4	0.082	0.015
Inlet	Passaic River (Inlet)	PRIN	GSWA	11/19/2000	19.7	0.026	0.016
Inlet	Passaic River (Inlet)	PRIN	GSWA	12/6/2000	20.1	0.028	0.014
Inlet	Passaic River (Inlet)	PRIN	GSWA	12/17/2000	290.8	0.074	0.016
Inlet	Passaic River (Inlet)	PRIN	GSWA	4/24/2001	34.7	0.039	0.011
Inlet	Passaic River (Inlet)	PRIN	GSWA	5/16/2001	25.7	0.043	0.011
Inlet	Passaic River (Inlet)	PRIN	GSWA	6/2/2001	401.6	0.160	0.021
Inlet	Passaic River (Inlet)	PRIN	GSWA	6/17/2001	110.1	0.090	0.050
Inlet	Passaic River (Inlet)	PRIN	GSWA	9/26/2001	20.9	0.050	0.005
Inlet	Passaic River (Inlet)	PRIN	GSWA	11/26/2001	19.6	0.070	0.005
Inlet	Passaic River (Inlet)	PRIN	GSWA	6/24/2002		0.054	0.015
Inlet	Passaic River (Inlet)	PRIN	GSWA	8/28/2002		0.053	0.012
Inlet	Passaic River (Inlet)	PRIN	GSWA	12/18/2002	29.7	0.037	0.009
Inlet	Passaic River (Inlet)	PRIN	GSWA	3/25/2003	47.9	0.026	0.003
Inlet	Passaic River (Inlet)	PRIN	GSWA	6/25/2003	49.4	0.049	0.023
Inlet	Passaic River (Inlet)	PRIN	GSWA	8/20/2003	24.8	0.036	0.007
Inlet	Passaic River (Inlet)	PRIN	GSWA	10/23/2003	23.9	0.044	0.011
Inlet	Passaic River (Inlet)	PRIN	GSWA	12/28/2003	61.8	0.030	0.015
Inlet	Passaic River (Inlet)	PRIN	GSWA	2/24/2004	37.3	0.033	0.010
Inlet	Passaic River (Inlet)	PRIN	GSWA	4/13/2004	76.4	0.088	0.015
Inlet	Passaic River (Inlet)	PRIN	GSWA	5/4/2004	56.6	0.075	0.018
Inlet	Passaic River (Inlet)	PRIN	GSWA	7/7/2004	17.2	0.060	0.023
Inlet	Passaic River (Inlet)	PRIN	GSWA	7/13/2004	93.3	0.080	0.021
Inlet	Passaic River (Inlet)	PRIN	GSWA	7/19/2004	49.4	0.058	0.025
Inlet	Passaic River (Inlet)	PRIN	GSWA	10/7/2004	19.4	0.040	0.001
Inlet	Passaic River (Inlet)	PRIN	GSWA	11/5/2004	41.6	0.065	0.001
Inlet	Passaic River (Inlet)	PRIN	GSWA	1/31/2005	30.2	0.010	0.008
Inlet	Passaic River (Inlet)	PRIN	GSWA	3/24/2005	45.0	0.040	0.001
Inlet	Passaic River (Inlet)	PRIN	GSWA	4/26/2005	33.2	0.040	0.032
Inlet	Passaic River (Inlet)	PRIN	GSWA	8/4/2005	13.9	0.080	0.019
Inlet	Passaic River (Inlet)	PRIN	GSWA	10/25/2005	77.7	0.070	0.011
Inlet	Primrose Brook (Inlet)	PB	GSWA	6/8/1999	1.1	0.054	0.025

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
Inlet	Primrose Brook (Inlet)	PB	GSWA	8/14/1999	2.8	0.537	0.029
Inlet	Primrose Brook (Inlet)	PB	GSWA	8/26/1999	2.0	0.768	0.021
Inlet	Primrose Brook (Inlet)	PB	GSWA	9/4/1999	0.6	0.036	0.020
Inlet	Primrose Brook (Inlet)	PB	GSWA	9/16/1999	929.1	0.613	0.028
Inlet	Primrose Brook (Inlet)	PB	GSWA	11/3/1999	2.8	0.153	0.008
Inlet	Primrose Brook (Inlet)	PB	GSWA	3/2/2000	3.1	0.020	0.007
Inlet	Primrose Brook (Inlet)	PB	GSWA	3/18/2000	37.4	0.158	0.016
Inlet	Primrose Brook (Inlet)	PB	GSWA	4/25/2000	9.4	0.029	0.012
Inlet	Primrose Brook (Inlet)	PB	GSWA	7/13/2000	8.0	0.038	0.035
Inlet	Primrose Brook (Inlet)	PB	GSWA	7/27/2000	46.7	0.189	0.039
Inlet	Primrose Brook (Inlet)	PB	GSWA	8/22/2000	6.8	0.034	0.023
Inlet	Primrose Brook (Inlet)	PB	GSWA	9/10/2000	8.7	0.037	0.026
Inlet	Primrose Brook (Inlet)	PB	GSWA	9/27/2000	1.5	0.280	0.053
Inlet	Primrose Brook (Inlet)	PB	GSWA	10/4/2000	5.0	0.036	0.021
Inlet	Primrose Brook (Inlet)	PB	GSWA	11/10/2000	6.8	0.330	0.036
Inlet	Primrose Brook (Inlet)	PB	GSWA	11/19/2000	0.0	0.016	0.014
Inlet	Primrose Brook (Inlet)	PB	GSWA	12/6/2000	6.3	0.018	0.014
Inlet	Primrose Brook (Inlet)	PB	GSWA	12/17/2000	144.1	0.048	0.015
Inlet	Primrose Brook (Inlet)	PB	GSWA	1/31/2001		0.068	0.011
Inlet	Primrose Brook (Inlet)	PB	GSWA	3/22/2001	42.4	0.170	0.012
Inlet	Primrose Brook (Inlet)	PB	GSWA	4/24/2001	116.5	0.193	0.003
Inlet	Primrose Brook (Inlet)	PB	GSWA	5/16/2001	54.9	0.038	0.019
Inlet	Primrose Brook (Inlet)	PB	GSWA	6/2/2001	1216.2	0.440	0.031
Inlet	Primrose Brook (Inlet)	PB	GSWA	6/17/2001	149.1	0.440	0.028
Inlet	Primrose Brook (Inlet)	PB	GSWA	9/26/2001	20.4	0.116	0.008
Inlet	Primrose Brook (Inlet)	PB	GSWA	11/26/2001	1.5	0.050	0.002
Inlet	Primrose Brook (Inlet)	PB	GSWA	6/24/2002	106.7	0.088	0.074
Inlet	Primrose Brook (Inlet)	PB	GSWA	8/28/2002	70.5	0.036	0.023
Inlet	Primrose Brook (Inlet)	PB	GSWA	12/18/2002	5.9	0.026	0.012
Inlet	Primrose Brook (Inlet)	PB	GSWA	3/25/2003	46.5	0.013	0.002
Inlet	Primrose Brook (Inlet)	PB	GSWA	6/25/2003	25.9	0.033	0.016
Inlet	Primrose Brook (Inlet)	PB	GSWA	8/20/2003	13.7	0.038	0.004
Inlet	Primrose Brook (Inlet)	PB	GSWA	10/23/2003	17.6	0.022	0.014

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
Inlet	Primrose Brook (Inlet)	PB	GSWA	12/28/2003	21.4	0.029	0.014
Inlet	Primrose Brook (Inlet)	PB	GSWA	2/24/2004	16.3	0.019	0.011
Inlet	Primrose Brook (Inlet)	PB	GSWA	4/13/2004	28.6	0.172	0.012
Inlet	Primrose Brook (Inlet)	PB	GSWA	5/4/2004	25.9	0.184	0.016
Inlet	Primrose Brook (Inlet)	PB	GSWA	7/7/2004	9.1	0.033	0.030
Inlet	Primrose Brook (Inlet)	PB	GSWA	7/13/2004	18.1	0.500	0.031
Inlet	Primrose Brook (Inlet)	PB	GSWA	7/19/2004	7.8	0.107	0.025
Inlet	Primrose Brook (Inlet)	PB	GSWA	10/7/2004	11.6	0.026	0.001
Inlet	Primrose Brook (Inlet)	PB	GSWA	11/5/2004	16.0	0.104	0.001
Inlet	Primrose Brook (Inlet)	PB	GSWA	1/31/2005	15.6	0.020	0.012
Inlet	Primrose Brook (Inlet)	PB	GSWA	3/24/2005	21.4	0.040	0.001
Inlet	Primrose Brook (Inlet)	PB	GSWA	4/26/2005	19.8	0.030	0.026
Inlet	Primrose Brook (Inlet)	PB	GSWA	8/4/2005	8.7	0.040	0.017
Inlet	Primrose Brook (Inlet)	PB	GSWA	8/4/2005		0.070	0.051
Inlet	Primrose Brook (Inlet)	PB	GSWA	10/25/2005	40.2	0.130	0.010
Inlet	Primrose Brook (Inlet)	PB	GSWA	11/30/2005	30.9	0.200	0.005
Inlet	Primrose Brook (Inlet)	PB	GSWA	11/30/2005		0.210	0.004
Outlet	Passaic River (Outlet)	PROUT	GSWA	6/8/1999		0.207	0.042
Outlet	Passaic River (Outlet)	PROUT	GSWA	9/4/1999		0.215	0.111
Outlet	Passaic River (Outlet)	PROUT	GSWA	1/13/2000		0.084	
Outlet	Passaic River (Outlet)	PROUT	GSWA	3/2/2000		0.064	0.014
Outlet	Passaic River (Outlet)	PROUT	GSWA	4/27/2000		0.084	0.035
Outlet	Passaic River (Outlet)	PROUT	GSWA	7/13/2000		0.130	0.039
Outlet	Passaic River (Outlet)	PROUT	GSWA	8/22/2000		0.196	0.082
Outlet	Passaic River (Outlet)	PROUT	GSWA	9/10/2000		0.130	0.037
Outlet	Passaic River (Outlet)	PROUT	GSWA	10/4/2000		0.057	0.027
Outlet	Passaic River (Outlet)	PROUT	GSWA	12/6/2000		0.094	0.025
Outlet	Passaic River (Outlet)	PROUT	GSWA	3/26/2001		0.043	0.013
Outlet	Passaic River (Outlet)	PROUT	GSWA	4/24/2001		0.106	0.035
Outlet	Passaic River (Outlet)	PROUT	GSWA	5/16/2001		0.171	0.031
Outlet	Passaic River (Outlet)	PROUT	GSWA	6/21/2001		0.184	0.075
Outlet	Passaic River (Outlet)	PROUT	GSWA	6/24/2002		0.133	0.065
Outlet	Passaic River (Outlet)	PROUT	GSWA	8/28/2002		0.104	0.040

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
Outlet	Passaic River (Outlet)	PROUT	GSWA	12/18/2002		0.059	0.016
Outlet	Passaic River (Outlet)	PROUT	GSWA	3/25/2003		0.031	0.006
Outlet	Passaic River (Outlet)	PA2	Omni - Phase I	6/9/2003		0.130	0.060
Outlet	Passaic River (Outlet)	PA2	Omni - Phase I	6/10/2003		0.120	0.070
Outlet	Passaic River (Outlet)	PROUT	GSWA	6/25/2003		0.158	0.094
Outlet	Passaic River (Outlet)	PA2	Omni - Phase I	7/14/2003		0.120	0.050
Outlet	Passaic River (Outlet)	PA2	Omni - Phase I	7/15/2003		0.070	0.010
Outlet	Passaic River (Outlet)	PA2	Omni - Phase I	8/5/2003		0.270	0.100
Outlet	Passaic River (Outlet)	PA2	Omni - Phase I	8/6/2003		0.140	0.060
Outlet	Passaic River (Outlet)	PROUT	GSWA	8/20/2003		0.230	0.110
Outlet	Passaic River (Outlet)	PA2	Omni - Phase I	8/25/2003		0.170	0.090
Outlet	Passaic River (Outlet)	PA2	Omni - Phase I	8/26/2003		0.190	0.100
Outlet	Passaic River (Outlet)	PROUT	GSWA	10/23/2003		0.065	0.026
Outlet	Passaic River (Outlet)	PA2	Omni - Phase I	11/3/2003		0.100	0.050
Outlet	Passaic River (Outlet)	PA2	Omni - Phase I	11/4/2003		0.150	0.060
Outlet	Passaic River (Outlet)	PA2	Omni - Phase I	11/17/2003		0.090	0.030
Outlet	Passaic River (Outlet)	PA2	Omni - Phase I	11/18/2003		0.050	0.030
Outlet	Passaic River (Outlet)	PROUT	GSWA	12/28/2003		0.035	0.015
Outlet	Passaic River (Outlet)	PROUT	GSWA	2/24/2004		0.034	0.011
Outlet	Passaic River (Outlet)	PROUT	GSWA	4/13/2004		0.068	0.018
Outlet	Passaic River (Outlet)	PROUT	GSWA	4/14/2004		0.074	0.013
Outlet	Passaic River (Outlet)	PROUT	GSWA	4/14/2004		0.077	0.020
Outlet	Passaic River (Outlet)	PROUT	GSWA	4/15/2004		0.060	0.023
Outlet	Passaic River (Outlet)	PROUT	GSWA	4/15/2004		0.066	0.023
Outlet	Passaic River (Outlet)	PROUT	GSWA	4/16/2004		0.059	0.017
Outlet	Passaic River (Outlet)	PROUT	GSWA	5/4/2004		0.105	0.051
Outlet	Passaic River (Outlet)	PROUT	GSWA	5/4/2004		0.129	0.062
Outlet	Passaic River (Outlet)	PROUT	GSWA	5/5/2004		0.103	0.054
Outlet	Passaic River (Outlet)	PROUT	GSWA	5/5/2004		0.106	0.067
Outlet	Passaic River (Outlet)	PROUT	GSWA	5/6/2004		0.097	0.058
Outlet	Passaic River (Outlet)	PROUT	GSWA	7/7/2004		0.122	0.061
Outlet	Passaic River (Outlet)	PROUT	GSWA	7/13/2004		0.132	0.057
Outlet	Passaic River (Outlet)	PROUT	GSWA	7/13/2004		0.140	0.052

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
Outlet	Passaic River (Outlet)	PROUT	GSWA	7/14/2004		0.130	0.062
Outlet	Passaic River (Outlet)	PROUT	GSWA	7/19/2004		0.123	0.061
Outlet	Passaic River (Outlet)	PROUT	GSWA	7/19/2004		0.138	0.057
Outlet	Passaic River (Outlet)	PROUT	GSWA	7/20/2004		0.122	0.062
Outlet	Passaic River (Outlet)	PROUT	GSWA	7/20/2004		0.130	0.072
Outlet	Passaic River (Outlet)	PROUT	GSWA	7/21/2004		0.131	0.077
Outlet	Passaic River (Outlet)	PROUT	GSWA	10/7/2004		0.089	0.055
Outlet	Passaic River (Outlet)	PROUT	GSWA	11/4/2004		0.078	0.001
Outlet	Passaic River (Outlet)	PROUT	GSWA	11/5/2004		0.095	0.001
Outlet	Passaic River (Outlet)	PROUT	GSWA	11/5/2004		0.100	0.001
Outlet	Passaic River (Outlet)	PROUT	GSWA	1/31/2005		0.050	0.046
Outlet	Passaic River (Outlet)	PROUT	GSWA	3/24/2005		0.030	0.001
Outlet	Passaic River (Outlet)	PROUT	GSWA	4/26/2005		0.050	0.038
Outlet	Passaic River (Outlet)	PROUT	GSWA	8/4/2005		0.120	0.029
Outlet	Passaic River (Outlet)	PROUT	GSWA	10/25/2005		0.070	0.033
Outlet	Passaic River (Outlet)	PROUT	GSWA	11/30/2005		0.070	0.019
STP	Chatham-Main STP	Chatham Main	DMR	7/15/2000	1.0	0.500	
STP	Chatham-Main STP	Chatham Main	DMR	8/15/2000	1.0	0.500	
STP	Chatham-Main STP	Chatham Main	DMR	9/15/2000	1.0	0.400	
STP	Chatham-Main STP	Chatham Main	DMR	10/15/2000	1.0	0.400	
STP	Chatham-Main STP	Chatham Main	DMR	11/15/2000	1.1	0.300	
STP	Chatham-Main STP	Chatham Main	DMR	12/15/2000	1.1	0.200	
STP	Chatham-Main STP	Chatham Main	DMR	1/15/2001	1.2	0.240	
STP	Chatham-Main STP	Chatham Main	DMR	2/15/2001	1.3	0.190	
STP	Chatham-Main STP	Chatham Main	DMR	3/15/2001	1.3	0.190	
STP	Chatham-Main STP	Chatham Main	DMR	4/15/2001	1.2	0.270	
STP	Chatham-Main STP	Chatham Main	DMR	5/15/2001	1.1	0.400	
STP	Chatham-Main STP	Chatham Main	DMR	6/15/2001	1.2	0.330	
STP	Chatham-Main STP	Chatham Main	DMR	7/15/2001	1.0	0.460	
STP	Chatham-Main STP	Chatham Main	DMR	8/15/2001	0.9	0.560	
STP	Chatham-Main STP	Chatham Main	DMR	9/15/2001	1.0	0.660	
STP	Chatham-Main STP	Chatham Main	DMR	10/15/2001	1.0	0.570	
STP	Chatham-Main STP	Chatham Main	DMR	11/15/2001	1.0	0.290	

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
STP	Chatham-Main STP	Chatham Main	DMR	12/15/2001	1.0	0.520	
STP	Chatham-Main STP	Chatham Main	DMR	1/15/2002	1.0	0.620	
STP	Chatham-Main STP	Chatham Main	DMR	2/15/2002	1.0	0.420	
STP	Chatham-Main STP	Chatham Main	DMR	3/15/2002	0.9	0.560	
STP	Chatham-Main STP	Chatham Main	DMR	4/15/2002	0.9	0.640	
STP	Chatham-Main STP	C_WWTP	Omni - Chatham	5/9/2002	1.0	0.900	0.680
STP	Chatham-Main STP	Chatham Main	DMR	5/15/2002	1.0	0.770	
STP	Chatham-Main STP	C_WWTP	Omni - Chatham	5/16/2002	1.1	0.690	0.440
STP	Chatham-Main STP	C_WWTP	Omni - Chatham	5/21/2002	1.1	0.720	0.290
STP	Chatham-Main STP	C_WWTP	Omni - Chatham	5/28/2002	1.1	0.820	0.510
STP	Chatham-Main STP	Chatham Main	DMR	6/15/2002	1.0	0.810	
STP	Chatham-Main STP	Chatham Main	DMR	7/15/2002	0.9	0.790	
STP	Chatham-Main STP	C_WWTP	Omni - Chatham	8/6/2002	0.8	0.760	0.690
STP	Chatham-Main STP	C_WWTP	Omni - Chatham	8/13/2002	0.9	0.590	0.500
STP	Chatham-Main STP	Chatham Main	DMR	8/15/2002	0.9	0.570	
STP	Chatham-Main STP	C_WWTP	Omni - Chatham	8/20/2002	0.8	0.440	0.360
STP	Chatham-Main STP	C_WWTP	Omni - Chatham	8/27/2002	0.9	0.490	0.400
STP	Chatham-Main STP	Chatham Main	DMR	9/15/2002	1.0	0.420	
STP	Chatham-Main STP	Chatham Main	DMR	10/15/2002	1.1	0.410	
STP	Chatham-Main STP	C_WWTP	Omni - Chatham	11/5/2002	1.1	0.150	0.090
STP	Chatham-Main STP	C_WWTP	Omni - Chatham	11/12/2002	1.2	0.270	0.210
STP	Chatham-Main STP	Chatham Main	DMR	11/15/2002	1.2	0.210	
STP	Chatham-Main STP	C_WWTP	Omni - Chatham	11/21/2002	1.3	0.190	0.160
STP	Chatham-Main STP	C_WWTP	Omni - Chatham	11/26/2002	1.3	0.250	0.190
STP	Chatham-Main STP	Chatham Main	DMR	12/15/2002	1.3	0.220	
STP	Chatham-Main STP	Chatham Main	DMR	1/15/2003	1.3	0.190	
STP	Chatham-Main STP	Chatham Main	DMR	2/15/2003	1.2	0.180	
STP	Chatham-Main STP	Chatham Main	DMR	3/15/2003	1.4	0.190	
STP	Chatham-Main STP	Chatham Main	DMR	4/15/2003	1.3	0.300	
STP	Chatham-Main STP	Chatham Main	DMR	5/15/2003	1.1	0.510	
STP	Chatham-Main STP	Chatham Main	Omni - Phase I	6/10/2003	1.5	0.450	0.360
STP	Chatham-Main STP	Chatham Main	DMR	6/15/2003	1.5	0.330	
STP	Chatham-Main STP	Chatham Main	Omni - Phase I	7/14/2003	1.1	0.360	0.250

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
STP	Chatham-Main STP	Chatham Main	DMR	7/15/2003	1.1	0.240	
STP	Chatham-Main STP	Chatham Main	Omni - Phase I	8/6/2003	1.2	0.340	0.260
STP	Chatham-Main STP	Chatham Main	DMR	8/15/2003	1.1	0.310	
STP	Chatham-Main STP	Chatham Main	Omni - Phase I	8/26/2003	1.0	0.370	0.180
STP	Chatham-Main STP	Chatham Main	DMR	9/15/2003	1.2	0.370	
STP	Chatham-Main STP	Chatham Main	DMR	10/15/2003	1.2	0.270	
STP	Chatham-Main STP	Chatham Main	Omni - Phase I	11/4/2003	1.2	0.360	0.270
STP	Chatham-Main STP	Chatham Main	DMR	11/15/2003	1.2	0.230	
STP	Chatham-Main STP	Chatham Main	Omni - Phase I	11/18/2003	1.1	0.230	0.160
STP	Chatham-Main STP	Chatham Main	DMR	12/15/2003	1.5	0.200	
STP	Chatham-Main STP	Chatham Main	DMR	1/15/2004	1.2	0.190	
STP	Chatham-Main STP	Chatham Main	DMR	2/15/2004	1.3	0.231	
STP	Chatham-Main STP	Chatham Main	DMR	3/15/2004	1.2	0.880	
STP	Chatham-Main STP	Chatham Main	DMR	4/15/2004	1.3	0.120	
STP	Chatham-Main STP	Chatham Main	DMR	5/15/2004	1.2	0.200	
STP	Chatham-Main STP	Chatham Main	DMR	6/15/2004	1.1	0.283	
STP	Chatham-Main STP	Chatham Main	DMR	7/15/2004	1.0	0.280	
STP	Chatham-Main STP	Chatham Main	DMR	8/15/2004	1.1	0.080	
STP	Chatham-Main STP	Chatham Main	DMR	9/15/2004	1.1	0.080	
STP	Chatham-Main STP	Chatham Main	DMR	10/15/2004	1.1	0.360	
STP	Chatham-Main STP	Chatham Main	DMR	11/15/2004	1.1	0.290	
STP	Chatham-Main STP	Chatham Main	DMR	12/15/2004	1.3	0.250	
STP	Chatham-Main STP	Chatham Main	DMR	1/15/2005	1.3	0.150	
STP	Chatham-Main STP	Chatham Main	DMR	2/15/2005	1.2	0.110	
STP	Chatham-Main STP	Chatham Main	DMR	3/15/2005	1.3	0.190	
STP	Chatham-Main STP	Chatham Main	DMR	4/15/2005	1.4	0.300	
STP	Morris-Woodland STP	Morris Woodland	DMR	7/15/2000	2.0	0.585	
STP	Morris-Woodland STP	Morris Woodland	DMR	8/15/2000	2.2	0.446	
STP	Morris-Woodland STP	Morris Woodland	DMR	9/15/2000	2.0	0.605	
STP	Morris-Woodland STP	Morris Woodland	DMR	10/15/2000	1.7	0.258	
STP	Morris-Woodland STP	Morris Woodland	DMR	11/15/2000	1.8	0.625	
STP	Morris-Woodland STP	Morris Woodland	DMR	12/15/2000	2.0	0.455	
STP	Morris-Woodland STP	Morris Woodland	DMR	1/15/2001	2.0	0.620	

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
STP	Morris-Woodland STP	Morris Woodland	DMR	2/15/2001	2.4	0.828	
STP	Morris-Woodland STP	Morris Woodland	DMR	3/15/2001	2.4	0.570	
STP	Morris-Woodland STP	Morris Woodland	DMR	4/15/2001	2.3	0.688	
STP	Morris-Woodland STP	Morris Woodland	DMR	5/15/2001	2.0	0.696	
STP	Morris-Woodland STP	Morris Woodland	DMR	6/15/2001	2.2	0.583	
STP	Morris-Woodland STP	Morris Woodland	DMR	7/15/2001	1.9	0.493	
STP	Morris-Woodland STP	Morris Woodland	DMR	8/15/2001	1.9	0.488	
STP	Morris-Woodland STP	Morris Woodland	DMR	9/15/2001	1.9	0.712	
STP	Morris-Woodland STP	Morris Woodland	DMR	10/15/2001	1.9	0.554	
STP	Morris-Woodland STP	Morris Woodland	DMR	11/15/2001	1.9	0.524	
STP	Morris-Woodland STP	Morris Woodland	DMR	12/15/2001	1.8	0.470	
STP	Morris-Woodland STP	Morris Woodland	DMR	1/15/2002	1.7	0.650	
STP	Morris-Woodland STP	Morris Woodland	DMR	2/15/2002	1.6	0.418	
STP	Morris-Woodland STP	Morris Woodland	DMR	3/15/2002	1.8	0.393	
STP	Morris-Woodland STP	Morris Woodland	DMR	4/15/2002	2.0	0.462	
STP	Morris-Woodland STP	Morris Woodland	DMR	5/15/2002	2.2	0.670	
STP	Morris-Woodland STP	Morris Woodland	DMR	6/15/2002	2.0	0.428	
STP	Morris-Woodland STP	Morris Woodland	DMR	7/15/2002	1.8	0.622	
STP	Morris-Woodland STP	Morris Woodland	DMR	8/15/2002	1.8	0.715	
STP	Morris-Woodland STP	Morris Woodland	DMR	9/15/2002	1.9	0.368	
STP	Morris-Woodland STP	Morris Woodland	DMR	10/15/2002	2.0	0.383	
STP	Morris-Woodland STP	Morris Woodland	DMR	11/15/2002	2.2	0.248	
STP	Morris-Woodland STP	Morris Woodland	DMR	12/15/2002	2.3	0.450	
STP	Morris-Woodland STP	Morris Woodland	DMR	1/15/2003	2.1	0.516	
STP	Morris-Woodland STP	Morris Woodland	DMR	2/15/2003	2.0	0.320	
STP	Morris-Woodland STP	Morris Woodland	DMR	3/15/2003	2.5	0.488	
STP	Morris-Woodland STP	Morris Woodland	DMR	4/15/2003	2.3	0.638	
STP	Morris-Woodland STP	Morris Woodland	DMR	5/15/2003	1.9	0.623	
STP	Morris-Woodland STP	Morris Woodland	Omni - Phase I	6/10/2003	3.6	0.500	0.370
STP	Morris-Woodland STP	Morris Woodland	DMR	6/15/2003	2.7	0.505	
STP	Morris-Woodland STP	Morris Woodland	Omni - Phase I	7/14/2003	3.0	0.550	0.410
STP	Morris-Woodland STP	Morris Woodland	DMR	7/15/2003	1.9	0.684	
STP	Morris-Woodland STP	Morris Woodland	Omni - Phase I	8/6/2003	2.8	0.410	0.290

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
STP	Morris-Woodland STP	Morris Woodland	DMR	8/15/2003	2.0	0.498	
STP	Morris-Woodland STP	Morris Woodland	Omni - Phase I	8/26/2003	1.9	0.420	0.300
STP	Morris-Woodland STP	Morris Woodland	DMR	9/15/2003	2.1	0.490	
STP	Morris-Woodland STP	Morris Woodland	DMR	10/15/2003	1.9	0.360	
STP	Morris-Woodland STP	Morris Woodland	Omni - Phase I	11/4/2003	2.9	0.120	0.070
STP	Morris-Woodland STP	Morris Woodland	DMR	11/15/2003	2.1	0.288	
STP	Morris-Woodland STP	Morris Woodland	Omni - Phase I	11/18/2003	2.9	0.230	0.190
STP	Morris-Woodland STP	Morris Woodland	DMR	12/15/2003	2.2	0.278	
STP	Morris-Woodland STP	Morris Woodland	DMR	1/15/2004	1.5	0.498	
STP	Morris-Woodland STP	Morris Woodland	DMR	2/15/2004	1.9	0.450	
STP	Morris-Woodland STP	Morris Woodland	DMR	3/15/2004	2.2	0.366	
STP	Morris-Woodland STP	Morris Woodland	DMR	4/15/2004	2.0	0.360	
STP	Morris-Woodland STP	Morris Woodland	DMR	5/15/2004	1.8	0.445	
STP	Morris-Woodland STP	Morris Woodland	DMR	6/15/2004	1.7	0.818	
STP	Morris-Woodland STP	Morris Woodland	DMR	7/15/2004	1.8	0.888	
STP	Morris-Woodland STP	Morris Woodland	DMR	8/15/2004	1.7	0.630	
STP	Morris-Woodland STP	Morris Woodland	DMR	9/15/2004	1.8	0.438	
STP	Morris-Woodland STP	Morris Woodland	DMR	10/15/2004	1.5	0.462	
STP	Morris-Woodland STP	Morris Woodland	DMR	11/15/2004	1.7	0.730	
STP	Morris-Woodland STP	Morris Woodland	DMR	12/15/2004	2.0	0.660	
STP	Morris-Woodland STP	Morris Woodland	DMR	1/15/2005	2.0	0.725	
STP	Morris-Woodland STP	Morris Woodland	DMR	2/15/2005	2.0	0.592	
STP	Morris-Woodland STP	Morris Woodland	DMR	3/15/2005	2.1	0.705	
STP	Morris-Woodland STP	Morris Woodland	DMR	4/15/2005	2.2	0.404	
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	5/9/2002	12.5	0.150	0.100
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	5/16/2002	67.4	0.130	0.020
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	5/21/2002	37.5	0.080	0.010
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	5/28/2002	8.1	0.210	0.110
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	8/6/2002	0.2	0.450	0.290
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	8/13/2002	0.1	0.390	0.280
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	8/20/2002	0.1	0.340	0.240
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	8/27/2002	0.2	0.370	0.270
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	11/5/2002	8.3	0.100	0.050

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	11/12/2002	8.7	0.060	0.020
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	11/21/2002	58.9	0.040	0.030
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	11/26/2002	29.2	0.080	0.050
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	5/13/2003	7.1	0.090	0.050
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	8/28/2003	2.6	0.190	0.120
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	11/18/2003	15.1	0.060	0.030
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	2/12/2004	57.8	0.060	0.010
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	5/4/2004	15.1	0.110	0.060
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	8/4/2004	16.1	0.340	0.190
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	11/9/2004	12.4	0.070	0.040
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	2/9/2005	10.8	0.030	0.020
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	5/10/2005	1.0	0.070	0.020
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	8/18/2005	0.3	0.350	0.100
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	11/14/2005	4.0	0.090	0.050
Swamp	Black Brook Downstream Trib	C_BB2	Omni - Chatham	1/4/2006	76.8	0.110	0.010
Swamp	Black Brook Mainstem	BB1	Omni - Phase I	6/10/2003		0.100	0.060
Swamp	Black Brook Mainstem	BB1	Omni - Phase I	7/14/2003		0.210	0.140
Swamp	Black Brook Mainstem	BB1	Omni - Phase I	7/15/2003		0.230	0.140
Swamp	Black Brook Mainstem	BB1	Omni - Phase I	8/5/2003		0.250	0.170
Swamp	Black Brook Mainstem	BB1	Omni - Phase I	8/6/2003		0.100	0.100
Swamp	Black Brook Mainstem	BB1	Omni - Phase I	8/25/2003		0.240	0.130
Swamp	Black Brook Mainstem	BB1	Omni - Phase I	8/26/2003		0.230	0.130
Swamp	Black Brook Mainstem	BB1	Omni - Phase I	11/3/2003		0.120	0.070
Swamp	Black Brook Mainstem	BB1	Omni - Phase I	11/4/2003		0.140	0.080
Swamp	Black Brook Mainstem	BB1	Omni - Phase I	11/17/2003		0.050	0.030
Swamp	Black Brook Mainstem	BB1	Omni - Phase I	11/18/2003		0.070	0.030
Swamp	Black Brook Tributary	C_T1	Omni - Chatham	5/9/2002	2.3	0.420	0.180
Swamp	Black Brook Tributary	C_T1	Omni - Chatham	5/16/2002	7.2	0.200	0.090
Swamp	Black Brook Tributary	C_T1	Omni - Chatham	5/21/2002	4.7	0.230	0.040
Swamp	Black Brook Tributary	C_T1	Omni - Chatham	5/28/2002	1.6	0.480	0.230
Swamp	Black Brook Tributary	C_T1	Omni - Chatham	8/6/2002	0.6	0.640	0.550
Swamp	Black Brook Tributary	C_T1	Omni - Chatham	8/13/2002	0.6	0.540	0.460
Swamp	Black Brook Tributary	C_T1	Omni - Chatham	8/20/2002	1.2	0.430	0.330

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
Swamp	Black Brook Tributary	C_T1	Omni - Chatham	8/27/2002	0.5	0.460	0.410
Swamp	Black Brook Tributary	C_T1	Omni - Chatham	11/5/2002	1.6	0.150	0.070
Swamp	Black Brook Tributary	C_T1	Omni - Chatham	11/12/2002	3.0	0.120	0.080
Swamp	Black Brook Tributary	C_T1	Omni - Chatham	11/21/2002	6.0	0.050	0.030
Swamp	Black Brook Tributary	C_T1	Omni - Chatham	11/26/2002	4.4	0.040	0.040
Swamp	Black Brook Upstream Trib	C_BB1	Omni - Chatham	5/9/2002		0.090	0.030
Swamp	Black Brook Upstream Trib	C_BB1	Omni - Chatham	5/16/2002		0.060	0.010
Swamp	Black Brook Upstream Trib	C_BB1	Omni - Chatham	5/21/2002		0.060	0.010
Swamp	Black Brook Upstream Trib	C_BB1	Omni - Chatham	5/28/2002		0.130	0.030
Swamp	Black Brook Upstream Trib	C_BB1	Omni - Chatham	8/6/2002		0.720	0.440
Swamp	Black Brook Upstream Trib	C_BB1	Omni - Chatham	8/13/2002		2.400	0.770
Swamp	Black Brook Upstream Trib	C_BB1	Omni - Chatham	11/5/2002		0.070	0.010
Swamp	Black Brook Upstream Trib	C_BB1	Omni - Chatham	11/12/2002		0.050	0.010
Swamp	Black Brook Upstream Trib	C_BB1	Omni - Chatham	11/21/2002		0.030	0.010
Swamp	Black Brook Upstream Trib	C_BB1	Omni - Chatham	11/26/2002		0.060	0.020
Swamp	Great Brook Mainstem	GB1	Omni - Phase I	6/9/2003		0.130	0.080
Swamp	Great Brook Mainstem	GB1	Omni - Phase I	6/10/2003		0.130	0.090
Swamp	Great Brook Mainstem	GB1	Omni - Phase I	7/14/2003		0.100	0.040
Swamp	Great Brook Mainstem	GB1	Omni - Phase I	7/15/2003		0.120	0.050
Swamp	Great Brook Mainstem	GB1	Omni - Phase I	8/5/2003		0.200	0.070
Swamp	Great Brook Mainstem	GB1	Omni - Phase I	8/6/2003		0.220	0.090
Swamp	Great Brook Mainstem	GB1	Omni - Phase I	8/25/2003		0.210	0.080
Swamp	Great Brook Mainstem	GB1	Omni - Phase I	8/26/2003		0.200	0.070
Swamp	Great Brook Mainstem	GB1	Omni - Phase I	11/3/2003		0.130	0.050
Swamp	Great Brook Mainstem	GB1	Omni - Phase I	11/4/2003		0.130	0.060
Swamp	Great Brook Mainstem	GB1	Omni - Phase I	11/17/2003		0.100	0.020
Swamp	Great Brook Mainstem	GB1	Omni - Phase I	11/18/2003		0.090	0.020
Upstream	Loantaka Brook (Downstream STP 1)	LB4	GSWA	2/7/2005		0.290	0.208
Upstream	Loantaka Brook (Downstream STP 1)	LB4	GSWA	5/9/2005		0.250	0.200
Upstream	Loantaka Brook (Downstream STP 1)	LB4	GSWA	8/9/2005		1.200	1.100
Upstream	Loantaka Brook (Downstream STP 1)	LB4	GSWA	11/6/2005		0.210	0.134
Upstream	Loantaka Brook (Downstream STP 3)	LB2	GSWA	2/7/2005		0.180	0.085
Upstream	Loantaka Brook (Downstream STP 3)	LB2	GSWA	5/9/2005		0.240	0.160

**Phase II Non-Tidal Passaic River Basin Nutrient TMDL  
Final Report – February 23, 2007**

**Data Used for Great Swamp Analysis**

Station Type	Location	Site ID	Source	Date	Flow (cfs)	TP (mg/l)	DRP (mg/l)
Upstream	Loantaka Brook (Downstream STP 3)	LB2	GSWA	8/9/2005		0.280	0.200
Upstream	Loantaka Brook (Downstream STP 3)	LB2	GSWA	11/6/2005		0.130	0.090
Upstream	Loantaka Brook (Upstream STP 2)	LB6	GSWA	2/7/2005		0.060	0.003
Upstream	Loantaka Brook (Upstream STP 2)	LB6	GSWA	5/9/2005		0.060	0.003
Upstream	Loantaka Brook (Upstream STP 2)	LB6	GSWA	8/9/2005		0.380	0.006
Upstream	Loantaka Brook (Upstream STP 2)	LB6	GSWA	11/6/2005		0.190	0.002
Upstream	Loantaka Brook Upstream STP 1)	LB5	GSWA	2/7/2005		0.030	0.004
Upstream	Loantaka Brook Upstream STP 1)	LB5	GSWA	5/9/2005		0.010	0.003
Upstream	Loantaka Brook Upstream STP 1)	LB5	GSWA	8/9/2005		0.030	0.015
Upstream	Loantaka Brook Upstream STP 1)	LB5	GSWA	11/6/2005		0.010	0.008
Upstream	Passaic River Upstream	PA1	Omni - Phase I	6/9/2003		0.060	0.020
Upstream	Passaic River Upstream	PA1	Omni - Phase I	6/10/2003		0.060	0.020
Upstream	Passaic River Upstream	PA1	Omni - Phase I	7/14/2003		0.020	0.010
Upstream	Passaic River Upstream	PA1	Omni - Phase I	7/15/2003		0.050	0.050
Upstream	Passaic River Upstream	PA1	Omni - Phase I	8/5/2003		0.030	0.010
Upstream	Passaic River Upstream	PA1	Omni - Phase I	8/6/2003		0.120	0.020
Upstream	Passaic River Upstream	PA1	Omni - Phase I	8/25/2003		0.050	0.010
Upstream	Passaic River Upstream	PA1	Omni - Phase I	8/26/2003		0.090	0.010
Upstream	Passaic River Upstream	PA1	Omni - Phase I	11/3/2003		0.120	0.010
Upstream	Passaic River Upstream	PA1	Omni - Phase I	11/4/2003		0.080	0.010
Upstream	Passaic River Upstream	PA1	Omni - Phase I	11/17/2003		0.030	0.010
Upstream	Passaic River Upstream	PA1	Omni - Phase I	11/18/2003		0.030	0.010