STONE LAKE
WISCONSIN LAKE MANAGEMENT
PLANNING GRANT
FINAL REPORT

Prepared for:

Town of Stone Lake
N6071 Stone Lake Road
Stone Lake, WI 54876

August 2002

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SIGNATURE PAGE

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Town of Stone Lake
N6071 Stone Lake Road
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EXECUTIVE SUMMARY

The Town of Stone Lake and the Shore Owners of Stone Lake Association (SOSLA) collaboratively conducted a lake planning grant project during the years 2001-2002. Being a segment of that project, this report is intended to provide information for the development of a future lake management plan and to guide the Town in protecting the watershed from impacts of future development.

The scope of this report was to conduct the following lake management activities for the Town of Stone Lake:

1. Establish a watershed delineation,
2. Create maps showing the GIS database and land use for the watershed and sub-areas,
3. Evaluate existing land uses on the lake and the impacts caused by them; and
4. Conduct water quantity and quality modeling analysis to determine what impacts the reconstruction of Main Street and future development will have on Stone Lake.

Watershed areas, color maps, and figures were prepared from using Geographical Information System (GIS), using ArcView 3.2 software, and Automated Computer Aided Design (AutoCAD), using R14 software (2002 updated version). Land cover data product was derived from LANDSAT Thermatic Mapper (TM) satellite imagery acquired from fly-overs. The total drainage area of Stone Lake was divided into one sub-watershed and two sub-areas and water quantity was modeled using HydroCAD and water quality was defined using the P8 Urban Catchment Model.

The project involved the collection of data from digital land cover data, soil inventory data, and various data form the Stone Lake sub-watershed. These data were used in conducting water quantity and quality modeling to determine possible impacts the reconstruction of Main Street and future development will have on Stone Lake. Existing forested and water land uses each comprise approximately 86 percent of the Stone Lake sub-watershed, with 53 percent and 33 percent, respectively (Figure 3).

Based on modeling results, the water quantity and quality budgets for each sub-area suggest:

1. Placing a detention pond or storm water treatment to remove sediment and excess nutrients from storm water run-off is highly recommended. The models indicated that storm water treatment would significantly reduce (by as much as 80%) the amounts of certain constituents that reach the existing wetland. Protection of the wetland is a key component of lake management because a healthy wetland will act as a natural “filter” for runoff that passes through it and eventually reaches Stone Lake. Removal of some sediment and nutrients prior to discharge to the wetland will enable the wetland to provide storm water treatment capabilities with little or no alterations from it’s natural state.
2. Street sweeping is usually helpful in reducing storm water run-off. Since there is little area in Stone Lake to be swept, results from the calculations did not show any significant improvements.

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I. INTRODUCTION

The county line passes through the middle of Town of Stone Lake and the Town of Sand Lake. Stone Lake is on the west side of the line in Washburn County, Wisconsin, and Town of Sand Lake is on the east side of the line in Sawyer County, Wisconsin. The Lake comprises a surface area of 523-acres, with a maximum depth of 40-feet. Being a seepage lake, Stone Lake is a landlocked water body that does not have an inlet or outlet.

As a continuation of the previous water testing efforts by the Shore Owners of Stone Lake Association (SOSLA) and the Main Street project (both providing valuable information in terms of water quality data and non-point source impacts on Stone Lake), the purpose of the report is to minimize storm water runoff, encourage infiltration, prevent property damage and hazardous conditions, prevent erosion, reduce nutrient and sediment deposition, and protect the water quality of Stone Lake. This report is funded for the Town of Stone Lake through a Wisconsin Department of Natural Resources lake management planning grant, and serves as a guide to enhance, protect and preserve the unique environmental characteristics of Stone Lake.

II. PROJECT DESCRIPTION

Stone Lake is located in a part of the state known as the Couderay River Watershed (UC20) of the Upper Chippewa River Basin. The Couderay River Watershed consists of a large portion of Sawyer County, with Stone Lake as the only portion within Washburn County. This watershed is rich with natural resources, containing more than 47 lakes with six designated as outstanding water resources, according to the *1996 Water Quality Management Plan*. The area is mostly forested and wetland, but some agricultural land and urban growth exit. Due to the numerous resources available for recreational purposes, this area has experienced increasing development pressure from urban center residents. As a result, the potential impacts caused by non-point source pollution have increased on these water bodies. Planning for the preservation and continued protection of lakes from this development pressure will ensure the continued enjoyment of these natural resources in the future.

A. Project Scope

All activities relating to the control and management of rainfall runoff including subsurface groundwater and surface water drainage, flood control and water quality refers to storm water management. This management is more than a local issue; it is a regional issue that requires the consolidation and coordination of many independent efforts into a system that recognizes the nature of storm water, floodwater runoff, groundwater, and water quality pollutant loads.

The primary goal of the Town of Stone Lake and the SOSLA is to first gather information necessary to identify potential water quality problems within their watershed and define the sources. Other phases that have been defined and will be implemented in the future include a comprehensive water quality study of Stone Lake and its watersheds, lake response modeling, and finally the preparation of a comprehensive lake management plan. The future watershed management plan will ultimately lead to the implementation of measures that collectively protect the watershed from impacts of future development (i.e., land use, site planning, riparian management, and storm water practices) and establish a baseline to gage the effectiveness of that implementation.

B. Project Goals

This project involves several steps for plan completion, including:

1. Gathering and mapping of information related to watersheds and delineate the watershed and sub-watersheds,
2. Evaluating existing land uses on the lake and the impacts caused by them,
3. Surveying lakeshore owners, sanitary district members, etc. to identify areas of concern/importance as a basis for developing a lake management plan,
4. Conducting a private septic system evaluation for Wisconsin Department of Commerce code compliance,
5. Conducting water quality and quantity modeling analysis to determine what impacts the reconstruction of Main Street will have on Stone Lake; and
6. Providing educational opportunities to the general public though publication of project goals/results.

This report primarily focuses on project goals 1, 2, 5, and 6 listed above. The report identifies local watershed boundaries and natural and manmade drainage features such as ditches and culverts. The report also identifies locations of significant natural resource areas, natural storage areas, including barren land, depressions, woods, prairie grasses, and wetlands. The report describes existing problems in the watershed related to drainage, local flooding, sedimentation, degradation of existing natural resources, and storm water quality. Based on existing and proposed conditions, the report proposes effective requirements for existing agricultural uses and new development, remediation needs, and opportunities for regional water quantity and quality control management.

C. General Description

Storm water runoff is conveyed to Stone Lake from the Town of Stone Lake, Town of Sand Lake and the surrounding watershed. There are no major rivers, streams or creeks draining into Stone Lake, but is connected to Little Stone Lake (30-acres surface area). Stone Lake is a seepage lake that does not have an inlet or outlet, and is landlocked water body. The principal source of water is precipitation or runoff, supplemented by groundwater from the immediate drainage area. Since seepage lakes commonly reflect groundwater levels and rainfall patterns, water levels fluctuate seasonally. The predominant watershed soils in the Town of Sand Lake sub-area include sandy loam and mucks.

1. Watershed Delineation

The watershed around Stone Lake has been delineated (Figure 1). The area was divided into three major sub-areas as shown on Figure 2 that looks into the issue on how the Town directly affects Stone Lake and it’s watershed. Sub-area A consists of the Town of Stone Lake and a small portion of Town Stone Lake (existing means the Town’s current urban land use size and proposed means the Town’s future estimated urban land use increased in size), the Sub-area B is a major wetland where the storm water is discharging from the Town of Stone Lake and Town of Sand Lake, and the entire Stone Lake watershed is Sub-area C. This methodology was utilized to define hydrologic and hydraulic effects. Hydrologic effects are influenced by entrance of tributary drainage ways, watershed shape, land use, slope changes, homogeneity of the runoff curve number, and existing or proposed structures (low area and detention basins).

One planning period was chosen to assess the storm water runoff hydrology within each of the sub-areas. Land use characteristics were projected for the planning period that includes present land use and futures projected land use analysis periods and are shown on Figures 3-5.

2. Existing Land Use

Existing land use conditions for the study area are listed in Tables 1-3 and were utilized for preparation of this report. They were based on the Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data (WISCLAND). This WISCLAND is a consortium of government and private organizations formed in 1993 to promote development of digital geographic data for the state. Figures 3-5 represent the land cover data product that was derived from LANDSAT Thermatic Mapper (TM) satellite imagery acquired from fly-overs occurring between August of 1991 and May of 1993.

Table 1 (FIG 4): Existing Land Use in Urban Stone Lake Sub-area		
	Acres	%
Urban	15	16
Agriculture	2	2
Forest	65	67
Grassland	13	13
Wetland	2	2
Total:	98	100

Table 2: Existing Land Use in Sub-area B		
	Acres	%
Wetland	2	29
Forest	6	70
Barren	0	1
Total:	8	100

Table 3: Existing Land Use in Sub-area C		
	Acres	%
Urban	15	1
Agriculture	40	2
Forest	919	53
Grassland	119	7
Wetland	51	3
Barren	16	1
Water	571	33
Total:	1732	100

3. Proposed Land Use

Proposed future land use conditions utilized for preparation of Stone Lakes Planning project water quantity and water quality modeling analysis were based on WISCLAND data. For areas outside Town of Stone Lake and Town of Sand Lake, we assume that existing land use would not change. We recommend that the town consider working with the county to prepare a Master Land Use Plan for all undeveloped land within the watershed boundary.

Table 4 (FIG 4): Proposed Land Use in Urban Stone Lake Sub-area		
	Acres	%
Urban	30	31
Agriculture	2	2
Forest	51	52
Grassland	13	13
Wetland	2	2
Total:	98	100

III. WATER QUANTITY

A. General Background

In order to provide a useful document that addresses all aspects of storm water management planning, an analysis of the existing system and of the proposed future system must be accomplished. The system analysis is a technical investigation of the land use, storm sewers, overland drainage, water quality, wetlands, lakes, ponds, streams, channels, and water quality, and drainage ways. The analysis was accomplished using the best available hydrologic and hydraulic modeling methodologies for storm water management water quantity which includes pipe flows, overland flows, drainage way flows, and wet pond storage of storm water runoff.

In the ideal design solution, most of the precipitation falling on a given drainage area would be absorbed or retained on-site. After development, the quantity and rate of water leaving the site would not exceed undeveloped conditions. The same principle would apply to nutrients and pollutants to avoid impacting the natural and water resources of the watershed. Unfortunately, the only true way to achieve this is by not developing or farming at all. By developing some areas, farm erosion would be reduced with installation of wet detention basins, constructed wetlands, lawn grass, and prairie grasses. Even when the pollutant loads and runoff rates could be matched underdeveloped conditions, the wildlife habitat, ecology, and aquatic biota is displaced by human activities and impervious surfaces. Therefore, the “real world” solution is to achieve an economically feasible balance between pre-development and post-development storm water quality and quantity to the most practical extent possible.

The management recommendations discussed in this report consist of interconnected open channels, drainage ways, ditches, prairie grass vegetation, pipes, culverts, bridges, ponds, and wetlands. The analysis of the storm water management system involves the following aspects:

- Division of the watershed into sub-watersheds and sub-areas based on contour maps, grading plans, and natural topographic features.
- Determine the amount of runoff anticipated under existing land use conditions and future land use conditions.
- Select a method of conveying that runoff.
- Delineate conveyance and detention areas for storm water runoff volume, storage, sediment, and pollutant treatment.
- Identification of vegetation cover types, woods, wetlands, and water bodies.
- Develop measures to maintain and enhance the groundwater recharge and water quality in the watershed.

B. Hydrology/Hydraulics

Storm water runoff is defined as the portion of precipitation that flows over the ground surface during, and for short period of time after, a storm event. The quantity of runoff is dependent on the intensity of the storm event, the initial moisture condition and infiltration capacity of the soil, the amount of antecedent rainfall, the length of the storm event, the type of surface the rain falls on, and the slope of the surface.

The intensity of the storm event is commonly associated with its period of return that designates the average period of years during which a storm of a certain magnitude has a probability of occurring. The degree of protection is determined by selecting a return storm event interval to be used as the basis for design. The storm events used in the report include 24-hour 1-inch rainfall, 2-, 10-, 25-, 100-year frequency storm events for overland drainage (Appendix A-E). For example, a ten-year frequency storm has a 10 percent probability for occurring or being exceeded in any given year, and a 100-year frequency storm has a 1 percent probability of occurring or being exceeded in any given year.

Based in historical data prepared by U.S. Weather Bureau Technical Paper No. 40 charts, a 10-year 24-hour frequency storm consists of 4.5 inches of rainfall in 24 hours, while a 100-year 24-hour frequency storm consists of 6.5 inches of rainfall in 24 hours.

Complete protections against large, infrequent storms with return intervals greater than 100-years are economically justified only for large, important flood control projects. For most developing areas within the watershed, the cost of construction of an excessively large capacity storm water management system is much greater than the amount of property damage that would result from flooding caused by a storm event which a smaller capacity system could not hold.

Hydrologic/Hydraulic Storm Water Runoff Water Quantity Analysis Tables present peak runoff rates in cubic feet per second (cfs) and total runoff volume in acre-feet (ac-ft) for Sub-area A within the sub-watershed. A number of methods are available to determine the expected maximum rate of runoff from a known area for a certain design storm and a certain soil moisture condition. The method chosen for this project is HydroCAD software that uses TR-20 and TR-55 calculations. A drainage diagram representing Stone Lake's existing and proposed storm water runoff is shown on Figure 6. Peak run-off rates and total run-off volume is provided below for area of the Main Street project. The effect of implementation the recommended storm water management practice is quite apparent. Table 6 depicts a future increase in development without supplemental treatment, and it indicates that storm water run-off will harmfully alter the natural wetland. The wetland will initially serve the needs of the Village, but sediment and other pollutants will soon be trapped in the wetland until it is filled-in and then Stone Lake will become affected and altered by the point-source storm water run-off pollution that over flows the wetland.

The change from existing to future land use is expressed as a decrease in run-off characteristics when considering the effects from treatment implementation of the recommended storm water best management practices. The affect of implementation of the recommendation storm water management practices is quite apparent. This BMP basin would store the pollutants, so the wetland and lake does not get filled in with sediment and that their habitat is not altered from excess nutrients or pollutants.

IV. WATER QUALITY

A. General Background

P8 Urban Catchment Model (Version 2.4) is the chosen method for predicting current and future water quality and quantity. This **p**rogram is primarily used for "**p**redicting **p**olluting **p**article **p**assage thru **p**its, **p**uddles, and **p**onds." This program was derived form other urban runoff models, like SWMM, STORM, HSPF, D3RM, and TR-20, by William W. Walker, Jr., Ph.D., Environmental Engineer.

While the program may serve a useful purpose in planning or design, it is intended primarily for use for evaluating runoff treatment systems (BMPs) for existing and/or proposed urban developments with minimal site-specific data. This model also predicts the generation and transport for storm water runoff pollutants in small urban catchments, much like Stone Lake. Continuous water-balance and mass-balance calculations on a user-defined system can consist of up to:

- 192 watersheds,
- 48 treatment devices (BMPs),
- 5 soil particle classes; and
- 10 water quality components

Simulations are driven by hourly rainfall and daily air temperature time series. Since this frequent of data was not collected in the Stone Lake area, other known data was used. The model will be simulating rainfall and precipitation data collected from the Minneapolis/ St. Paul Airport. Also, the model was initially calibrated with certain water quality parameters under the EPA's Nationwide Urban Runoff Program (NURP, Athayede et al., 1983).

Primary uses of program:

1. Evaluating site plans for compliance with treatment objective, expressed in terms of removal efficiency for total suspended solids (TSS) or a single particle class.
   An 85% TSS removal in "Sensitive Areas" is achievable (DNR proposed TMDL regulation).

2. In a design mode, selecting and sizing BMPs to achieve treatment objective. This program will automatically size BMPs to match user-defined watersheds, storm time series, target particle class, and target removal efficiency.

These two applications are insensitive to errors associated with predicting untreated runoff water quality and are therefore more accurate than predictions of concentrations or loads.

Secondary Users of Program ("Absolute Predictions"):

1. Predicting runoff water quality, loads, and violation frequencies.
2. Predicting water quality impacts due to proposed development.
   Upstream vs. downstream changes
   Existing vs. future changes
3. Calculating loads for driving receiving water quality models.
4. Watershed scale land-use planning.

These four types of applications are subject to greater error because of the high degree of variability (i.e., storm-to-storm and site-to-site) associated with urban runoff quality, as documented under the EPA's Nationwide Urban Runoff Program (NURP) (Athayde et al., 1983).

B. Water Quality Analysis Pollutant Loading

Water Quality Analysis Pollutant Loading Summary Tables present loading per acre and annual pollutant loadings per acre for total suspended solids (sediment, TSS), dissolved solids, total phosphorus (TP), dissolved phosphorus, copper (Cu), lead (Pb), and zinc (Zn). The storm events used in this section of the report include 1-inch Type2 Storm loading and annual loading (Tables 7-24, Appendix F-K). Pollutant loads were determined using the EPA's Nationwide Urban Runoff Program (NURP) data and simulated rainfall and precipitation data collected from the Minneapolis/ St. Paul Airport.

Pollutant loading data is provided in Tables 8-25 for existing and future land use conditions. Tables that depict no differences in existing and future land use conditions indicate that the developed Town of Stone Lake and Town of Sand Lake sub-area does not support infiltration. In fact, the data shows the same amount of pollutants entering the Town's are directly entering the wetland or proposed detention pond. These tables indicate increases in pollutant loadings based on projected land use changes. Tables depict low loadings of zinc, copper, and lead represent that the sub-area is lightly urban and primarily forested, because high concentrations of zinc, copper, lead, and other heavy metals originate from heavily used streets and parking lots typical of large urban land uses.

C. Run-off Analysis Summary After Storm Water Quality Management Practices

Pollutant Loading Summary Analysis after Storm Water Quality Management Practices Tables present the future condition land use after implementation for total suspended solids (sediment, TSS), dissolved solids, total phosphorus (TP), dissolved phosphorus, copper (Cu), lead (Pb), and zinc (Zn). Tables 26-31 show the removal efficiency of the wetland and proposed wet pond treatment for current conditions and proposed future conditions, after a 1-inch Type2 loading event and an annual loading event.

V. BEST MANAGEMENT PRACTICES

A. General

Best management practices (BMPs) recommended in this plan for the Stone Lake watershed are measures intended to reduce or mitigate water quantity and water quality concerns to the maximum extent practical. Certain measures can help reduce impacts, but no BMP will totally mitigate past problems, agricultural practices and proposed urban development. There are many ways to approach BMP site design and it is most easily done within developing areas.

Rural and developing areas allow for unique opportunities to incorporate BMPs into site design. The BMPs can be incorporated into natural areas serving as open spaces for community enjoyment. This idea can be expanded into a fingerprinting concept that requires developments to duplicate BMPs to some extent at each site.

Another technique is for Town's Lake Association in Washburn and Sawyer County, or WDNR to purchase land next to a water resource and create a buffer strip around the area and construct structural BMPs. In certain cases, this may be the only way to protect a sensitive water body from further degradation, even with several structural and non-structural BMPs in place.

Water Quality and Flood Control Best Management Practices can be categorized as either structural or non-structural controls. Structural best management controls include:

- Wet detention detention-sediment basins,
- Constructed wetlands,
- Infiltration basins,
- Infiltration trenches
- Dry detention/retention basins,
- Sump storm sewer inlets,
- Riprap
- Gabions,
- Construction of grassed channels and drainage ways
- Silt fence,
- Stone weeper berms; and
- Straw bales.

Non-structural best management controls include:

- Street sweeping,
- Catch basin control on winter streets,
- Leaf and lawn waste control,
- Fertilizer and pesticide application control,
- Hazardous waste and spill prevention program,
- Pet and farm animal waste control,

- Construction site erosion control regulations and enforcement,
- Storm water management planning education,
- Ordinances; and
- Land use planning

Using non-structural best management practices rather than using expensive structural best management practices can obtain a large percentage of water quantity and quality control benefits. However, some structural controls must be provided in order to obtain the greatest amount of pollutant reduction and flood control within the Stone Lake watershed. *We recommend that the following best management practices be implemented to address pollutant loadings and flood control within the Stone Lake watershed.*

B. Recommended Best Management Practices

1. Wet Detention Basins

Wet detention basins are the most effective and most commonly used best management practices for flood control, sedimentation control, and control of numerous pollutants found in storm water runoff. They are reliable and attractive systems that help and control storm water quality and quantity. They are the most cost effective systems to operate and maintain. These systems consist of a single or multiple permanent pools of water or a combination of a single permanent pool of water with a pretreatment sedimentation area that treats incoming storm water and discharges improved storm water quality to sensitive receiving water bodies and groundwater recharge areas. Wet detention basins are typically engineered with four to eight feet of standing water, allowing sediments and pollutants to settle out, with a defined sedimentation basin forebay, and outlet control structure.

Many studies have shown that wet detention basins consistently remove sediments and pollutants that attach to sediments. Removal rates can vary from 50 to 90 percent, depending on particle sizes and on the design size and shape of the system. Wet detention basins can also control pollutants such as heavy metals, phosphorus, and bacteria, but at lower removal rates than sediments. Pollution control rates can also vary depending on the construction system.

The change from existing to future land use is expressed as a decrease in run-off characteristics considering the effects of the recommended storm water best management practices. Significant pollutant loadings are apparent because of the increased high-density, residential, commercial, and increased presence of motor vehicles. The increase of pollutant loadings will be greatly reduced by the installation of structural controls and enforcement of non-structural controls. The affect of implementation of the recommendation storm water management practices is quite apparent. A wet detention (BMP) basin would store the pollutants, so the wetland and lake does not get filled in with sediment and that their habitat does not get altered from excess nutrients or pollutants.

We recommend a 10-15 year sediment clean-out cycle for wet detention basins. This schedule may need to be revised based on special site design and field observations. Extra storage in the lower stage can be provided to accommodate additional sediment deposition. To reduce removal costs, we recommend provisions be made for on-site disposal or the Town of Stone Lake and Town of Sand Lake should plan for use of the accumulated sediment at some future date.

2. Street and Parking Lot Sweeping

Past research and studies show that street sweeping has limited success as a BMP on existing urban land uses if automobiles are not moved away from the curb during sweeping operations. However, street sweeping can be used in conjunction with other BMPs to control sediments and pollutants in storm water runoff.

Street sweeping is usually helpful in reducing storm water run-off. Since there is little area in Stone Lake to be swept, results from the calculations did not show any significant improvements.

VI. SUMMARY RECOMMENDATIONS

The following are major recommendations provided throughout this report to minimize storm water runoff, encourage storm water infiltration, prevent property damage, and hazardous conditions, minimize soil erosion, reduce sediment and nutrient deposition in the storm water conveyance systems, protect the quality of groundwater, protect the water supply aquifer, preserve drainage ways, and Stone Lake as assets to the community, and minimize the negative impact of existing and future storm water discharges to wetlands, drainage ways, lake, and the environment.

- Detention basins should be designed to limit their outflow rates to no more than the allowable capacity of existing downstream conveyance and storage system;
- Encourage construction of grass and prairie grass infiltration systems to increase water quality benefits and lower long term operation and maintenance costs;
- Encourage construction of wet detention basin systems in lieu of dry detention basins due to increased water quality benefits and lower operation and maintenance costs;
- Make efficient use of open space by combining park systems with detention basin, infiltration areas, and storm water conveyance and management systems;
- Mitigate sediment discharge during construction by limiting and/or programming the area proposed for mass stripping and earthwork operations at a given time;
- Mitigate sediment discharge during construction by engineering, locating, and constructing temporary sedimentation basins and traps or permanent detention basins at the point of discharge form the construction site prior to discharge off-site; this should be done at the time of construction and prior to commencing any land-disturbing activities;
- Most efficient wet detention pond is one that has a static water storage volume (permanent water pool) greater than or equal to the volume of runoff form a 2-inch storm event under full projected watershed development with a 25% increase for sediment storage

In Tables 26 and 29, the data indicates the current wetland efficiently removes 96% TSS and 97% TSS (as well as other pollutants), respectively. This great removal rate surpasses the WDNR proposed TMDL 85% TSS removal rates. With future development and without implementing runoff treatment systems, the efficiency removal reduces to 94% TSS in a 1-

inch Type2 storm loading and 95% TSS in annual loading (Tables 27 & 30). Looking more specifically at sedimentation, Tables 8–25 represent the different conditions for TSS and other pollutants to runoff and hopefully be captured before reaching Stone Lake. For example, Tables 8-10 are broken down on the top of Figure 7 to show current sediment loading. The current sediment transport conditions consists of 119 pounds running off of the 98-acre Town of Stone Lake and Town of Sand Lake, the wetland filtered out 116 pounds of sediment, and 3 pounds ran off to the rest of Stone Lake's watershed. Figure 7 and Figure 8 show the calculated TSS loading rates from Tables 8-25 with the different loading rate diagrams represented by 5-gallon pail increments.

But with treatment in the future, there are increasing benefits. With the combined wet pond implementation and wetland, the overall system efficiently removes 96% TSS in a 1-inch Type2 storm and 98% TSS in a 1-year storm that is runoff the Town of Stone Lake and Town of Sand Lake (Tables 28 & 31). Looking specifically at Tables 23-25, TSS is presented in a diagram at the bottom of Figure 8 that shows the pond's filtering effectiveness. This figure shows (with the predicted increase of the Town of Stone Lake and Town of Sand Lake to 98-acres) that 6,838 pounds of TSS runs off the Town, the pond captures 6,059 pounds of TSS and 779 runs off into the wetland, the wetland then filters out 681 pounds of TSS and 98 pounds run off into Stone Lake and the Stone Lake watershed. Of that overall removal efficiency rate, the wet pond will efficiently remove 84% TSS in a 1-inch Type2 storm and 88% TSS in annual loading. The wetland will support natural exchanges of nutrients, where the changes in frequency, duration, and timing of discharging storm water may impact spawning, migration, species composition, and food chain support of the wetland and associated downstream systems (Crance 1988). Normal hydrologic flux allows exchange of nutrients, de tritus, and passage of aquatic life between systems.

The effect of implementing the recommended storm water management practice is quite apparent. Future increases in development without supplemental treatment indicate that storm water run-off will eventually have a negative impact on the wetland's natural habitat. Also, the WIDNR will not favor dredging or filling a wetland; however, dredging out sediment filled ponds is more commonly accepted. The wetland will initially serve the needs of the Village, but sediment and other pollutants will be trapped in the wetland until it is overburdened and then Stone Lake will be subjected the storm water runoff that over flows the wetland.

existing and proposed future land use conditions.

Currently, Sub-area A has 15-acres of urban development and 83-acres of undeveloped area (Table 1). The Town of Stone Lake and Town of Sand Lake's storm water is set-up to discharge into a 2.4-acre wetland. Table 5 summarizes the modeled information and shows that an increase in storm water runoff rates and volume with current conditions.

Table 5: Existing Land Use Condition: Sub-area A (98-ac): Run-off Analysis Results		
Storm Frequency	Peak Run-off Rate (cfs)	Total Run-off Volume (ac-ft)
24-hour/ 1 in.	6.0	0.5
2-years/24-hr	16.6	2.7
10-years/24-hr	55.7	7.7
25-years/24-hr	78.3	9.9
100-years/24-hr	135.3	15.3

If a 250-foot long by 100-foot wide by 6-foot deep pond were introduced to the landscape, the storm water would first flow into the detention pond and take on most of the sediment. This would prevent the wetland's habitat from altering and from filling in with sediment, pollutants, and other debris. Also, assuming that the urban development increases to 30-acres and leaving 68-acres undeveloped, the following peak runoff will result.

Table 6: Future Condition: Sub-area A: Run-off Analysis Results		
Storm Frequency	Peak Run-off Rate (cfs)	Total Run-off Volume (ac-ft)
24-hour	11.8	0.9
2-year	31.6	3.8
10-year	68.8	9.1
25-year	90.4	11.4
100-year	146.2	17.1

The recommended and proposed detention pond ends up being primarily used for the small, frequent storms. Even the 2-year storm will cause it to overflow, but not by much. Most sediment that is trapped in Stone Lake is from the more frequent, low volume storms.

C. Run-off Analysis Summary After Storm Water Quantity Management Practices

Run-off Analysis Summary after Storm Water Quantity Management Table 6 present the future condition land use after implementation for recommended water quantity control management recommendations. This table also indicates the wet detention basin analysis recommended storage requirements. Figure 1 and 2 depicts sub-watershed, individual sub-areas, and design

TABLES

Table 1 (FIG 4): Existing Landuse in Urban Stone Lake Sub-area

	Acres	%
Urban	15	16
Agriculture	2	2
Forest	65	67
Grassland	13	13
Wetland	2	2
Total:	98	100

Table 2 (FIG 4): Existing Landuse in Wetland

	Acres	%
Wetland	2	29
Forest	6	70
Barren	0	1
Total:	8	100

Table 3 (FIG 3): Existing Landuse in Stone Lake Watershed

	Acres	%
Urban	15	1
Agriculture	40	2
Forest	919	53
Grassland	119	7
Wetland	51	3
Barren	16	1
Water	571	33
Total:	1732	100

Table 4 (FIG 4): Proposed Landuse in Urban Stone Lake Sub-area

	Acres	%
Urban	30	31
Agriculture	2	2
Forest	51	52
Grassland	13	13
Wetland	2	2
Total:	98	100

Table 5: Existing Landuse Condition
Sub-area A (98-ac): Run-off Analysis Results

Storm Frequency	Peak Run-off Rate (cfs)	Total Run-off Volume (ac-ft)
24-hour/ 1 in.	6.0	0.5
2-years/24-hr	16.6	2.7
10-years/24-hr	55.7	7.7
25-years/24-hr	78.3	9.9
100-years/24-hr	135.3	15.3

Table 6: Future Landuse Condition
Sub-area A (98-ac): Run-off Analysis Results

Storm Frequency	Peak Run-off Rate (cfs)	Total Run-off Volume (ac-ft)
24-hour/ 1 in.	11.8	0.9
2-years/24-hr	31.6	3.8
10-years/24-hr	68.8	9.1
25-years/24-hr	90.4	11.4
100-years/24-hr	146.2	17.1

Table 7: Future Landuse Condition
Sub-area B: Run-off Analysis Results – Pond Treatment

Storm Frequency	Peak Run-off Rate (cfs)	Total Run-off Volume (ac-ft)
24-hour/ 1 in.	2.8	0.9
2-years/24-hr	5.8	3.8
10-years/24-hr	41.2	9.1
25-years/24-hr	58.4	11.4
100-years/24-hr	101.5	17.1

Table 8: Existing Conditions: Sub-area A
Loading onto 98+/- acres after 1 inch Type2 Storm

Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	119	3
Total Phosphorus	0.38	--
Total Kjeldahl Nitrogen	2	--
Copper	0.04	--
Lead	0.02	--
Zinc	0.18	--

Table 9: Existing Conditions: Sub-area B
Loading 2.4 +/- acres after 1 inch Type2 Storm

Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	119	49
Total Phosphorus	0.38	--
Total Kjeldahl Nitrogen	2	1
Copper	0.04	--
Lead	0.02	--
Zinc	0.18	--

Table 10: Existing Conditions: Sub-area C
Loading after 1 inch Type2 Storm

Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	3	--
Total Phosphorus	0.07	--
Total Kjeldahl Nitrogen	0.38	--
Copper	0.01	--
Lead	0	--
Zinc	0.04	--

Table 11: Future Conditions: Sub-area A
Increased Urban Area *without* Treatment
Loading onto 98 +/- acres after 1 inch Type2-Storm

Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	270	3
Total Phosphorus	0.86	--
Total Kjeldahl Nitrogen	4	--
Copper	0.09	--
Lead	0.05	--
Zinc	0.41	--

Table 12: Future Conditions: Sub-area B
Increased Urban Area *without* Treatment
Loading 2.4 +/- acres after 1 inch Type2-Storm

Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	270	112
Total Phosphorus	0.86	--
Total Kjeldahl Nitrogen	4	2
Copper	0.09	--
Lead	0.05	--
Zinc	0.41	--

Table 13: Future Conditions: Sub-area C
Increased Urban Area *without* Treatment
Loading after 1 inch Type2-Storm

Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	16	--
Total Phosphorus	0.25	--
Total Kjeldahl Nitrogen	1	--
Copper	0.03	--
Lead	0.01	--
Zinc	0.15	--

Table 14: Future Conditions: Sub-area A & *Wet Pond*
Increased Urban Area *with* Treatment
Loading onto 98 +/- & 0.57 +/- acres after 1 inch Type2-Storm

Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	270	3
Total Phosphorus	0.86	--
Total Kjeldahl Nitrogen	4	--
Copper	0.09	--
Lead	0.05	--
Zinc	0.41	--

Table 15: Future Conditions: Sub-area B
Increased Urban Area *with* Treatment
Loading onto 2.4 +/- acres after 1 inch Type2-Storm

Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	38	67
Total Phosphorus	0.35	1
Total Kjeldahl Nitrogen	2	3
Copper	0.04	--
Lead	0.01	--
Zinc	0.19	--

Table 16: Future Conditions: Sub-area C
Increased Urban Area *with* Treatment
Loading after 1 inch Type2-Storm

Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	4	--
Total Phosphorus	0.15	--
Total Kjeldahl Nitrogen	0.89	--
Copper	0.02	--
Lead	0	--
Zinc	0.1	--

Table 17: Existing Conditions: Sub-area A
Loading onto 98 +/- acres after annual storms

Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/acre/year)
Total Suspended Solids	140	1
Total Phosphorus	--	--
Total Kjeldahl Nitrogen	2	--
Copper	0.05	--
Lead	0.03	--
Zinc	--	--

Table 18: Existing Conditions: Sub-area B
Loading onto 2.4 +/- acres after annual storms

Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/acre/year)
Total Suspended Solids	140	1
Total Phosphorus	--	--
Total Kjeldahl Nitrogen	2	--
Copper	0.05	--
Lead	--	--
Zinc	--	--

Table 19: Existing Conditions: Sub-area C
Loading after annual storms

Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/acre/year)
Total Suspended Solids	5	--
Total Phosphorus	--	--
Total Kjeldahl Nitrogen	1	--
Copper	0.01	--
Lead	--	--
Zinc	--	--

Table 20: Future Conditions: Sub-area A
Increased Urban Area *without* Treatment
Loading onto 98 +/- acres after annual storms

Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/year)
Total Suspended Solids	6838	70
Total Phosphorus	22	--
Total Kjeldahl Nitrogen	97	1
Copper	2	--
Lead	1	--
Zinc	10	--

Table 21: Future Conditions: Sub-area B
Increased Urban Area *without* Treatment
Loading onto 2.4 +/- acres after annual storms

Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/year)
Total Suspended Solids	6838	2849
Total Phosphorus	22	9
Total Kjeldahl Nitrogen	97	40
Copper	2	1
Lead	1	1
Zinc	10	4

Table 22: Future Conditions: Sub-area C
Increased Urban Area *without* Treatment
Loading after annual storms

Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/year)
Total Suspended Solids	322	--
Total Phosphorus	7	--
Total Kjeldahl Nitrogen	38	--
Copper	0.85	--
Lead	0.17	--
Zinc	4	--

Table 23: Future Conditions: Sub-area A & *Wet Pond*
Increased Urban Area *with* Treatment
Loading onto 98 +/- & 0.57 +/- acres after annual storms

Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/year)
Total Suspended Solids	6806	69
Total Phosphorus	22	--
Total Kjeldahl Nitrogen	97	1
Copper	2	--
Lead	1	--
Zinc	10	--

Table 24: Future Conditions: Sub-area B
Increased Urban Area *with* Treatment
Loading onto 2.4 +/- acres after annual storms

Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/year)
Total Suspended Solids	779	1367
Total Phosphorus	9	15
Total Kjeldahl Nitrogen	45	79
Copper	1	2
Lead	0.25	0
Zinc	5	8

Table 25: Future Conditions: Sub-area C
Increased Urban Area *with* Treatment
Loading after annual storms

Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/year)
Total Suspended Solids	98	--
Total Phosphorus	5	--
Total Kjeldahl Nitrogen	32	--
Copper	0.72	--
Lead	0.12	--
Zinc	3	--

Table 26: Existing Conditions:
Removal efficiencies from 98 +/- acres
loading after 1 inch Type2-Storm

Pollutant	Removal Efficiency (%)
Total Suspended Solids	96
Total Phosphorus	68
Total Kjeldahl Nitrogen	59
Copper	59
Lead	88
Zinc	59

Table 27: Future Conditions *without* Treatment:
Removal efficiencies from 2.4 +/- acres
loading after 1 inch Type2-Storm

Pollutant	Removal Efficiency (%)
Total Suspended Solids	94
Total Phosphorus	65
Total Kjeldahl Nitrogen	56
Copper	56
Lead	85
Zinc	56

Table 28: Future Conditions *with* Treatment
Removal efficiencies after 1 inch Type2-Storm

Pollutant	Overall Removal Efficiencies (%)	Wet Pond Removal Efficiency (%)	Wetland Removal Efficiency (%)
Total Suspended Solids	96	84	86
Total Phosphorus	68	54	35
Total Kjeldahl Nitrogen	59	47	26
Copper	59	47	26
Lead	88	77	53
Zinc	59	47	26

Table 29: Existing Conditions.
Removal efficiencies from 98 +/- acres
Loading after annual storms

Pollutant	Removal Efficiency (%)
Total Suspended Solids	97
Total Phosphorus	70
Total Kjeldahl Nitrogen	60
Copper	60.4
Lead	88.7
Zinc	60

Table 30: Future Conditions *without* Treatment.
Removal efficiencies from 2.4 +/- acres
Loading after annual storms

Pollutant	Removal Efficiency (%)
Total Suspended Solids	95
Total Phosphorus	67
Total Kjeldahl Nitrogen	59
Copper	59
Lead	87
Zinc	59

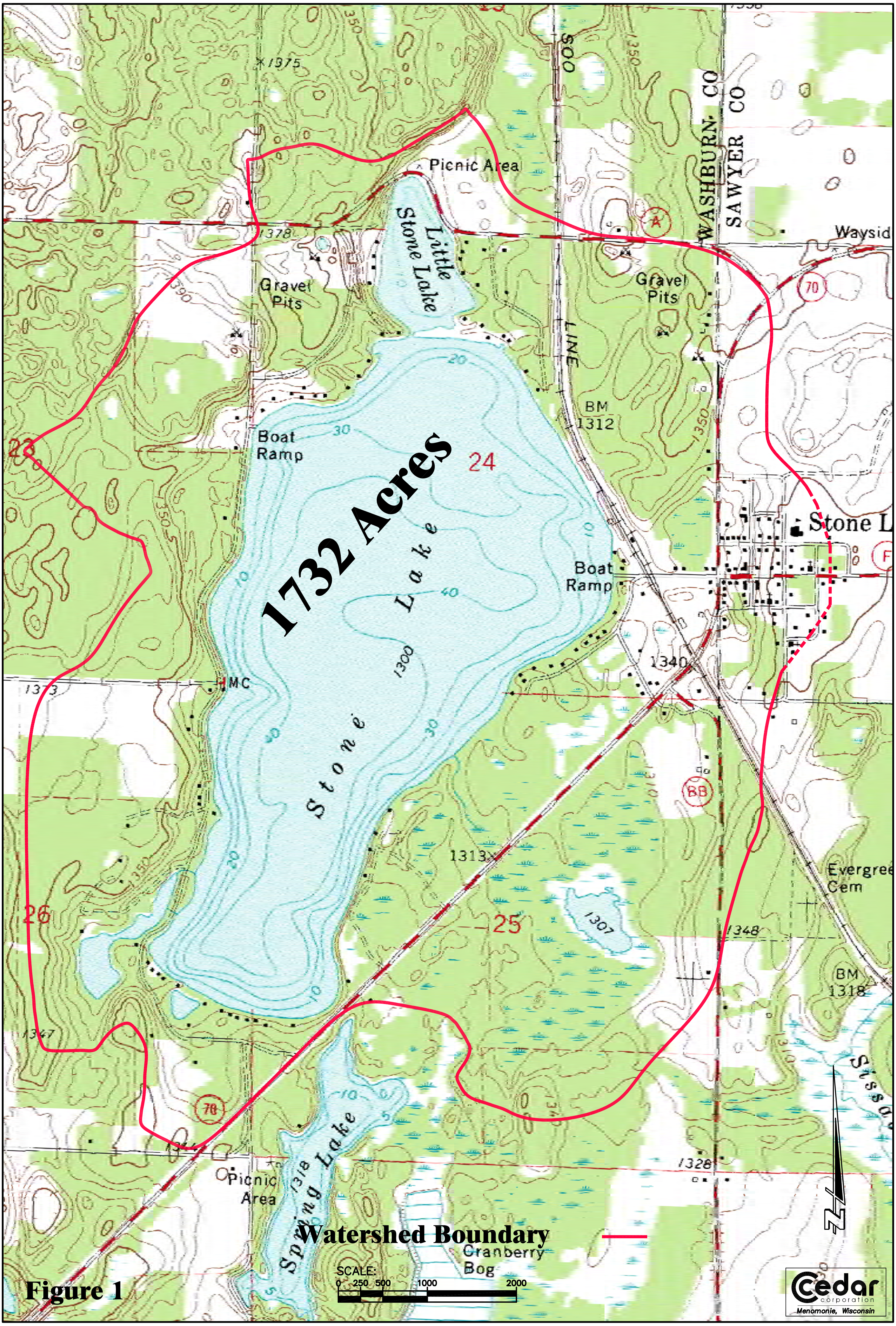
Table 31: Future Conditions *with* Treatment.
Removal efficiencies Loading after annual storms

Pollutant	Overall Removal Efficiencies (%)	Wet Pond Removal Efficiency (%)	Wetland Removal Efficiency (%)
Total Suspended Solids	98	88	87
Total Phosphorus	71	59	30
Total Kjeldahl Nitrogen	62	51	22
Copper	62	51	22
Lead	90	81	89
Zinc	62	51	22

FIGURES

FIGURES

STONE LAKE WATERSHED AREAS AND TOPOGRAPHY



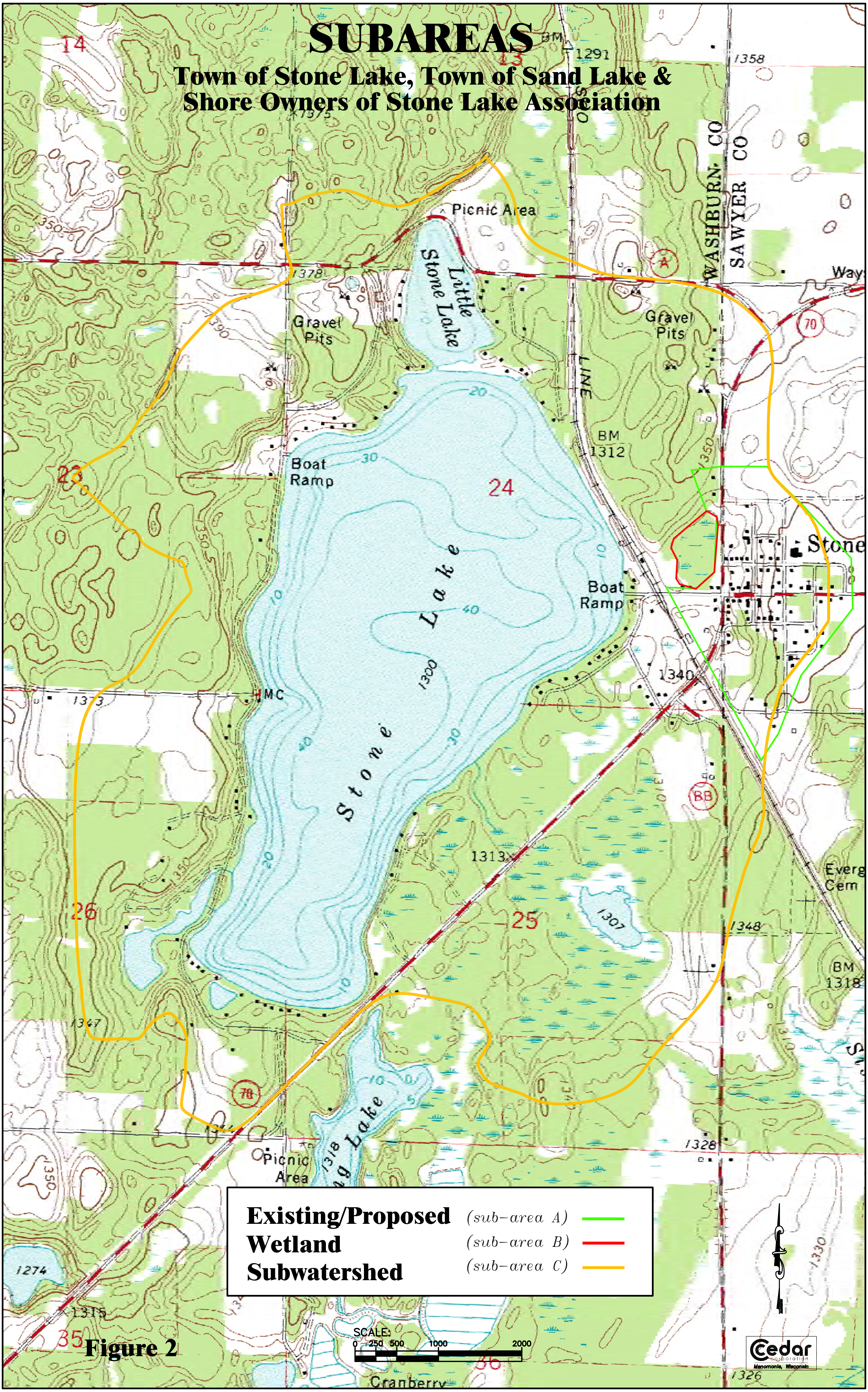
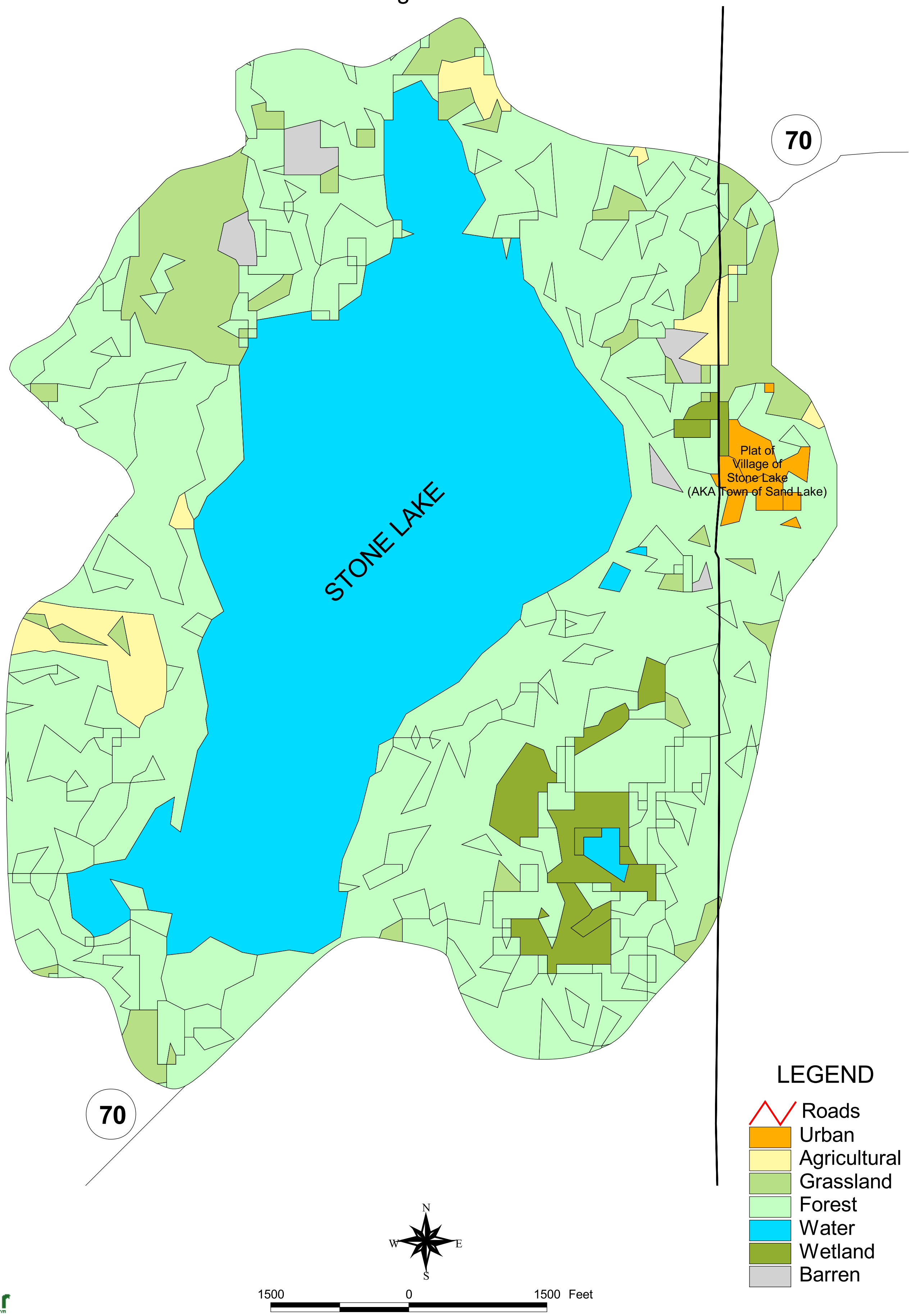

SUBAREAS
Town of Stone Lake, Town of Sand Lake &
Shore Owners of Stone Lake Association
Existing/Proposed (sub-area A)
Wetland (sub-area B)
Subwatershed (sub-area C)
Stone Lake
Little Stone Lake
Picnic Area
Gravel Pits
Boat Ramp
WASHBURN CO
SAWYER CO
LINE
BM 1312
BM 1318
Evergr Cem
SCALE: 0 250 500 1000 2000
Cedar Corporation Menomonie, Wisconsin

Figure 2

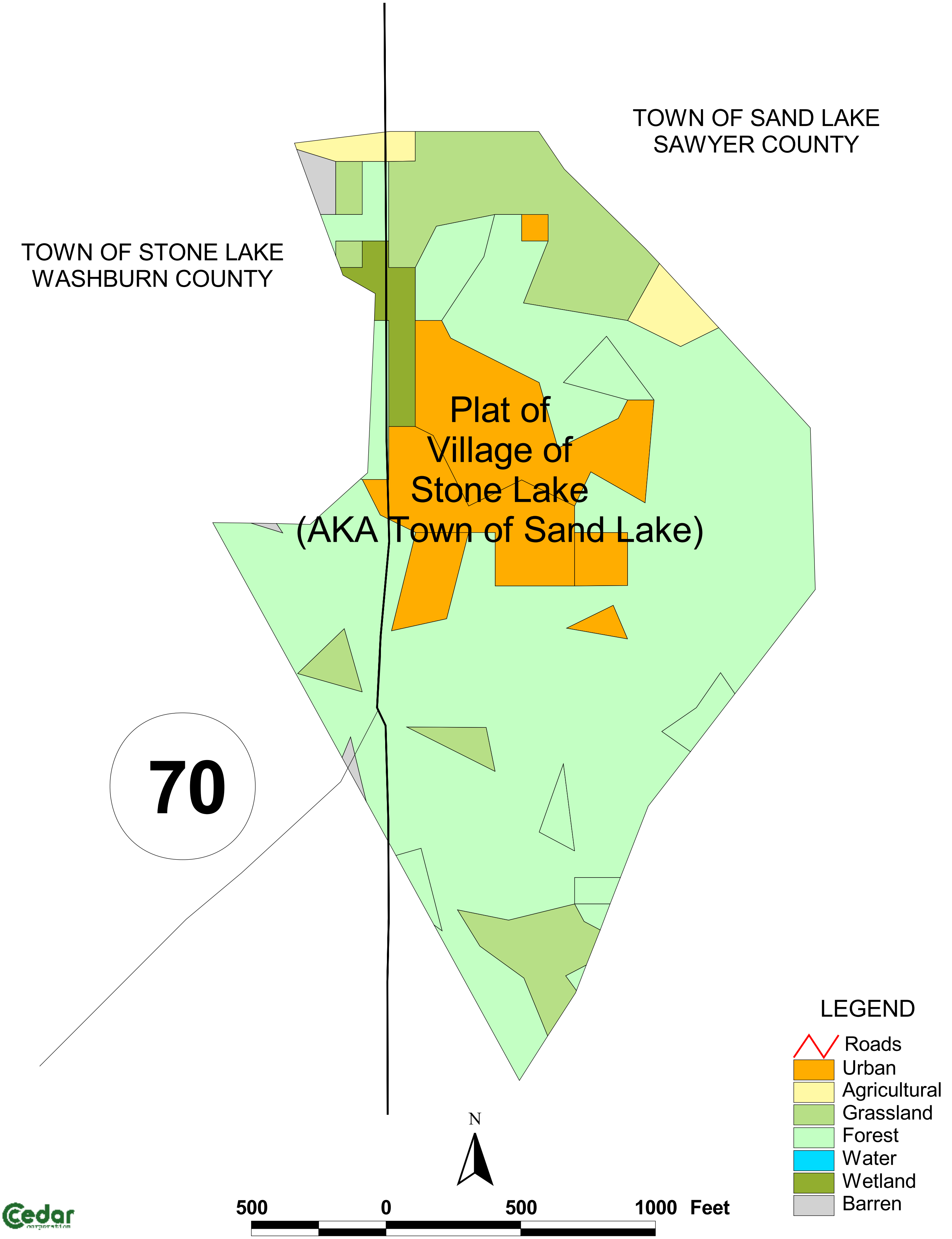
STONE LAKE WATERSHED LAND COVER

Figure 3



EXISTING URBAN AND WETLAND LAND COVER

Figure 4



PROPOSED URBAN AND WETLAND LAND COVER

Figure 5

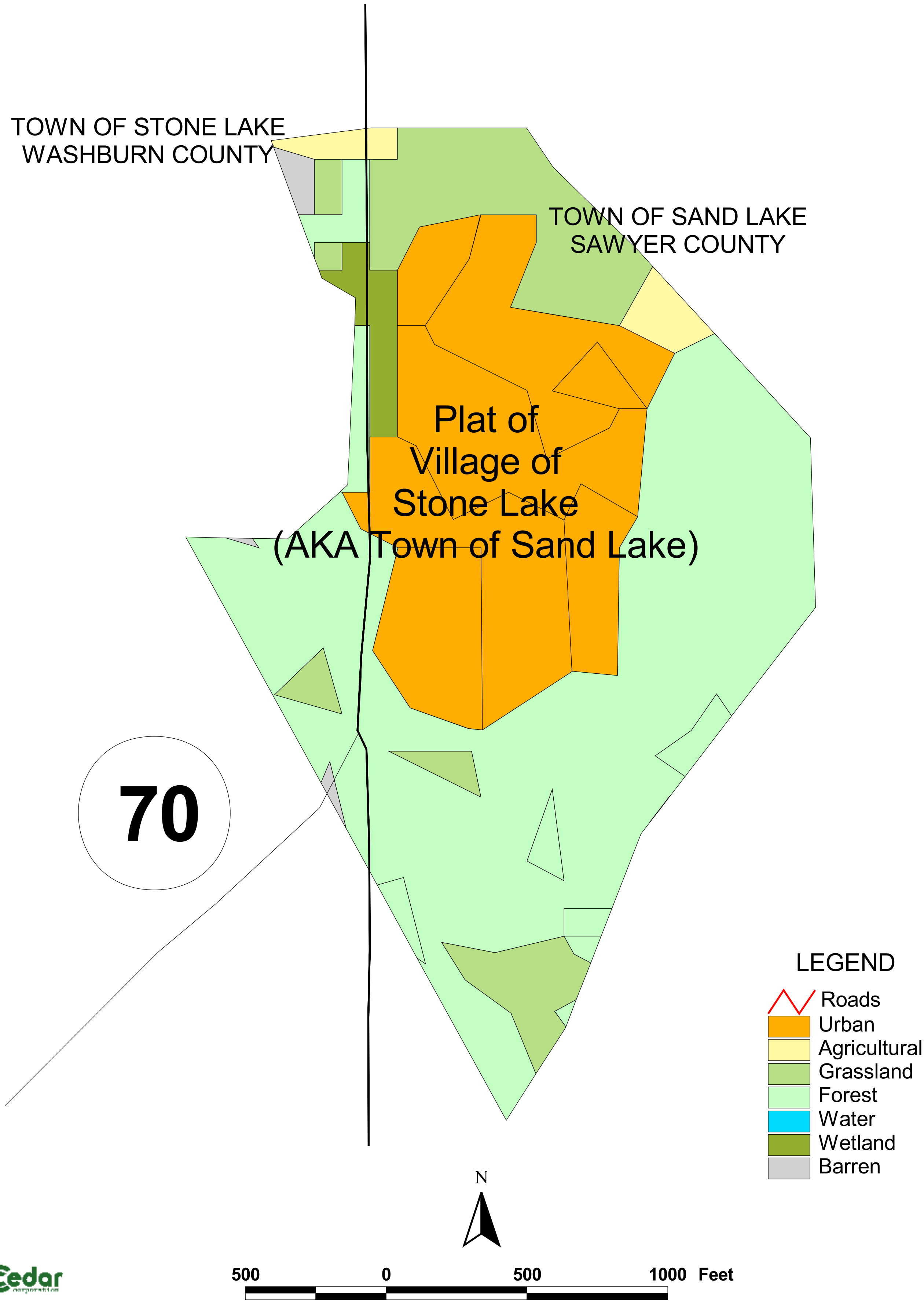
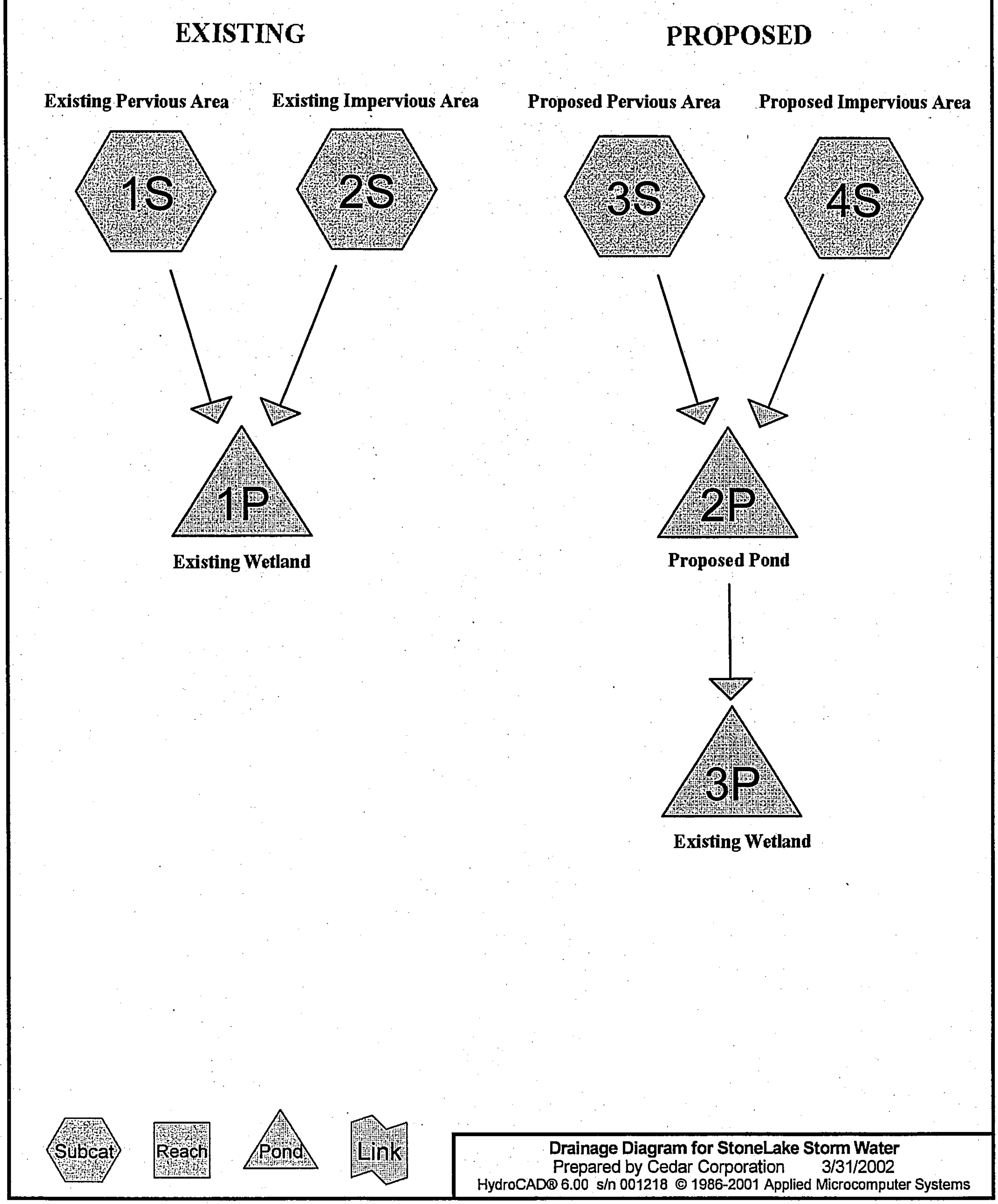
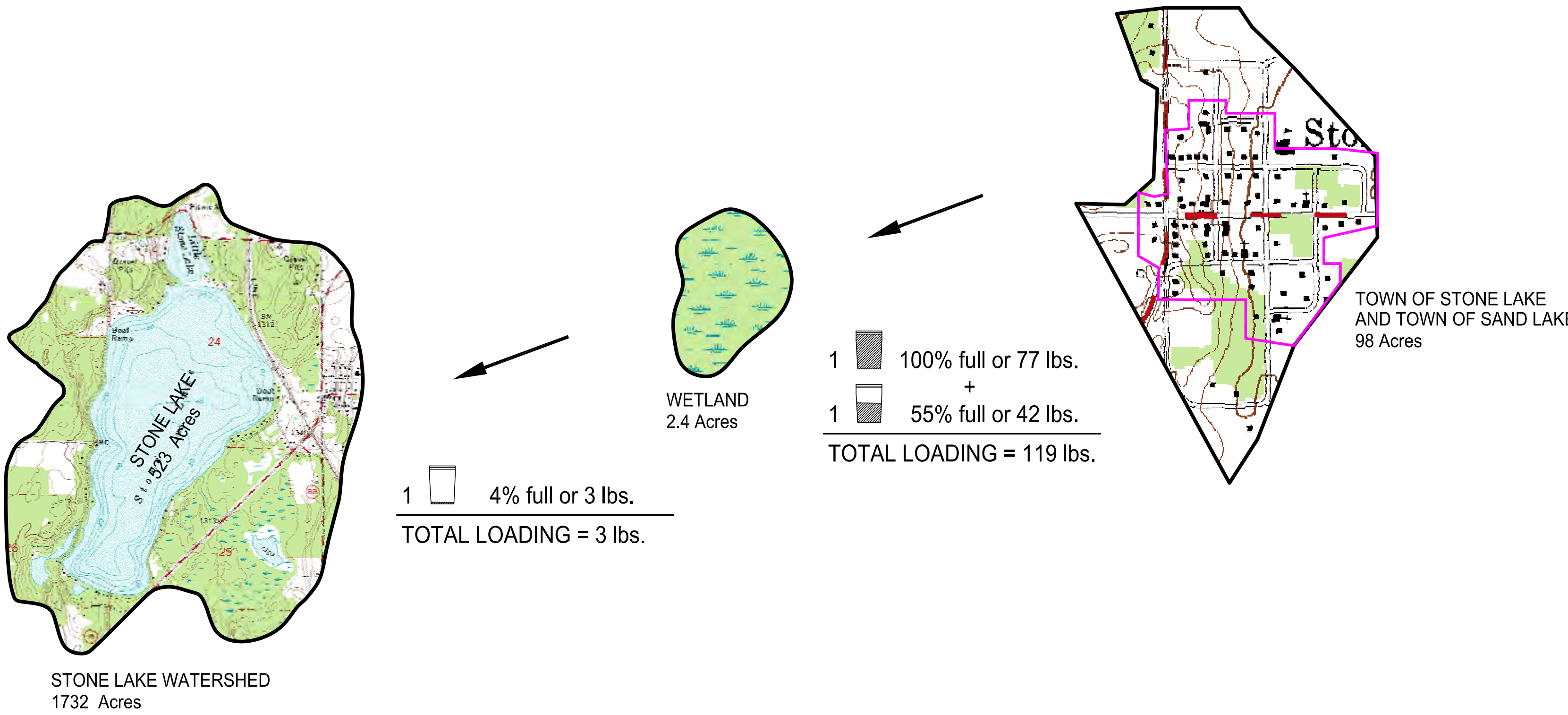


Figure 6: Storm Water Drainage Diagram of Stone Lake



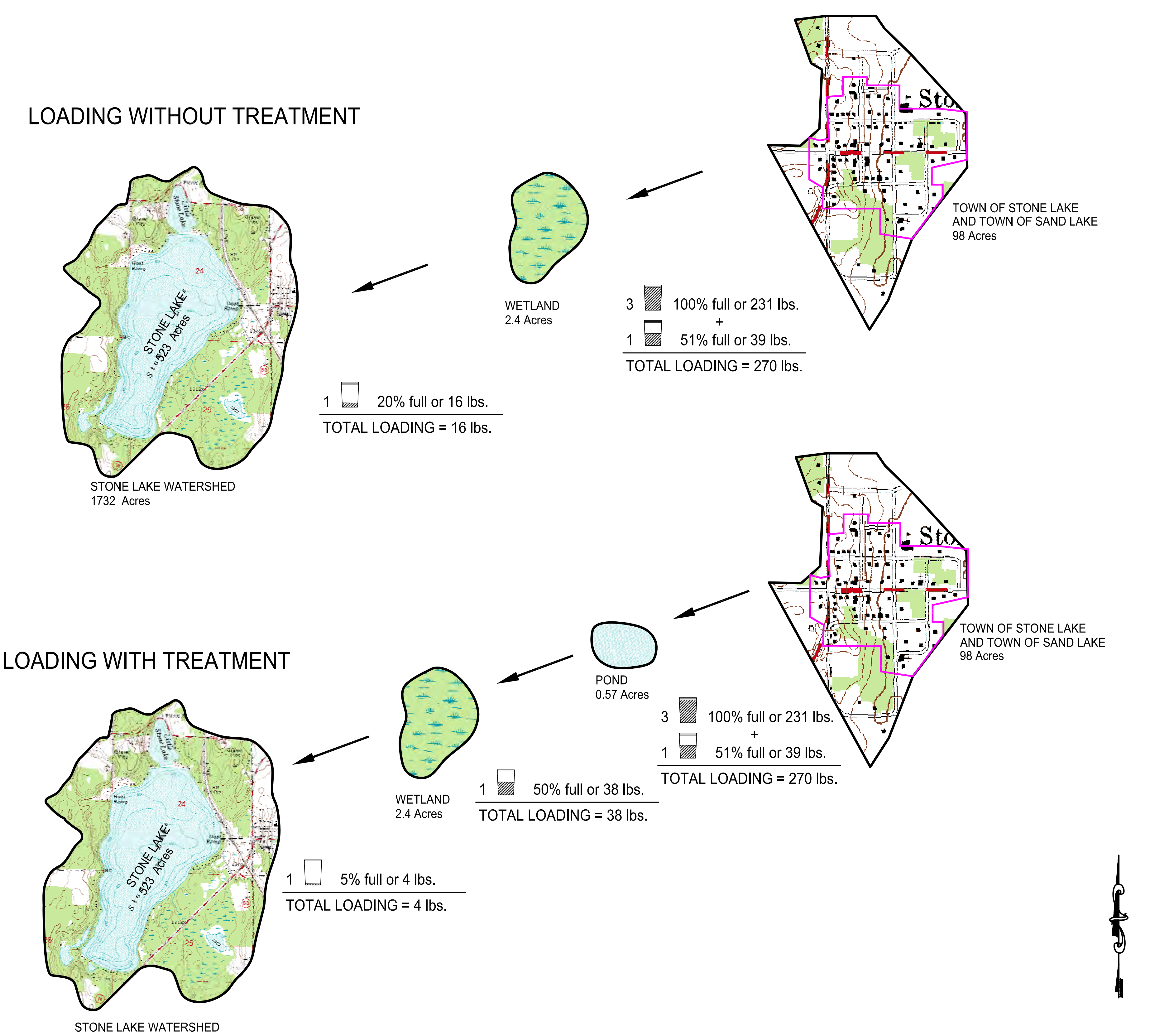
P8 URBAN CATCHMENT MODEL RESULTS CURRENT SUSPENDED SEDIMENT TRANSPORT CONDITIONS

Loading After 1-inch Type 2 Storm
(Note: Represented in 5-gallon pail increments)



P8 URBAN CATCHMENT MODEL RESULTS PROPOSED FUTURE SUSPENDED SEDIMENT TRANSPORT CONDITIONS

Loading After 1-inch Type 2 Storm
(Note: Represented in 5-gallon pail increments)

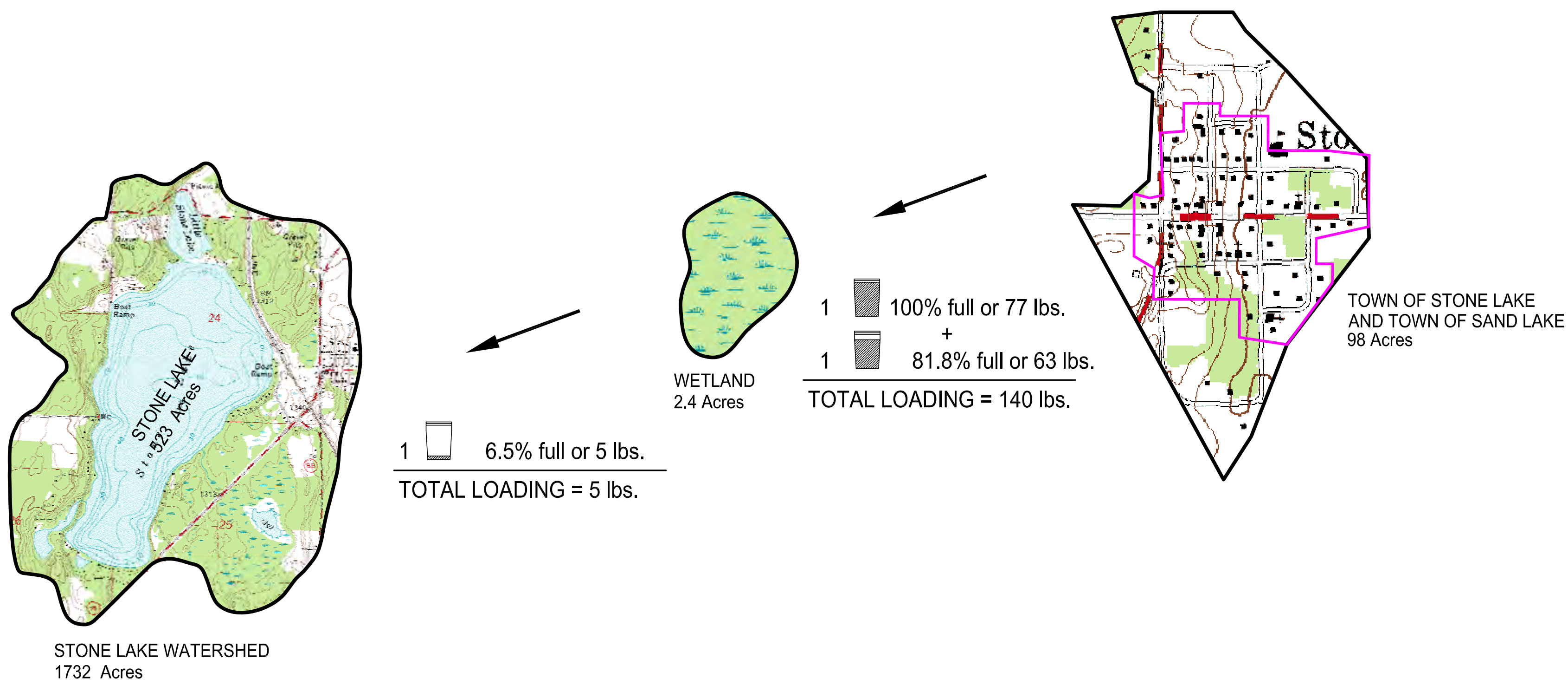


* Not to scale

FIGURE 7

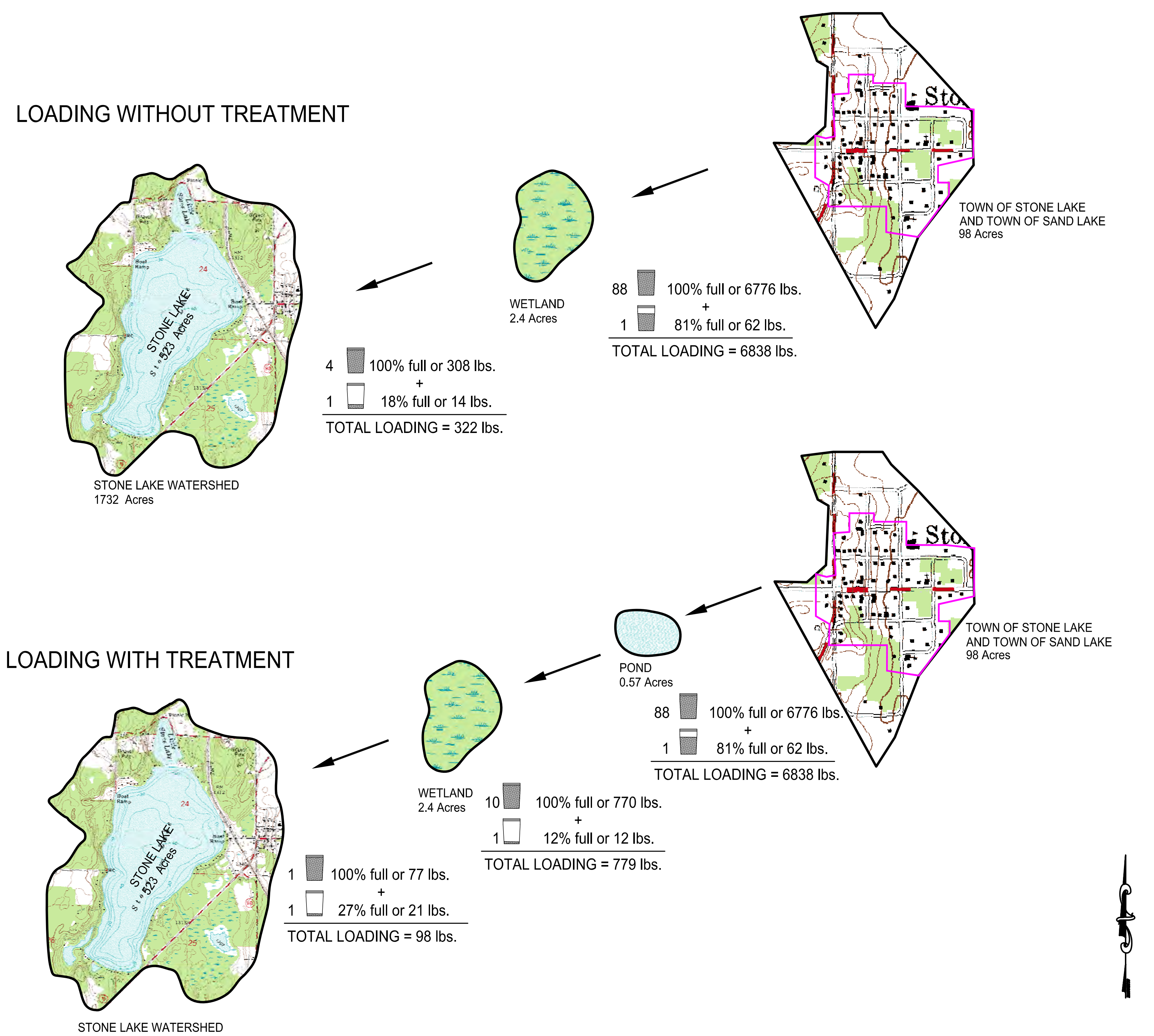
P8 URBAN CATCHMENT MODEL RESULTS EXISTING SUSPENDED SEDIMENT TRANSPORT CONDITIONS

Annual Loading
(Note: Represented in 5-gallon pail increments)



P8 URBAN CATCHMENT MODEL RESULTS PROPOSED FUTURE SUSPENDED SEDIMENT TRANSPORT CONDITIONS

Annual Loading
(Note: Represented in 5-gallon pail increments)



* Not to scale

FIGURE 8

APPENDIX A

1-inch Rainfall

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Type II 24-hr Rainfall=1.00"
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Existing Pervious Area
Tc=30.0 min CN=60 Area=92.400 ac Runoff= 0.00 cfs 0.000 af

Subcatchment 2S: Existing Impervious
Tc=15.0 min CN=100 Area=5.600 ac Runoff= 6.02 cfs 0.466 af

Subcatchment 3S: Proposed Urban Pervious
Tc=30.0 min CN=60 Area=87.000 ac Runoff= 0.00 cfs 0.000 af

Subcatchment 4S: Proposed Impervious
Tc=15.0 min CN=100 Area=11.000 ac Runoff= 11.82 cfs 0.915 af

Pond 1P: Wetland
Inflow= 6.02 cfs 0.466 af
Primary= 6.02 cfs 0.466 af

Pond 2P: Wet Pond
Peak Storage= 70,665 cf Inflow= 11.82 cfs 0.915 af
Primary= 2.78 cfs 0.837 af Outflow= 2.78 cfs 0.837 af

Pond 3P: Wetland
Inflow= 2.78 cfs 0.837 af
Primary= 2.78 cfs 0.837 af

Runoff Area = 196.000 ac Volume = 1.380 af Average Depth = 0.08"

Subcatchment 1S: Existing Pervious Area

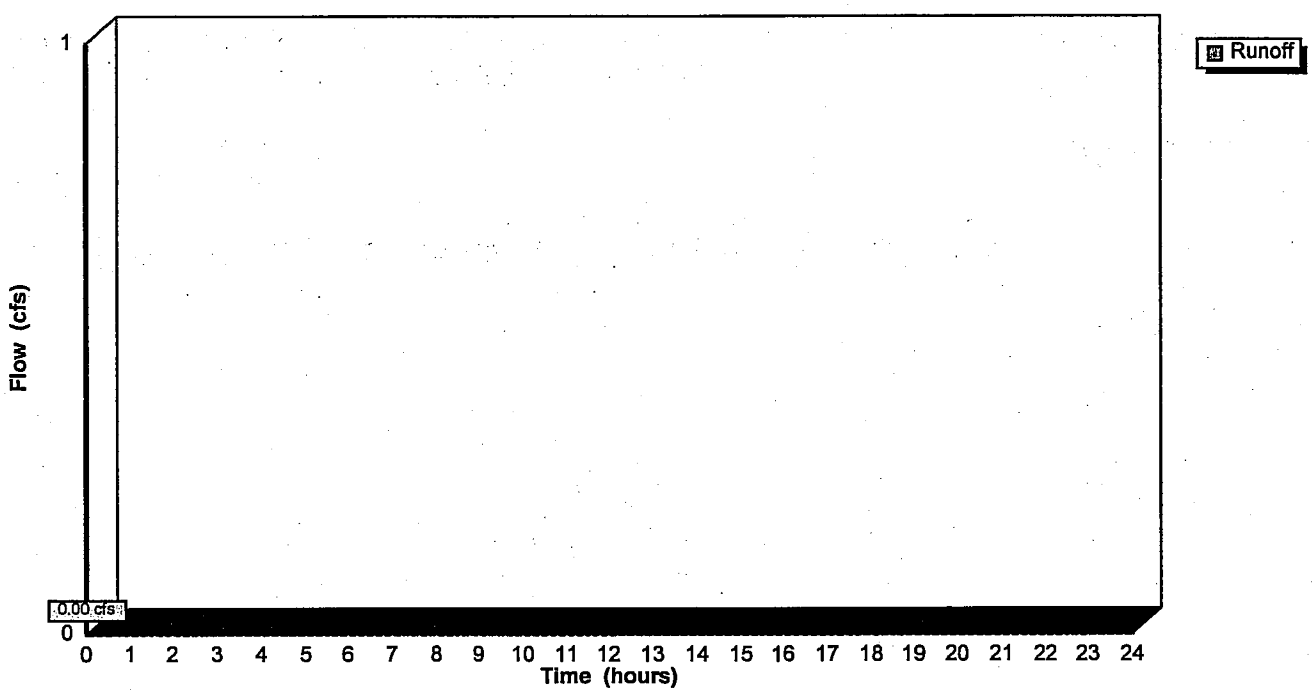
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=1.00"

Area (ac)	CN	Description
9.700	60	Urban Development (pervious)
82.700	60	Non-Developed (pervious)
92.400	60	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, estimated Tc**

Subcatchment 1S: Existing Pervious Area



Subcatchment 2S: Existing Impervious

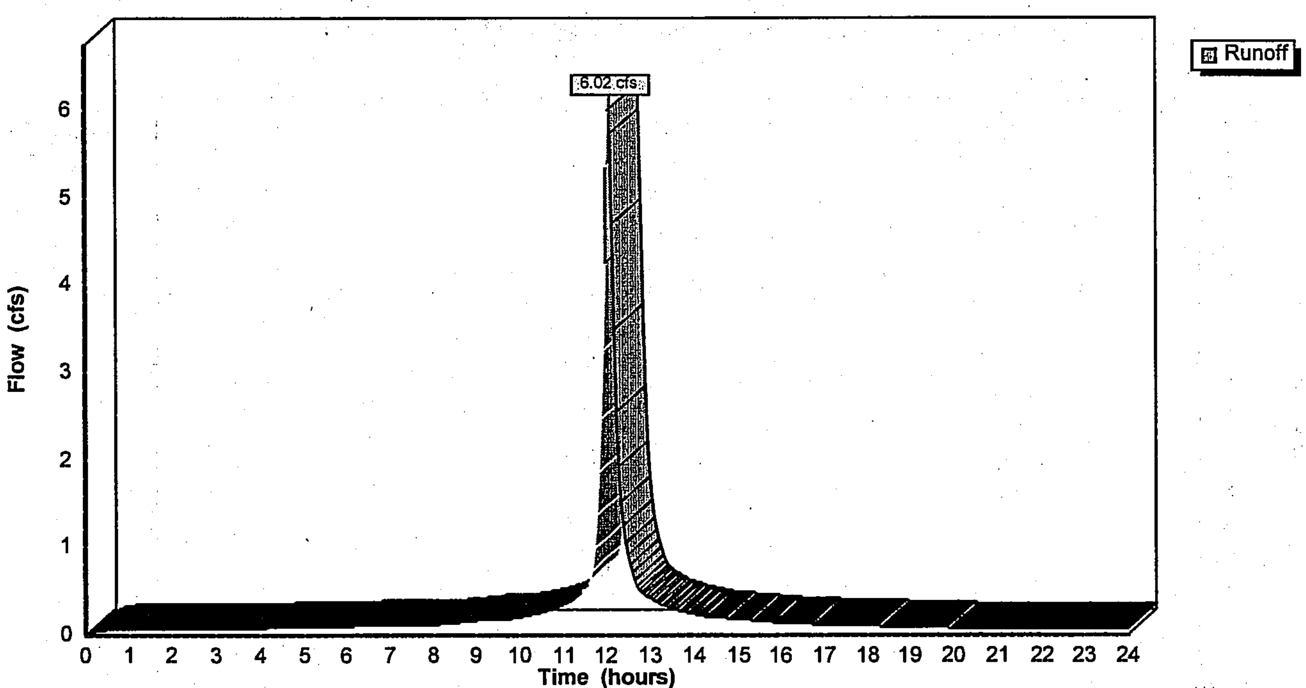
Runoff = 6.02 cfs @ 12.06 hrs, Volume= 0.466 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=1.00"

Area (ac)	CN	Description
5.600	100	Urban Development (Impervious)

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Assumed**

Subcatchment 2S: Existing Impervious



Subcatchment 3S: Proposed Urban Pervious

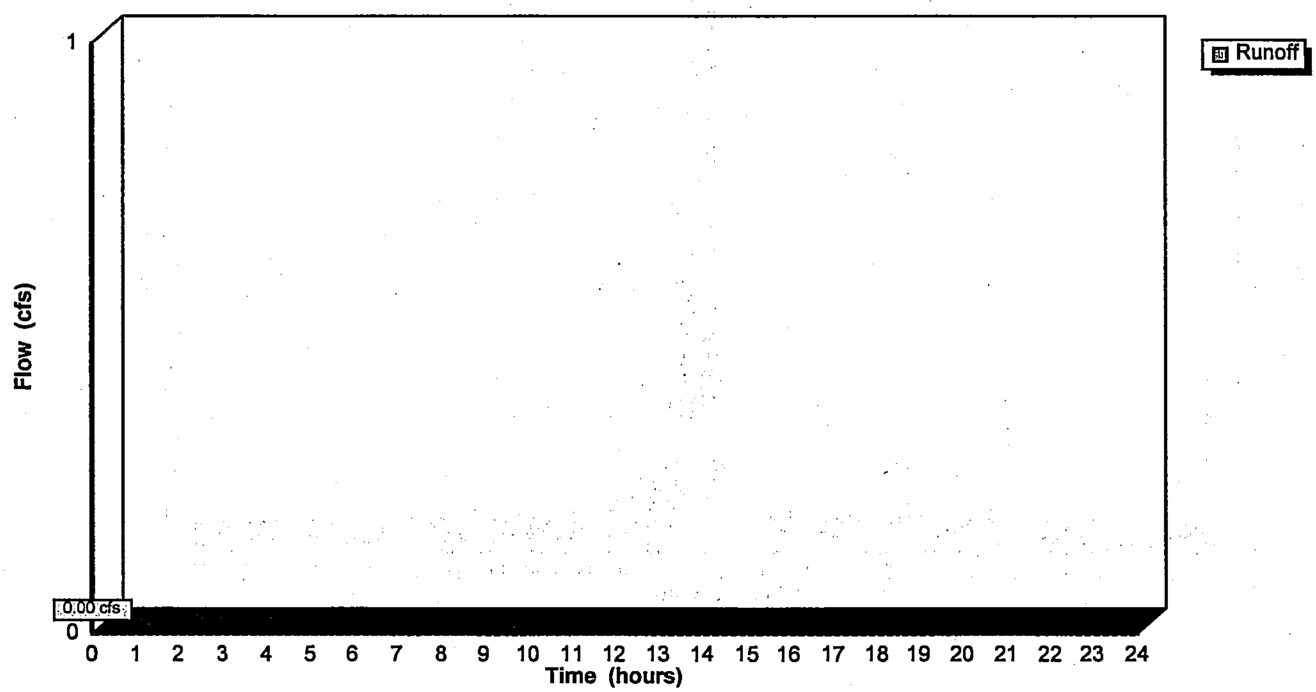
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=1.00"

Area (ac)	CN	Description
19.000	60	Developed Pervious
68.000	60	Undeveloped
87.000	60	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, Assumed**

Subcatchment 3S: Proposed Urban Pervious



Subcatchment 4S: Proposed Impervious

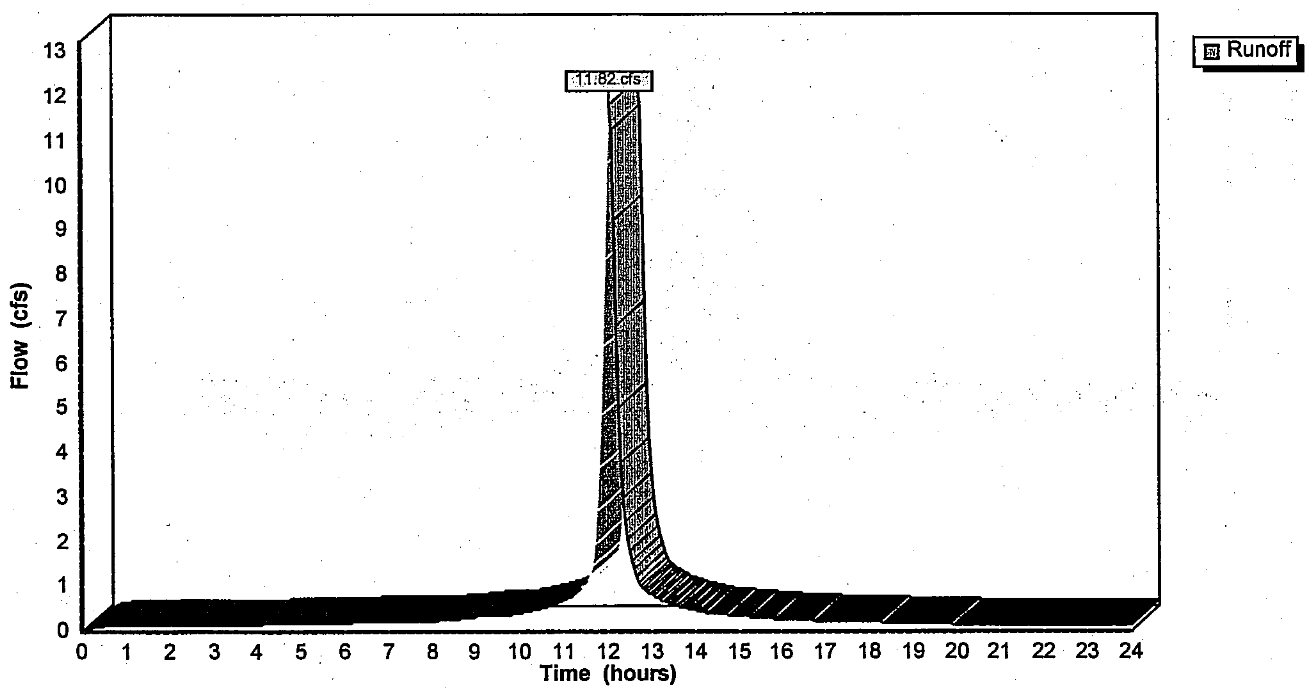
Runoff = 11.82 cfs @ 12.06 hrs, Volume= 0.915 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=1.00"

Area (ac)	CN	Description
11.000	100	Developed Impervious Areas

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Assumed**

Subcatchment 4S: Proposed Impervious

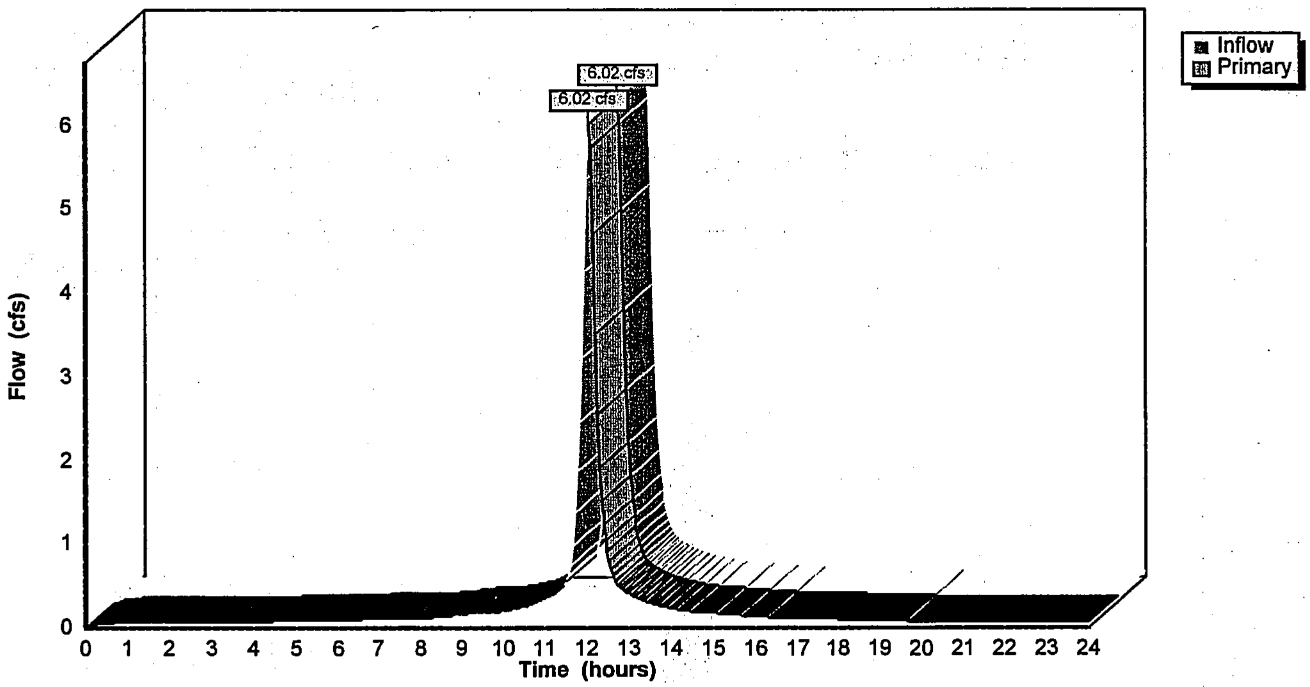


Pond 1P: Wetland

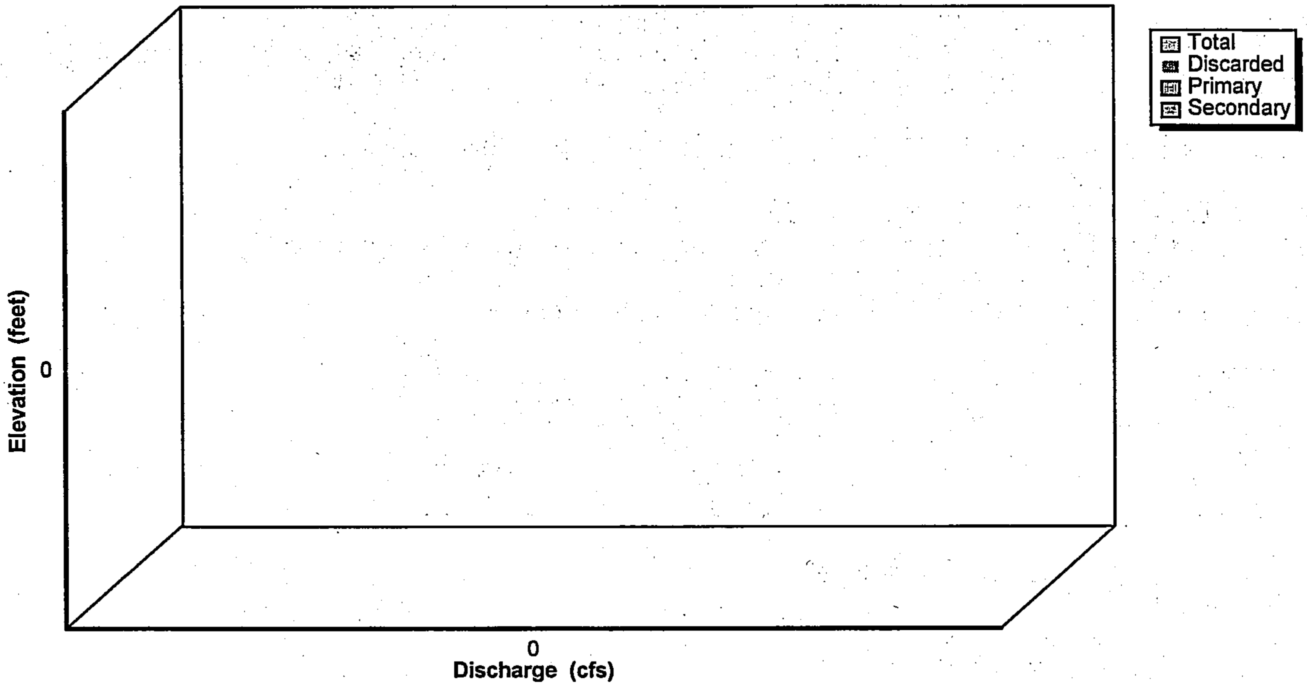
Inflow	=	6.02 cfs @ 12.06 hrs,	Volume=	0.466 af
Primary	=	6.02 cfs @ 12.06 hrs,	Volume=	0.466 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

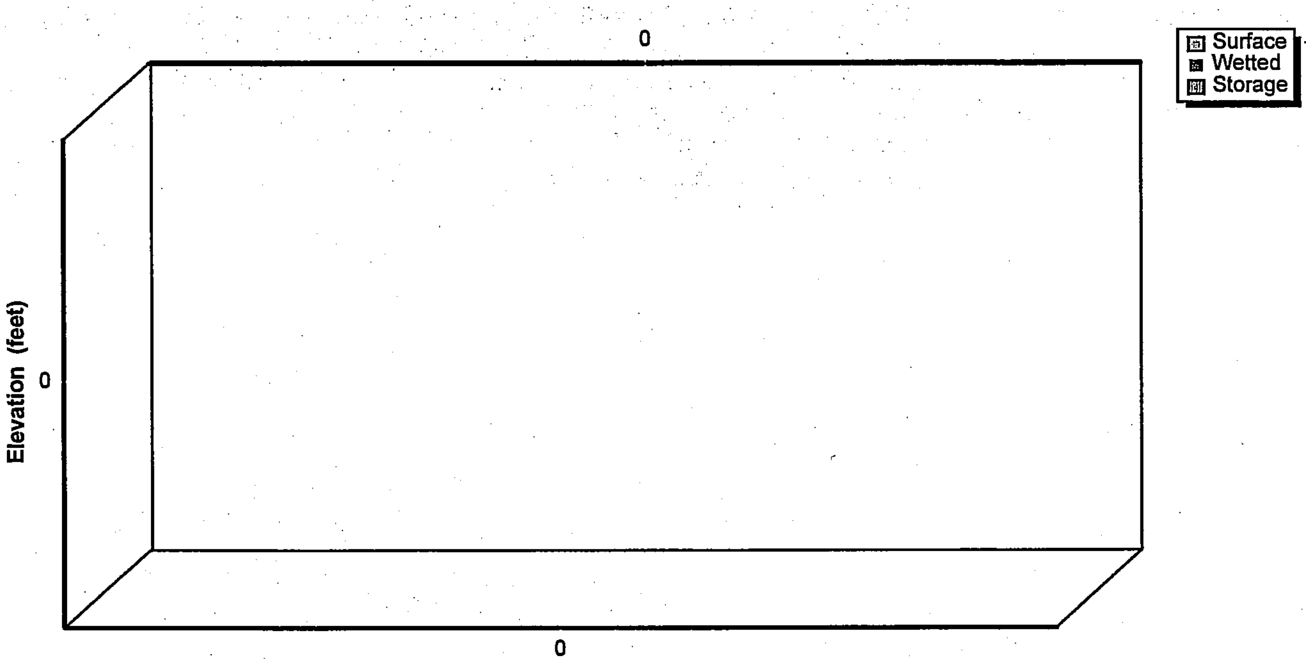
Pond 1P: Wetland



Pond 1P: Wetland



Pond 1P: Wetland



Pond 2P: Wet Pond

Inflow	=	11.82 cfs @	12.06 hrs, Volume=	0.915 af
Outflow	=	2.78 cfs @	12.37 hrs, Volume=	0.837 af, Atten= 77%, Lag= 18.7 min
Primary	=	2.78 cfs @	12.37 hrs, Volume=	0.837 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5

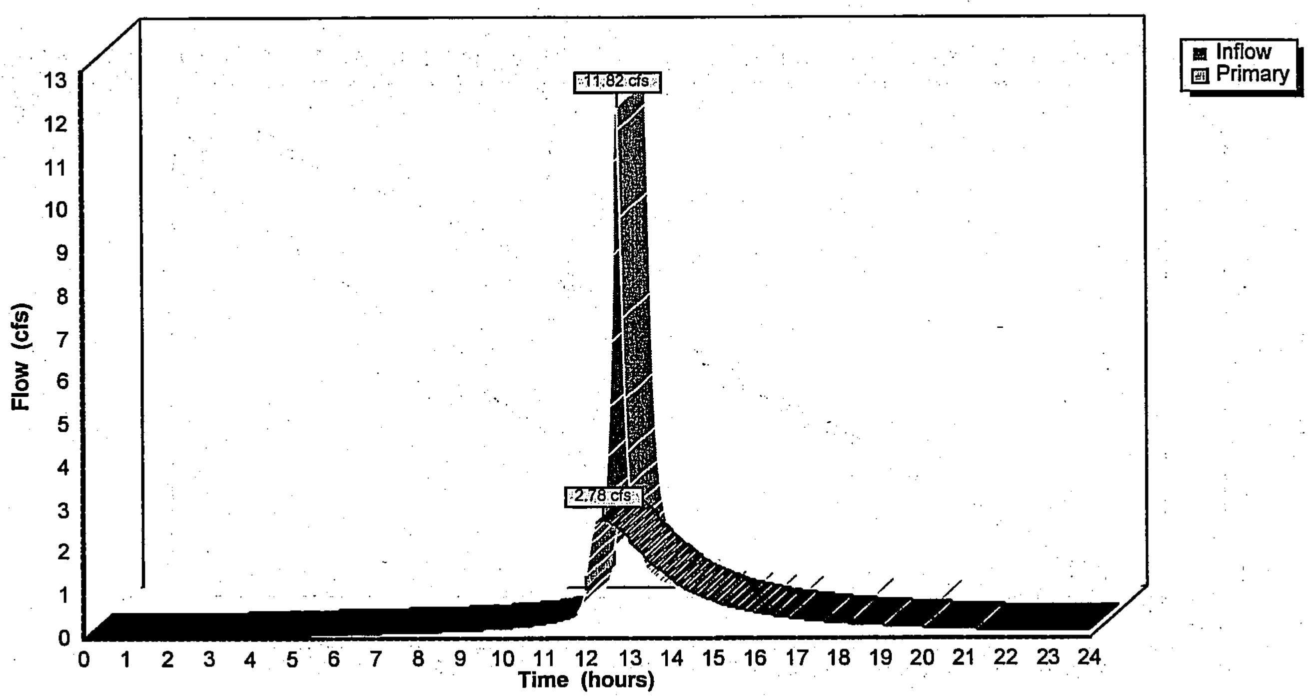
Starting Elev= 103.00' Storage= 52,500 cf
Peak Elev= 104.04' Storage= 70,665 cf (18,165 cf above starting storage)
Plug-Flow detention time= (not calculated)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
100.00	10,000	0	0
106.00	25,000	105,000	105,000
107.00	25,000	25,000	130,000

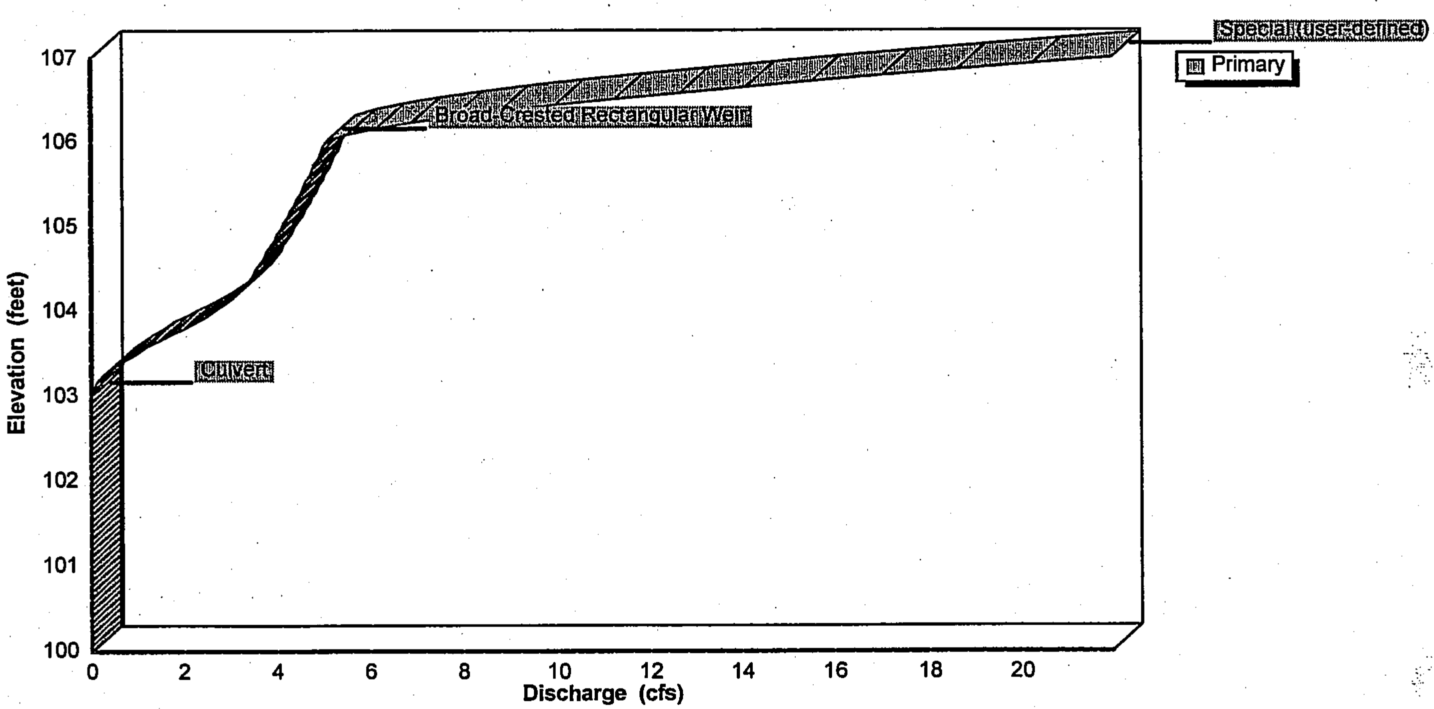
Primary OutFlow (Free Discharge)
—1=Culvert
—2=Broad-Crested Rectangular Weir
—3=Special (user-defined)

#	Routing	Invert	Outlet Devices
1	Primary	103.00'	**12.0" x 100.0' long Culvert** Ke= 0.500 Outlet Invert= 102.00' S= 0.0100 '/' n= 0.013 Cc= 0.900
2	Primary	106.00'	**6.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
3	Primary	107.00'	**Special (user-defined)** Head (feet) 0.00 1.00 Disch. (cfs) 0.00 200.00

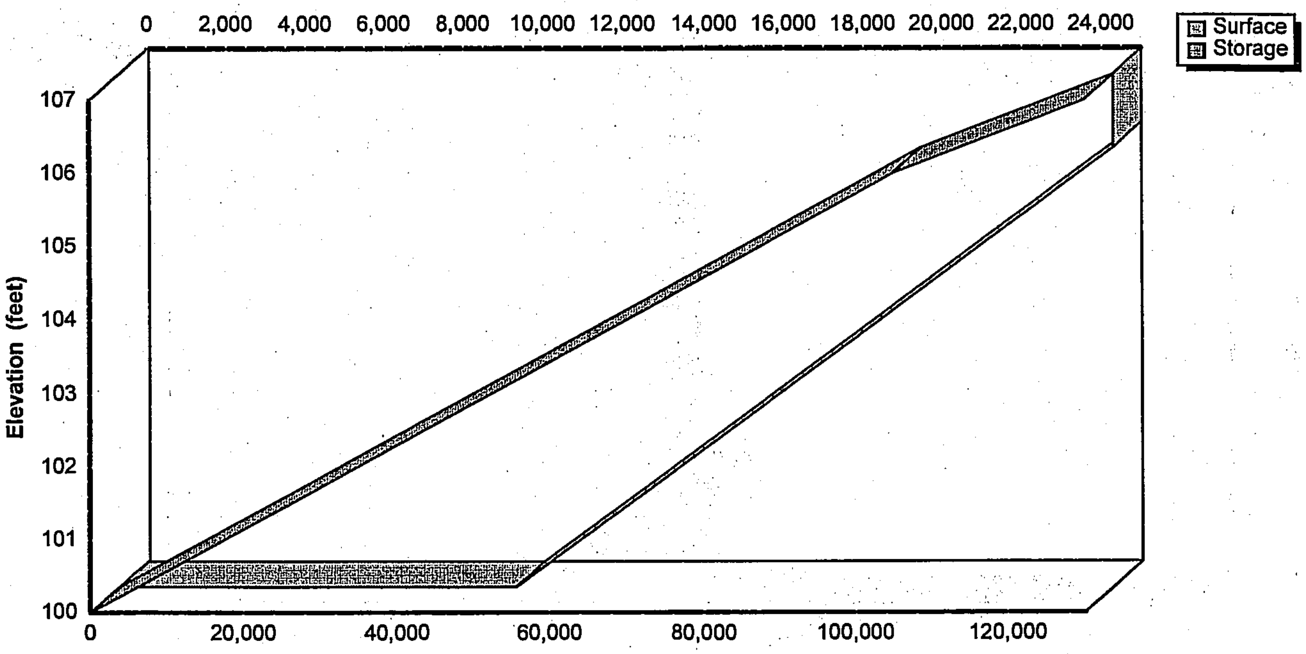
Pond 2P: Wet Pond



Pond 2P: Wet Pond



Pond 2P: Wet Pond

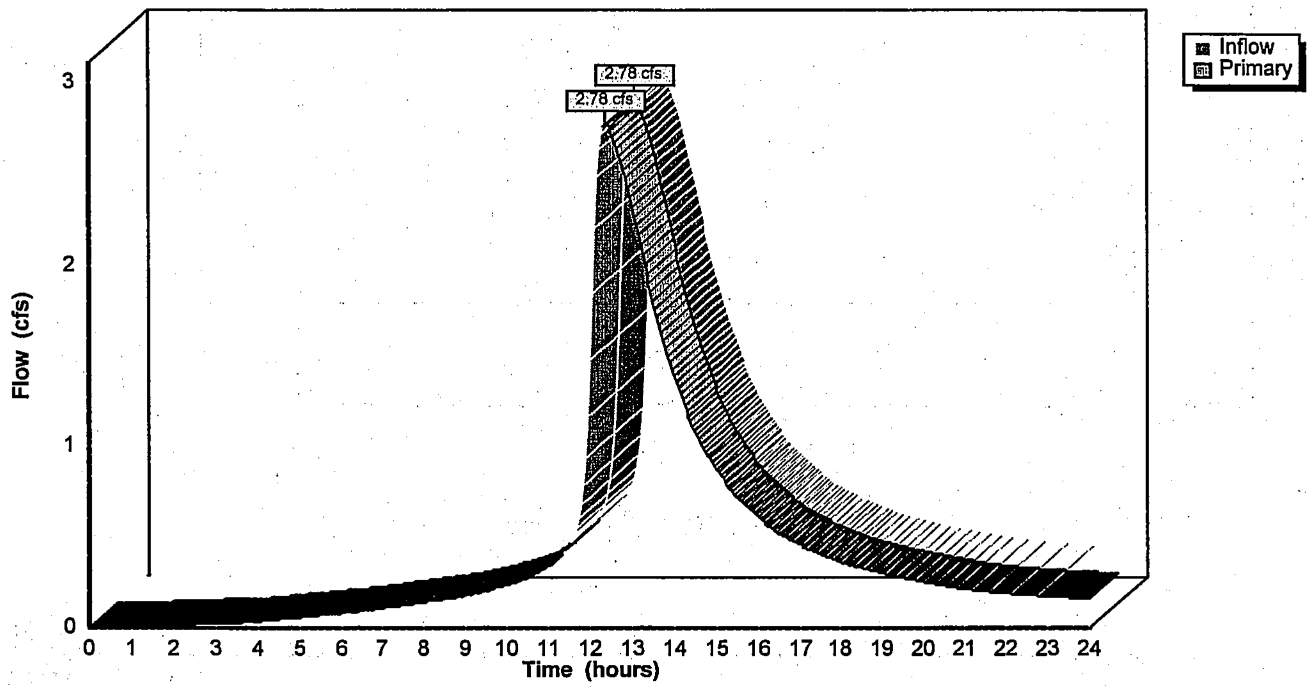


Pond 3P: Wetland

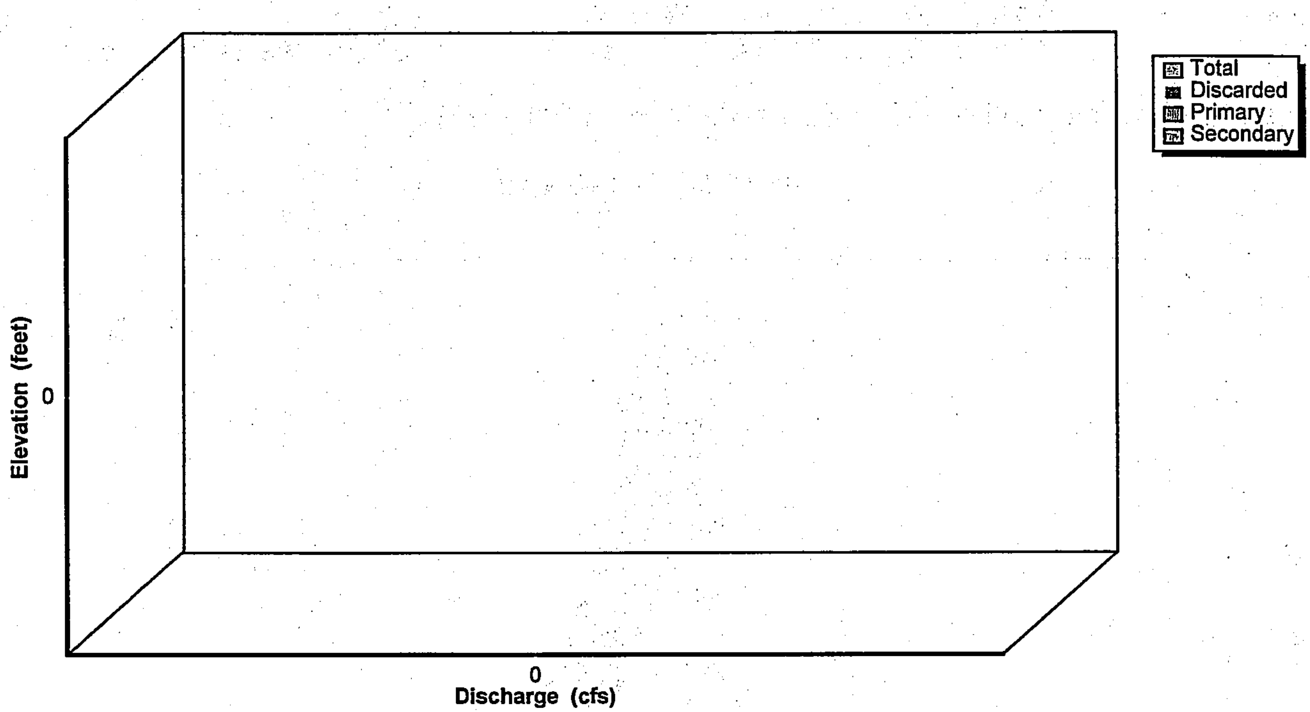
Inflow	=	2.78 cfs @	12.37 hrs,	Volume=	0.837 af
Primary	=	2.78 cfs @	12.37 hrs,	Volume=	0.837 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

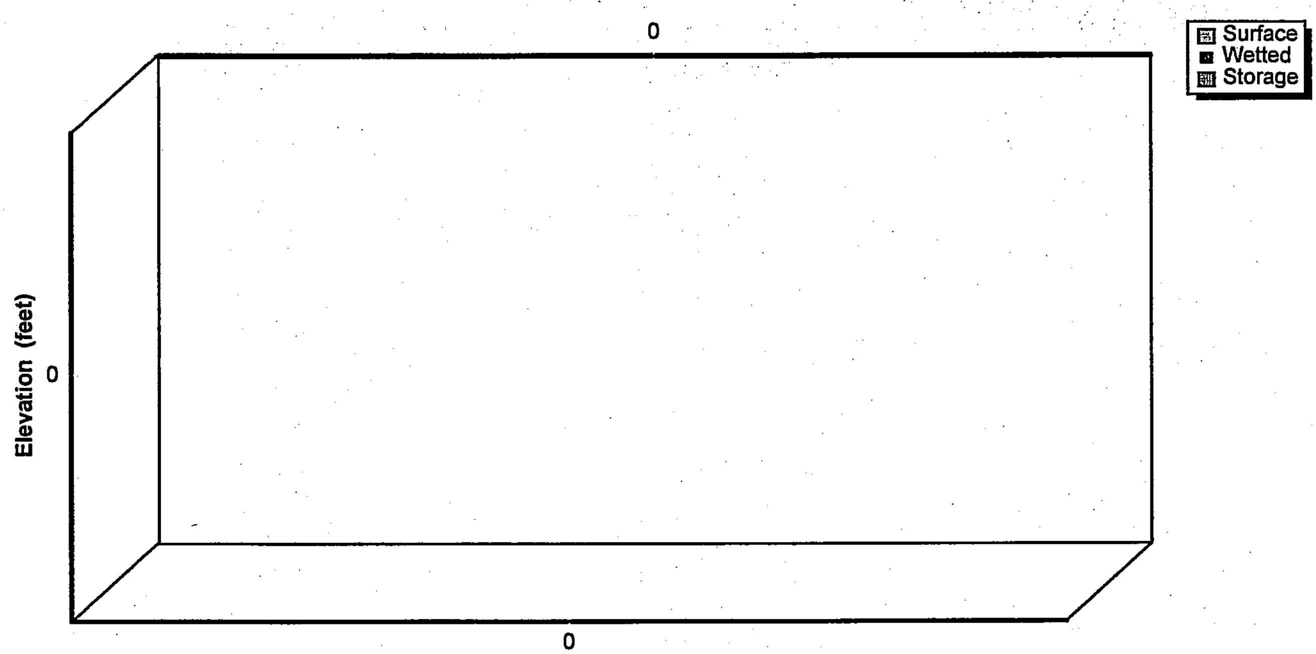
Pond 3P: Wetland



Pond 3P: Wetland



Pond 3P: Wetland



APPENDIX B

2-year Storm

(2-yr storm)

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Type II 24-hr Rainfall=2.60"
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Existing Pervious Area
Tc=30.0 min CN=60 Area=92.400 ac Runoff= 6.16 cfs 1.529 af

Subcatchment 2S: Existing Impervious
Tc=15.0 min CN=100 Area=5.600 ac Runoff= 15.64 cfs 1.211 af

Subcatchment 3S: Proposed Urban Pervious
Tc=30.0 min CN=60 Area=87.000 ac Runoff= 5.80 cfs 1.439 af

Subcatchment 4S: Proposed Impervious
Tc=15.0 min CN=100 Area=11.000 ac Runoff= 30.73 cfs 2.378 af

Pond 1P: Wetland
Inflow= 16.57 cfs 2.739 af
Primary= 16.57 cfs 2.739 af

Pond 2P: Wet Pond
Peak Storage= 107,959 cf Inflow= 31.58 cfs 3.817 af
Primary= 5.79 cfs 3.593 af Outflow= 5.79 cfs 3.593 af

Pond 3P: Wetland
Inflow= 5.79 cfs 3.593 af
Primary= 5.79 cfs 3.593 af

Runoff Area = 196.000 ac Volume = 6.556 af Average Depth = 0.40"

Subcatchment 1S: Existing Pervious Area

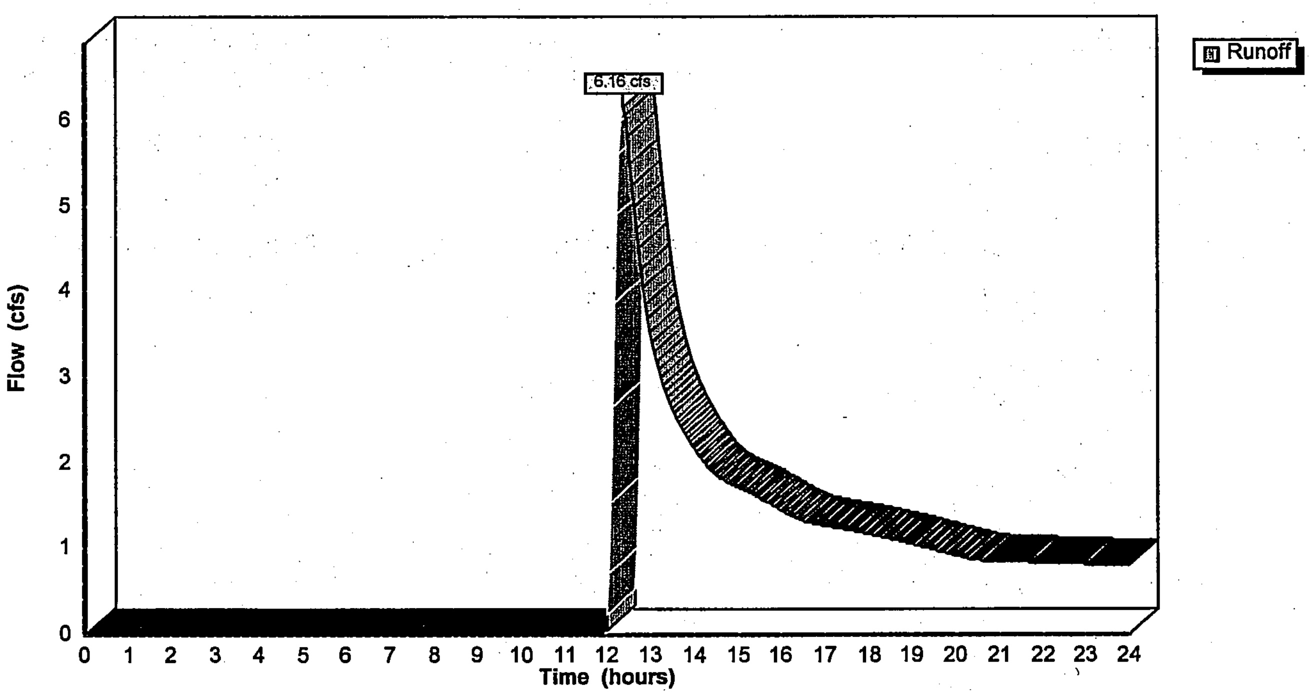
Runoff = 6.16 cfs @ 12.41 hrs, Volume= 1.529 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=2.60"

Area (ac)	CN	Description
9.700	60	Urban Development (pervious)
82.700	60	Non-Developed (pervious)
92.400	60	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, estimated Tc**

Subcatchment 1S: Existing Pervious Area



Subcatchment 2S: Existing Impervious

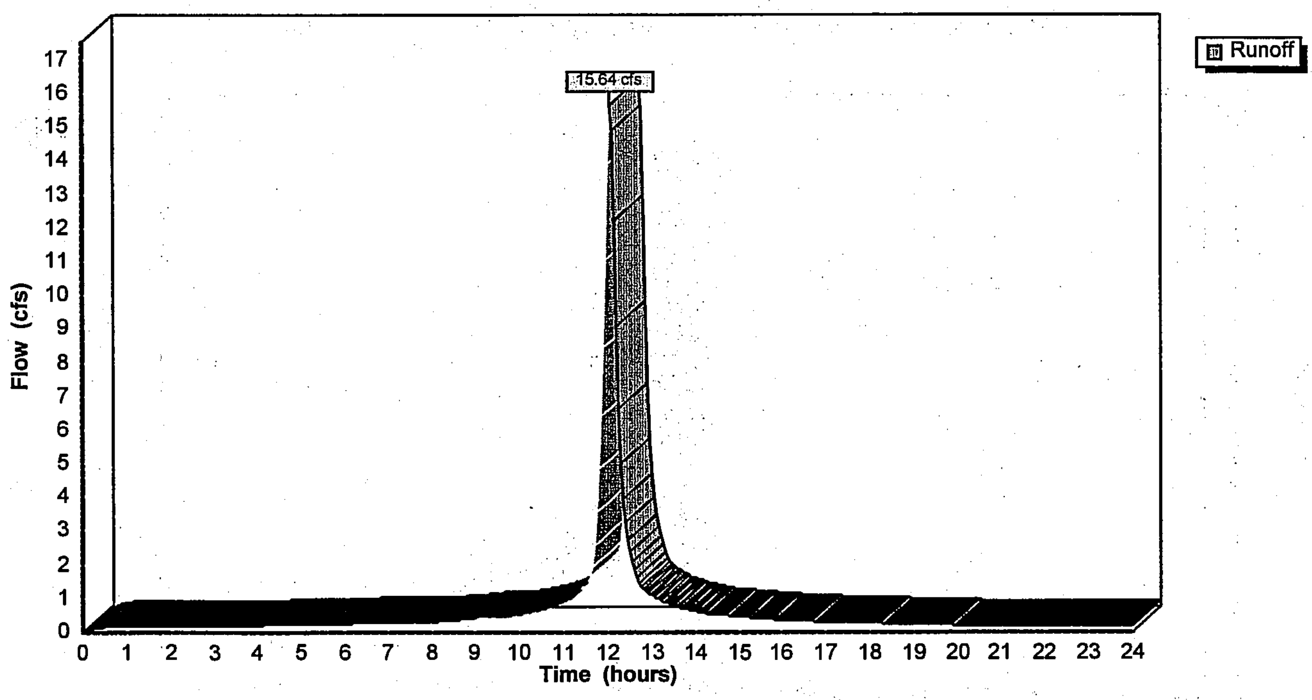
Runoff = 15.64 cfs @ 12.06 hrs, Volume= 1.211 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=2.60"

Area (ac)	CN	Description
5.600	100	Urban Development (Impervious)

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Assumed**

Subcatchment 2S: Existing Impervious



Subcatchment 3S: Proposed Urban Pervious

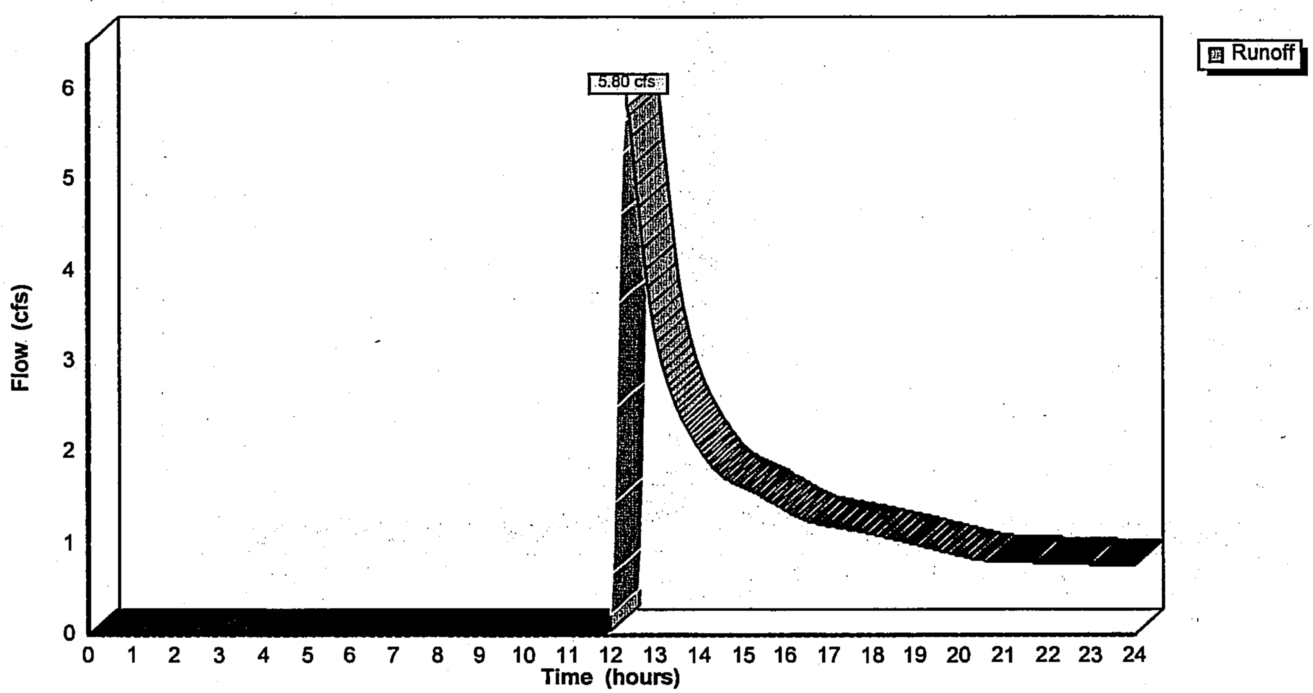
Runoff = 5.80 cfs @ 12.41 hrs, Volume= 1.439 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=2.60"

Area (ac)	CN	Description
19.000	60	Developed Pervious
68.000	60	Undeveloped
87.000	60	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, Assumed**

Subcatchment 3S: Proposed Urban Pervious



Subcatchment 4S: Proposed Impervious

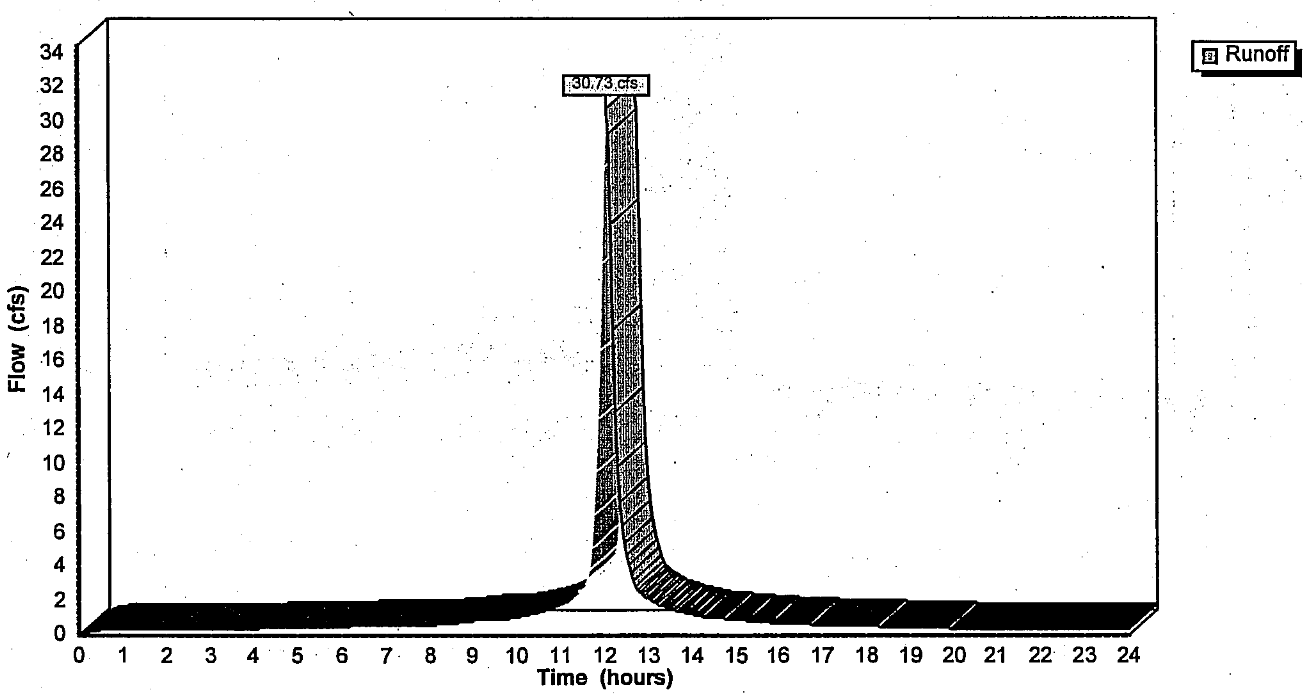
Runoff = 30.73 cfs @ 12.06 hrs, Volume= 2.378 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=2.60"

Area (ac)	CN	Description
11.000	100	Developed Impervious Areas

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Assumed**

Subcatchment 4S: Proposed Impervious

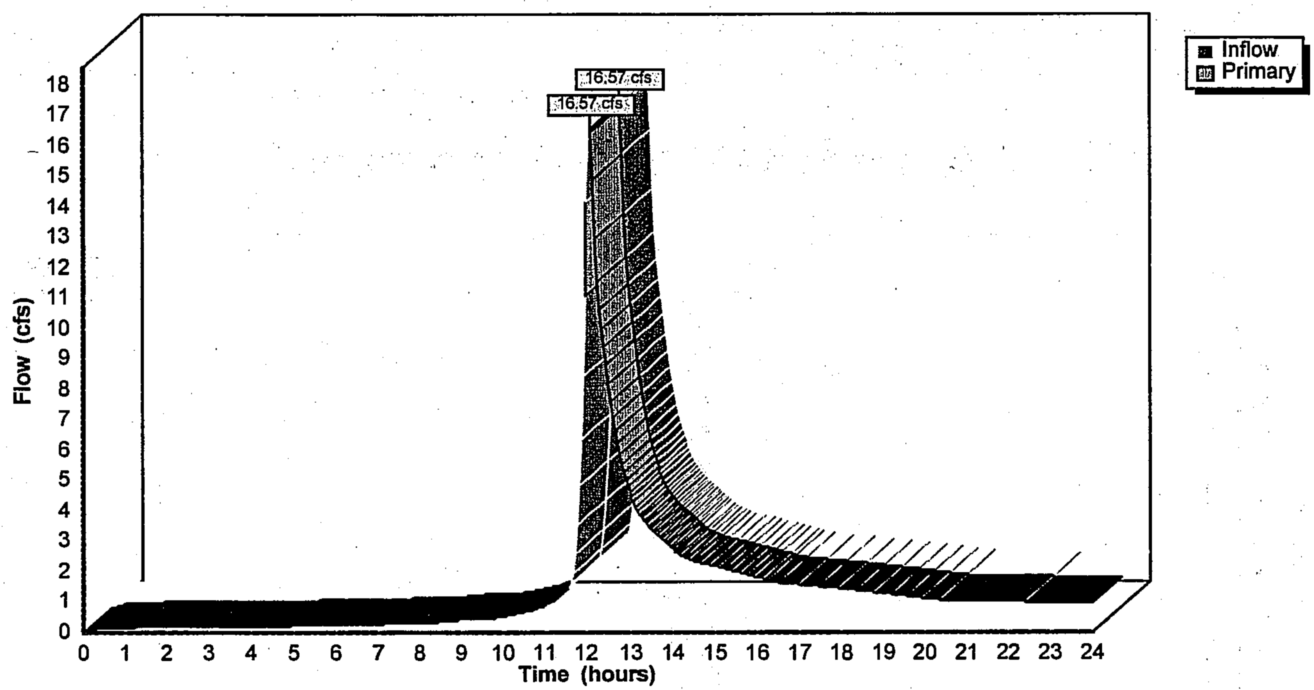


Pond 1P: Wetland

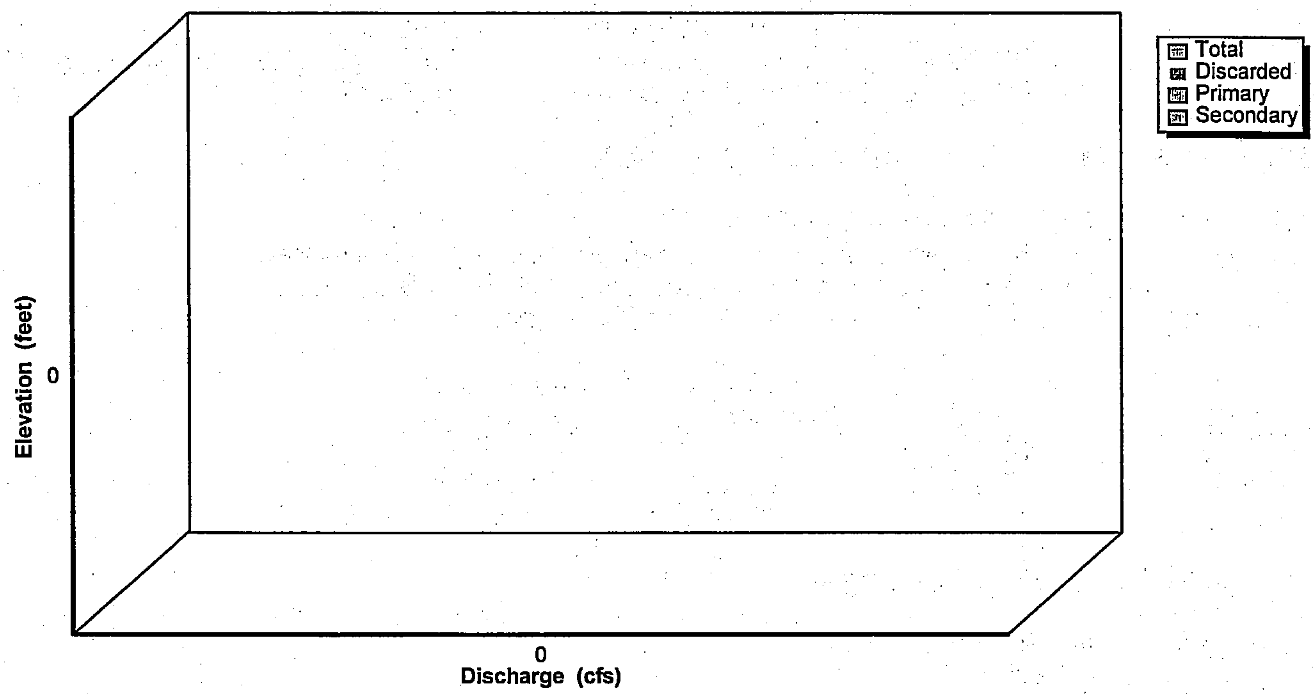
Inflow	=	16.57 cfs @	12.08 hrs, Volume=	2.739 af	
Primary	=	16.57 cfs @	12.08 hrs, Volume=	2.739 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

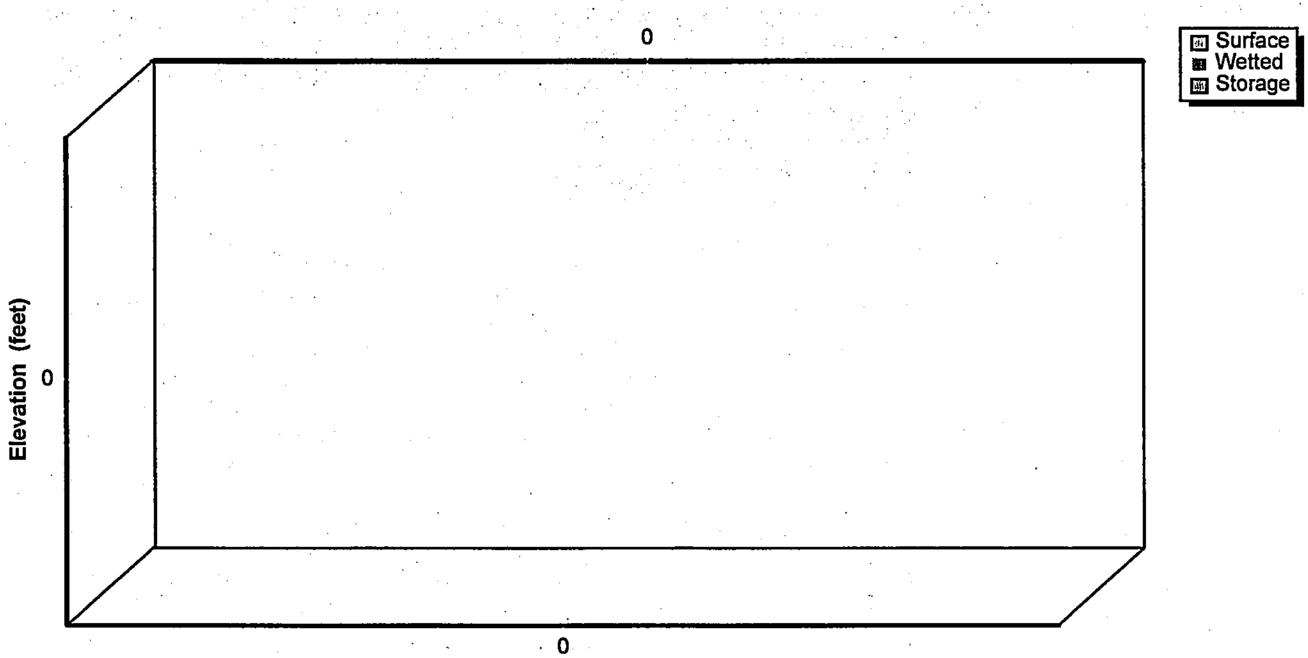
Pond 1P: Wetland



Pond 1P: Wetland



Pond 1P: Wetland



Pond 2P: Wet Pond

Inflow	=	31.58 cfs @ 12.07 hrs, Volume=	3.817 af	
Outflow	=	5.79 cfs @ 12.93 hrs, Volume=	3.593 af,	Atten= 82%, Lag= 51.5 min
Primary	=	5.79 cfs @ 12.93 hrs, Volume=	3.593 af	

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5

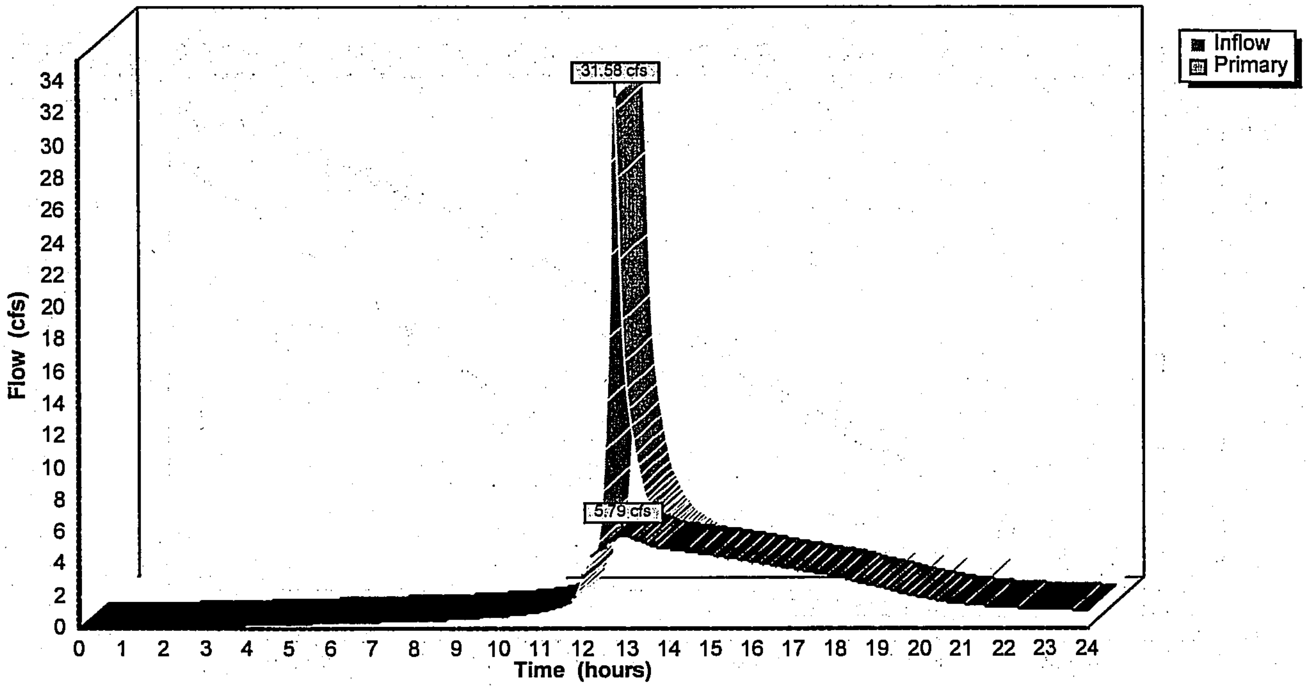
Starting Elev= 103.00' Storage= 52,500 cf
Peak Elev= 106.12' Storage= 107,959 cf (55,459 cf above starting storage)
Plug-Flow detention time= 380.7 min calculated for 2.388 af (63% of inflow)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
100.00	10,000	0	0
106.00	25,000	105,000	105,000
107.00	25,000	25,000	130,000

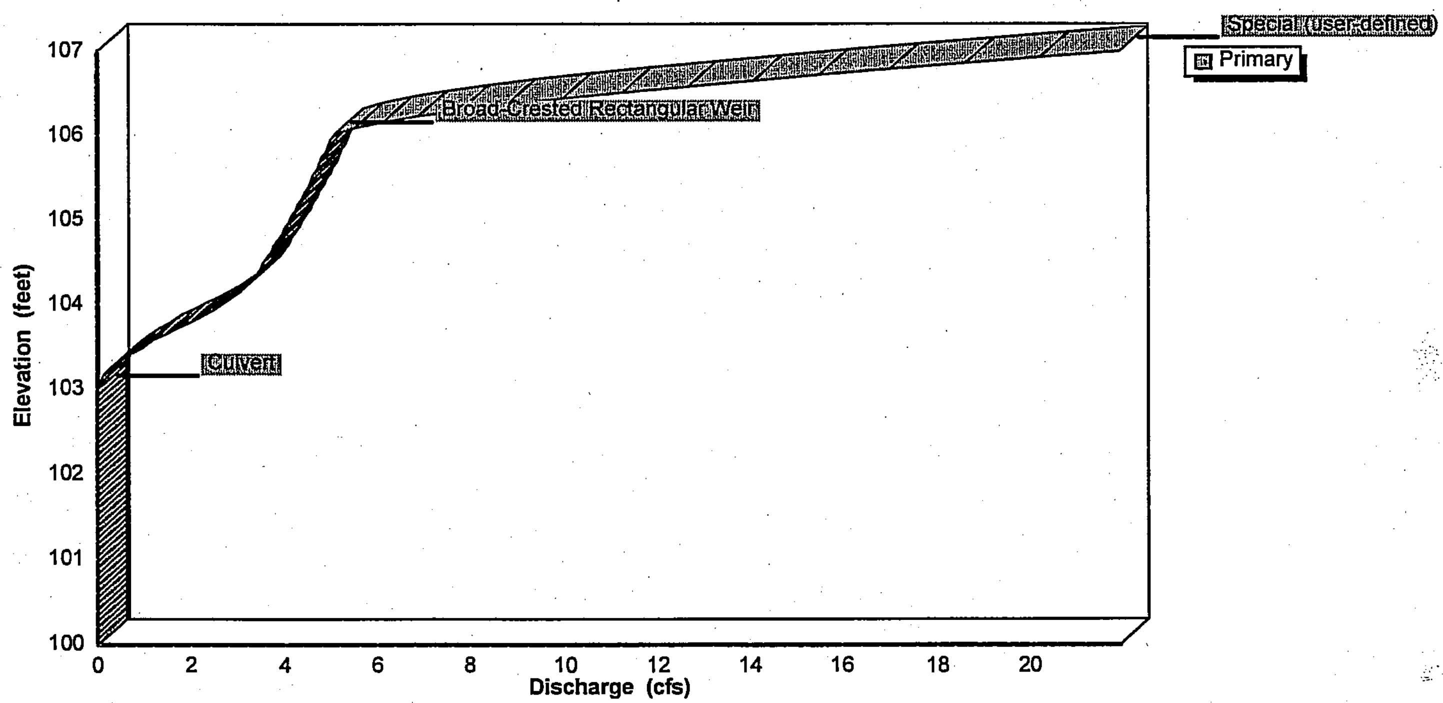
Primary OutFlow (Free Discharge)
- 1=Culvert
- 2=Broad-Crested Rectangular Weir
- 3=Special (user-defined)

#	Routing	Invert	Outlet Devices
1	Primary	103.00'	**12.0" x 100.0' long Culvert** Ke= 0.500 Outlet Invert= 102.00' S= 0.0100 '/' n= 0.013 Cc= 0.900
2	Primary	106.00'	**6.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
3	Primary	107.00'	**Special (user-defined)** Head (feet) 0.00 1.00 Disch. (cfs) 0.00 200.00

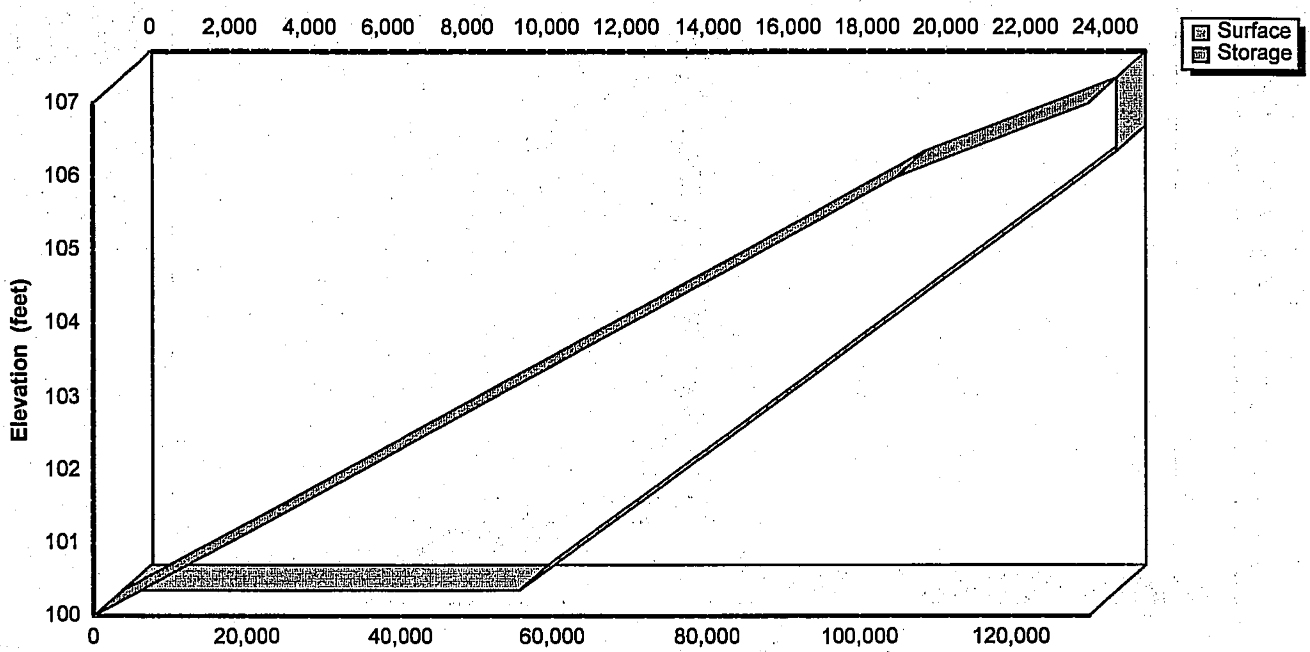
Pond 2P: Wet Pond



Pond 2P: Wet Pond



Pond 2P: Wet Pond

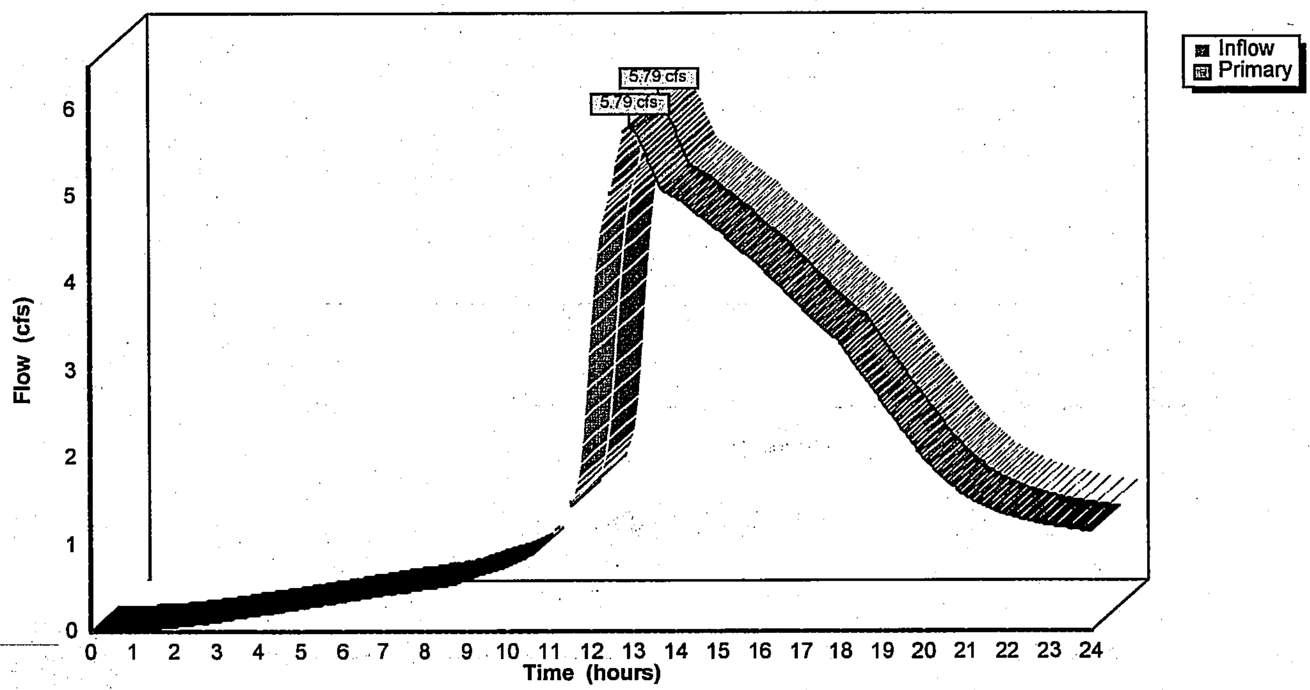


Pond 3P: Wetland

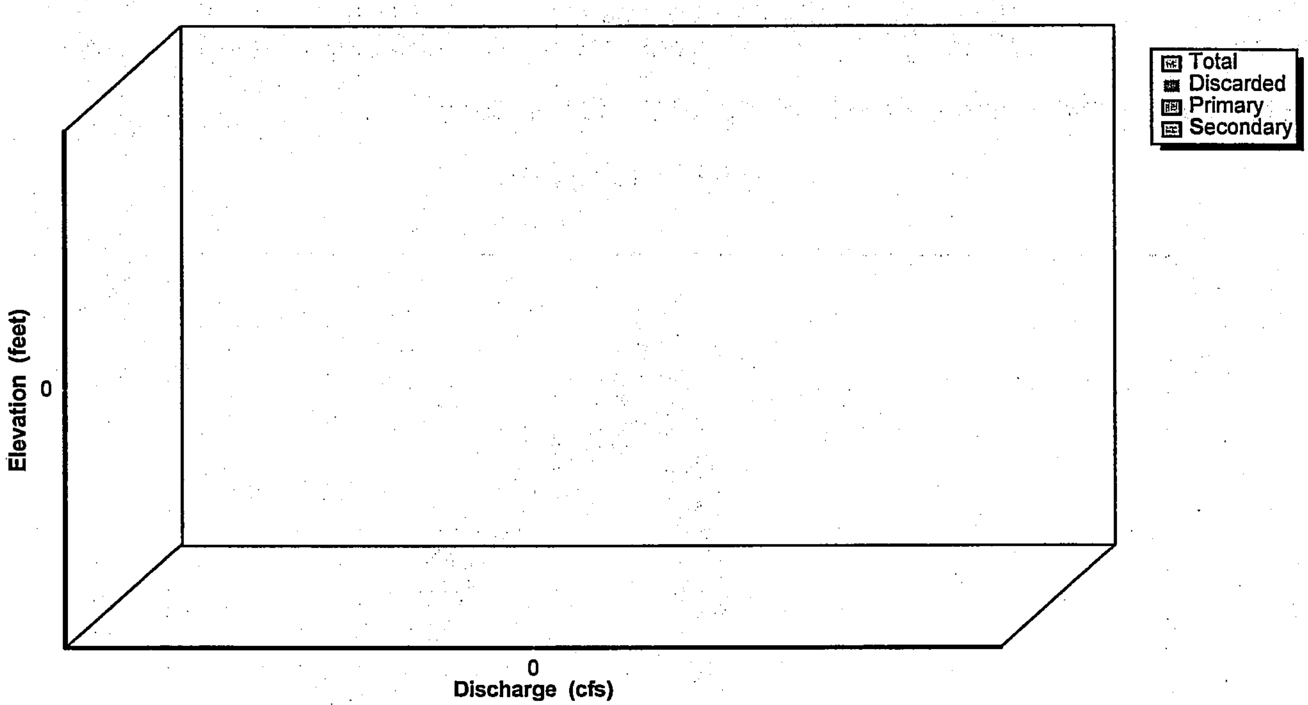
Inflow	=	5.79 cfs @	12.93 hrs,	Volume=	3.593 af
Primary	=	5.79 cfs @	12.93 hrs,	Volume=	3.593 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

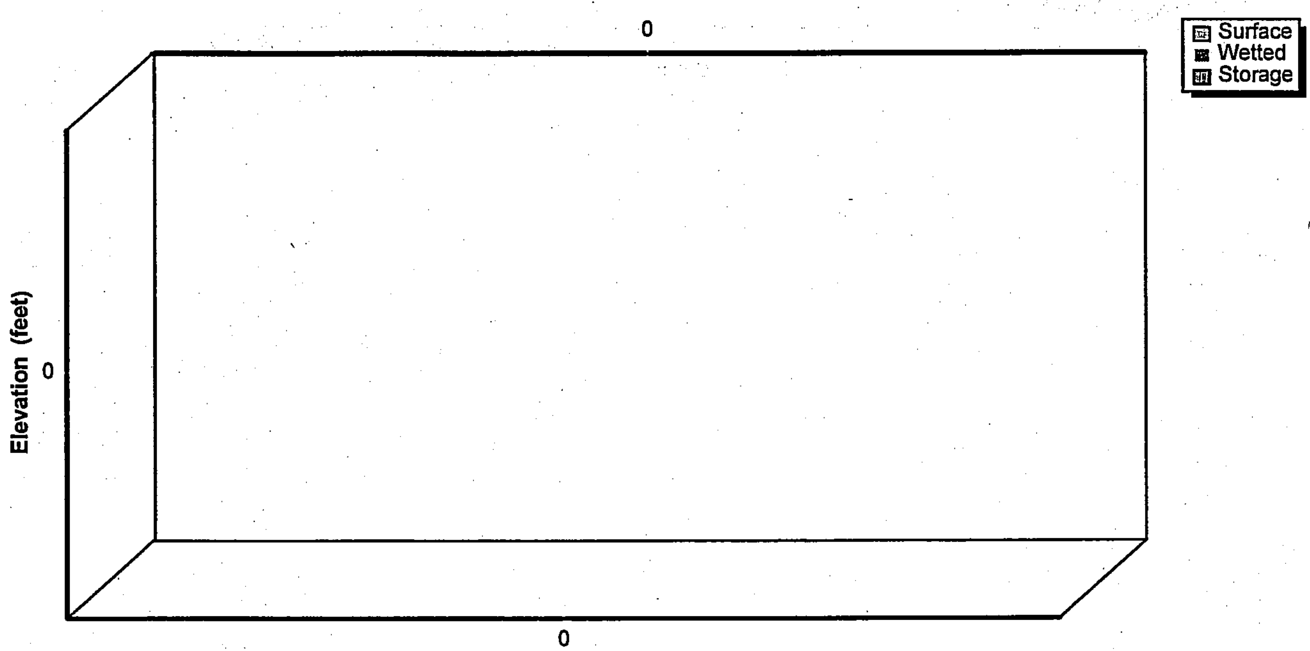
Pond 3P: Wetland



Pond 3P: Wetland



Pond 3P: Wetland



APPENDIX C

10-year Storm

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Type II 24-hr Rainfall=4.00"
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

(10-yr storm)

Subcatchment 1S: Existing Pervious Area
Tc=30.0 min CN=60 Area=92.400 ac Runoff= 46.75 cfs 5.793 af

Subcatchment 2S: Existing Impervious
Tc=15.0 min CN=100 Area=5.600 ac Runoff= 24.07 cfs 1.862 af

Subcatchment 3S: Proposed Urban Pervious
Tc=30.0 min CN=60 Area=87.000 ac Runoff= 44.01 cfs 5.455 af

Subcatchment 4S: Proposed Impervious
Tc=15.0 min CN=100 Area=11.000 ac Runoff= 47.28 cfs 3.658 af

Pond 1P: Wetland
Inflow= 55.71 cfs 7.656 af
Primary= 55.71 cfs 7.656 af

Pond 2P: Wet Pond
Peak Storage= 149,971 cf Inflow= 68.78 cfs 9.113 af
Primary= 41.23 cfs 8.606 af Outflow= 41.23 cfs 8.606 af

Pond 3P: Wetland
Inflow= 41.23 cfs 8.606 af
Primary= 41.23 cfs 8.606 af

Runoff Area = 196.000 ac Volume = 16.768 af Average Depth = 1.03"

Subcatchment 1S: Existing Pervious Area

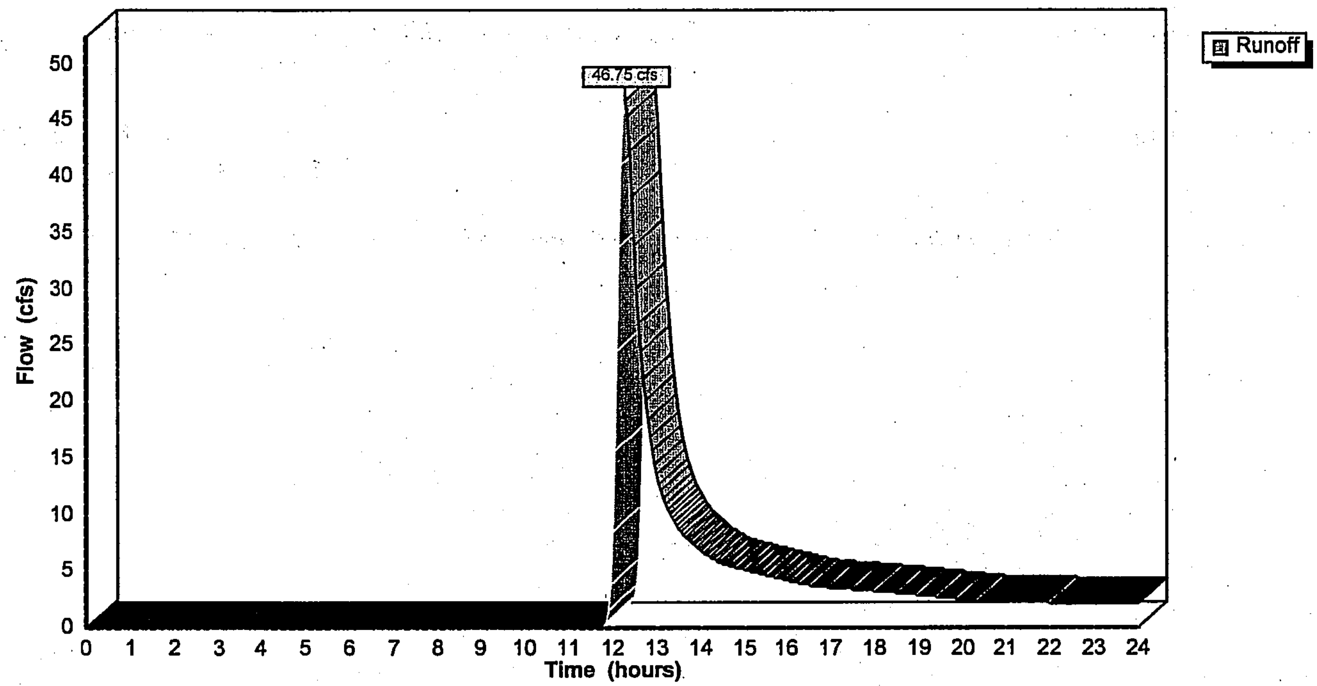
Runoff = 46.75 cfs @ 12.30 hrs, Volume= 5.793 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=4.00"

Area (ac)	CN	Description
9.700	60	Urban Development (pervious)
82.700	60	Non-Developed (pervious)
92.400	60	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, estimated Tc**

Subcatchment 1S: Existing Pervious Area



Subcatchment 2S: Existing Impervious

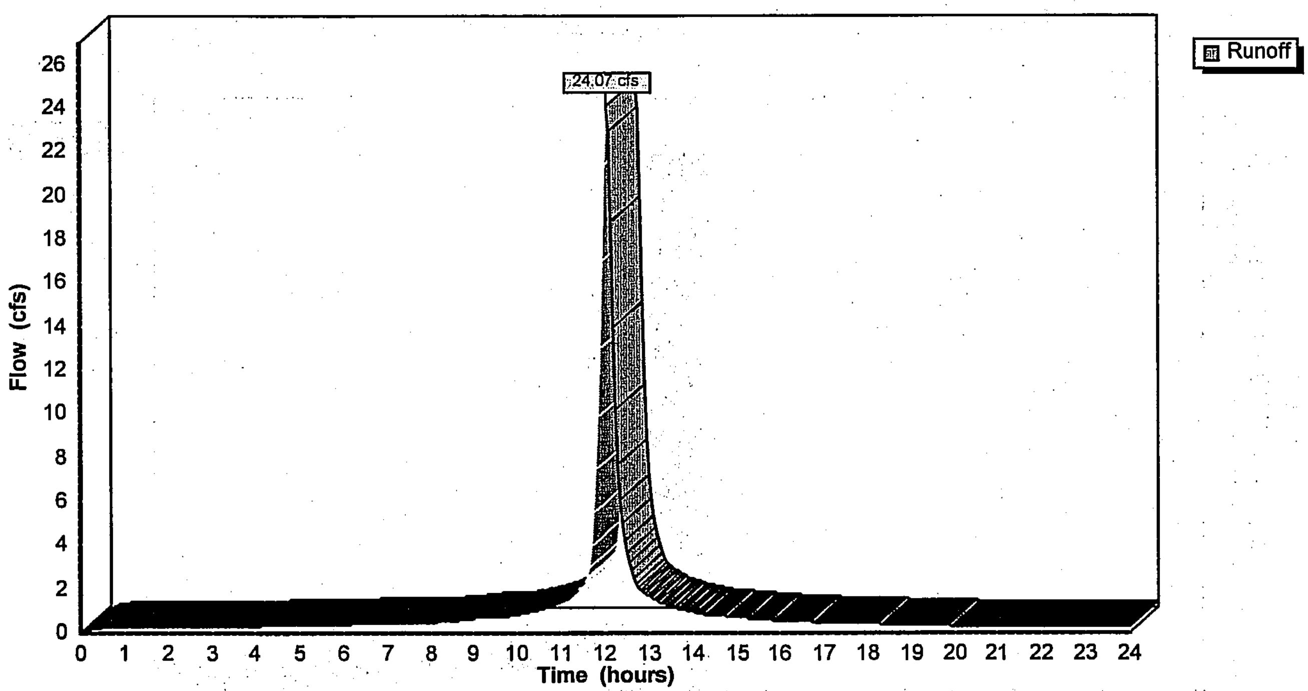
Runoff = 24.07 cfs @ 12.06 hrs, Volume= 1.862 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=4.00"

Area (ac)	CN	Description
5.600	100	Urban Development (Impervious)

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Assumed**

Subcatchment 2S: Existing Impervious



Subcatchment 3S: Proposed Urban Pervious

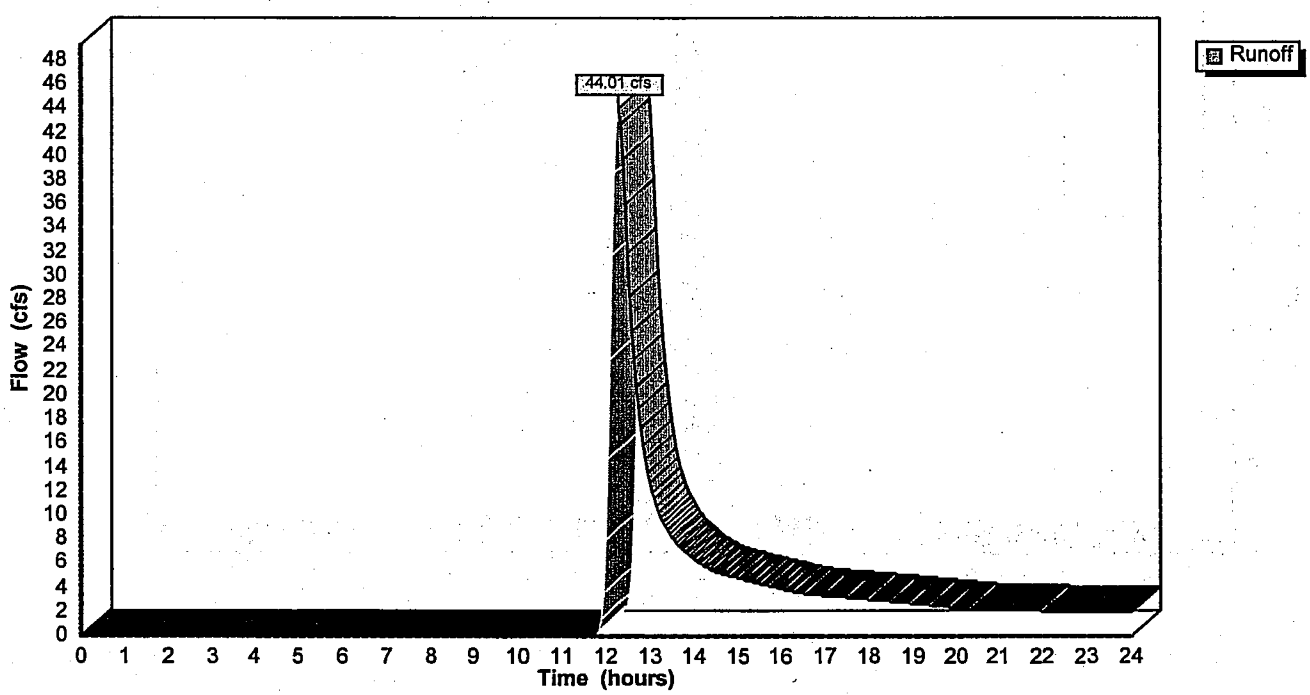
Runoff = 44.01 cfs @ 12.30 hrs, Volume= 5.455 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=4.00"

Area (ac)	CN	Description
19.000	60	Developed Pervious
68.000	60	Undeveloped
87.000	60	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, Assumed**

Subcatchment 3S: Proposed Urban Pervious



Subcatchment 4S: Proposed Impervious

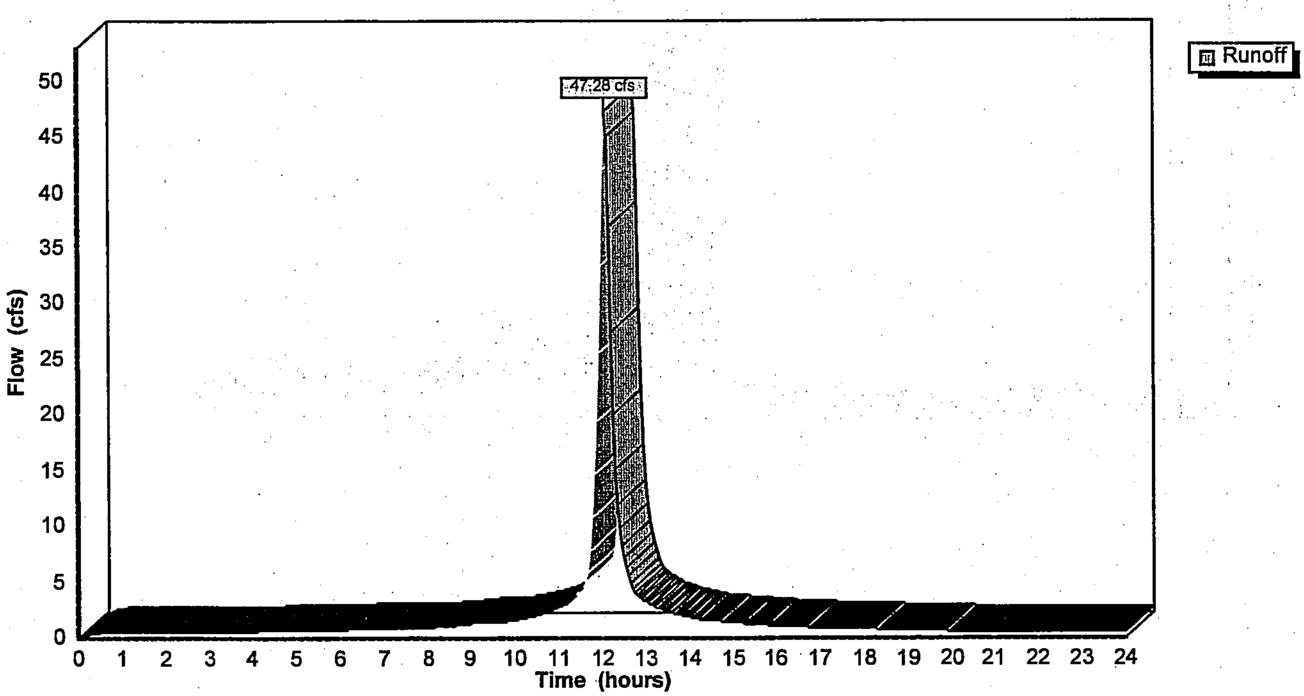
Runoff = 47.28 cfs @ 12.06 hrs, Volume= 3.658 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=4.00"

Area (ac)	CN	Description
11.000	100	Developed Impervious Areas

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Assumed**

Subcatchment 4S: Proposed Impervious

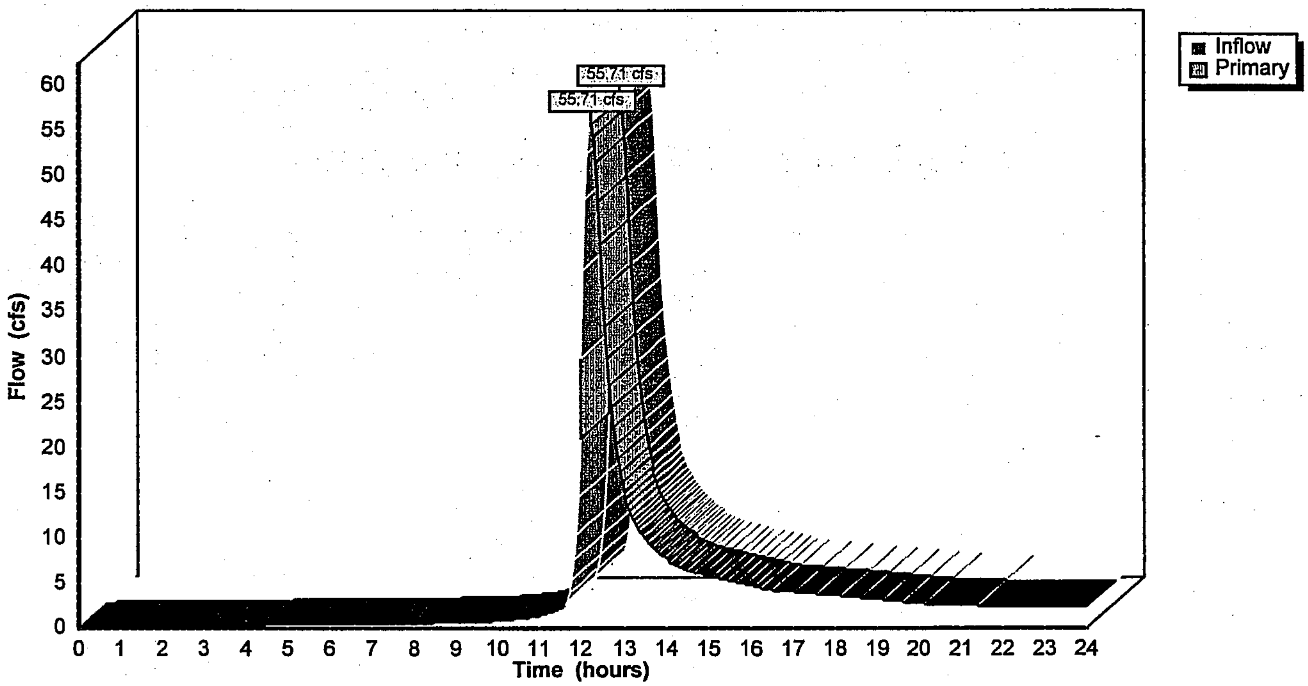


Pond 1P: Wetland

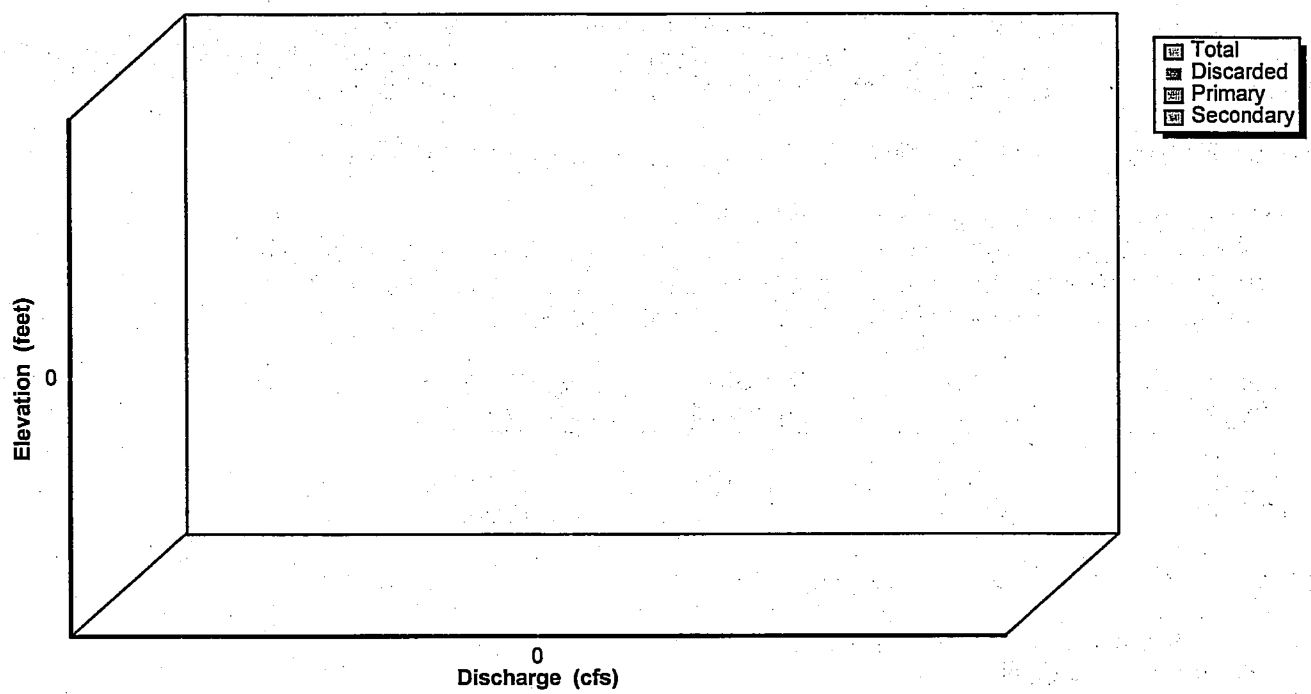
Inflow	=	55.71 cfs @	12.24 hrs, Volume=	7.656 af	
Primary	=	55.71 cfs @	12.24 hrs, Volume=	7.656 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

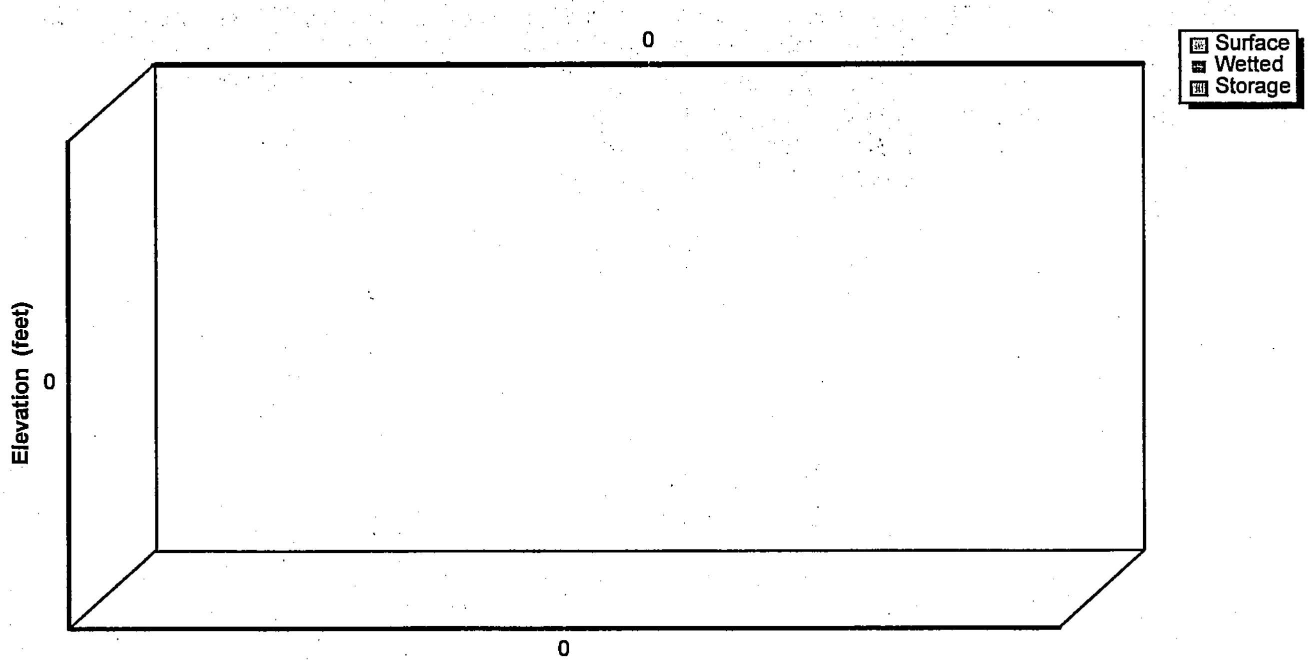
Pond 1P: Wetland



Pond 1P: Wetland



Pond 1P: Wetland



Pond 2P: Wet Pond

Inflow	=	68.78 cfs @	12.14 hrs,	Volume=	9.113 af
Outflow	=	41.23 cfs @	12.48 hrs,	Volume=	8.606 af, Atten= 40%, Lag= 20.7 min
Primary	=	41.23 cfs @	12.48 hrs,	Volume=	8.606 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5

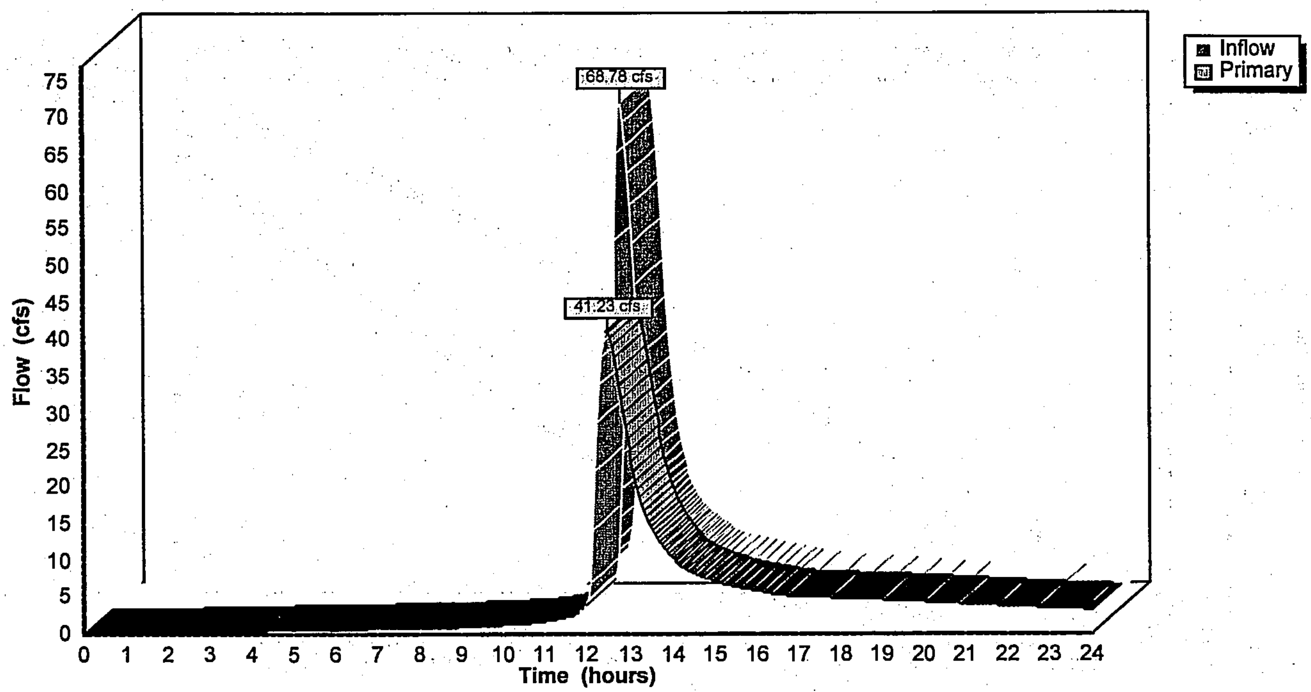
Starting Elev= 103.00' Storage= 52,500 cf
Peak Elev= 107.80' Storage= 149,971 cf (97,471 cf above starting storage)
Plug-Flow detention time= 207.5 min calculated for 7.401 af (81% of inflow)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
100.00	10,000	0	0
106.00	25,000	105,000	105,000
107.00	25,000	25,000	130,000

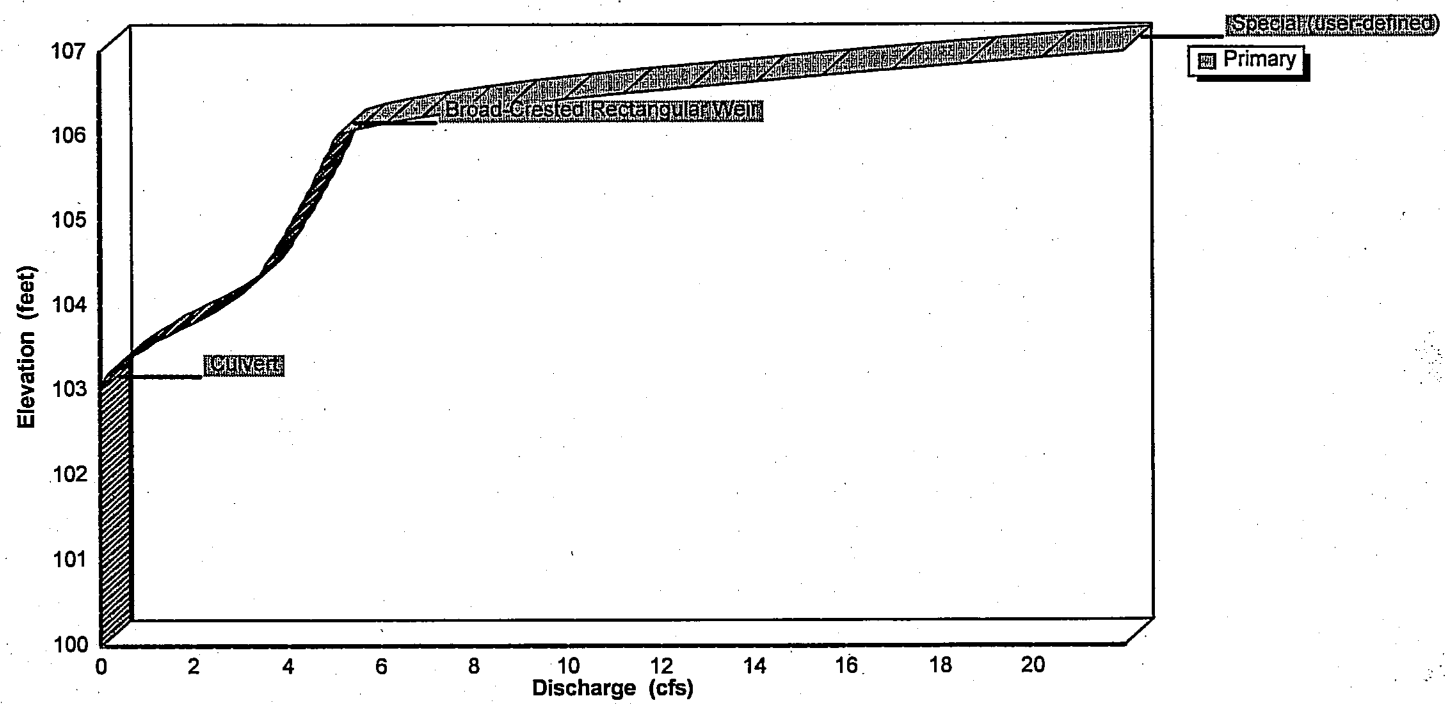
Primary OutFlow (Free Discharge)
—1=Culvert
—2=Broad-Crested Rectangular Weir
—3=Special (user-defined)

#	Routing	Invert	Outlet Devices
1	Primary	103.00'	**12.0" x 100.0' long Culvert** Ke= 0.500 Outlet Invert= 102.00' S= 0.0100 '/' n= 0.013 Cc= 0.900
2	Primary	106.00'	**6.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
3	Primary	107.00'	**Special (user-defined)** Head (feet) 0.00 1.00 Disch. (cfs) 0.00 200.00

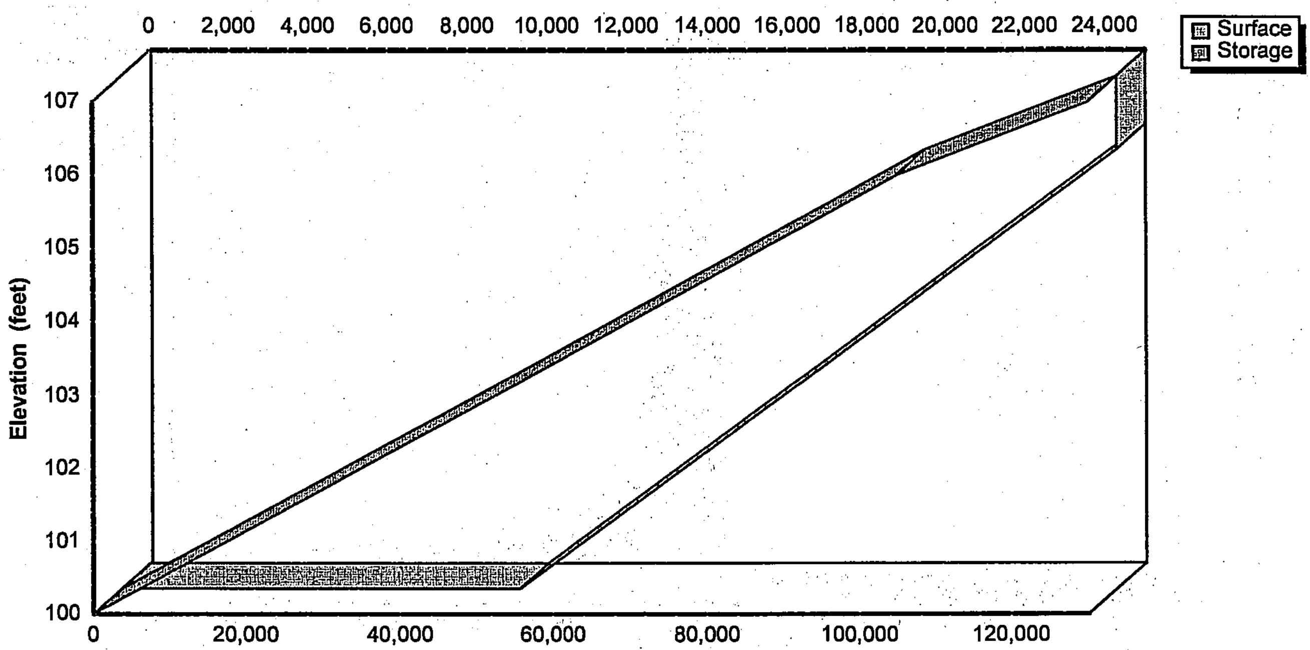
Pond 2P: Wet Pond



Pond 2P: Wet Pond



Pond 2P: Wet Pond

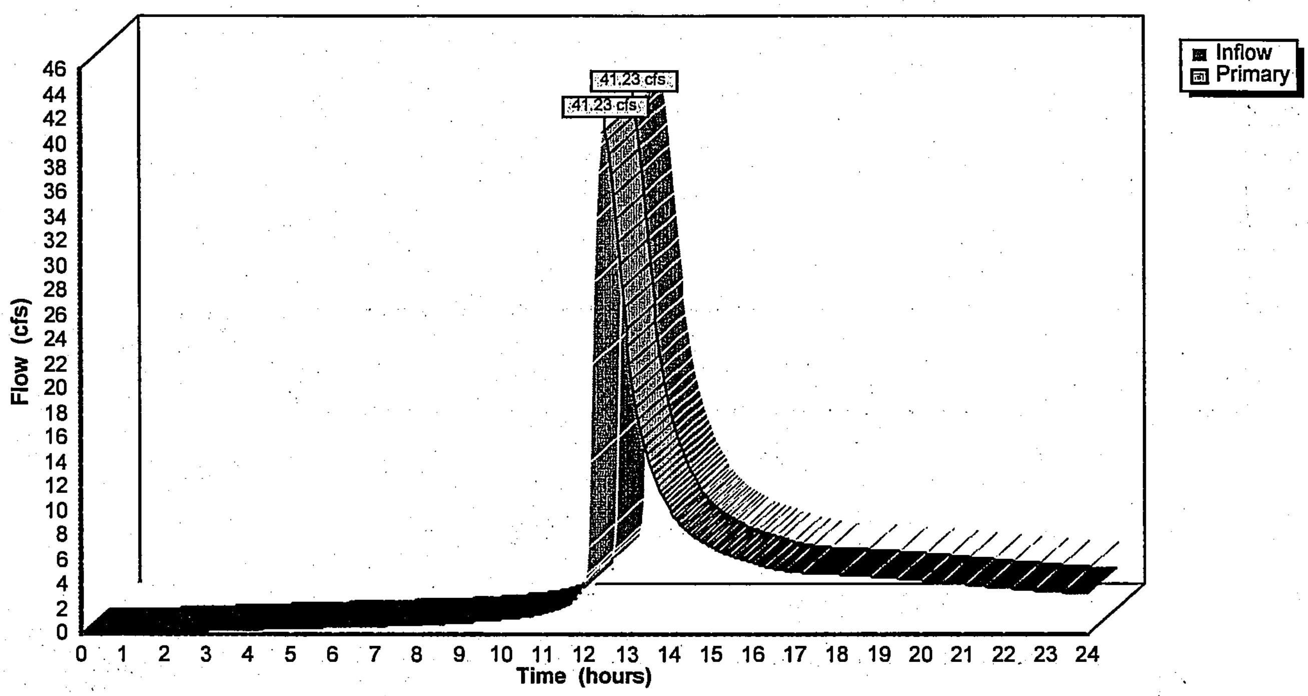


Pond 3P: Wetland

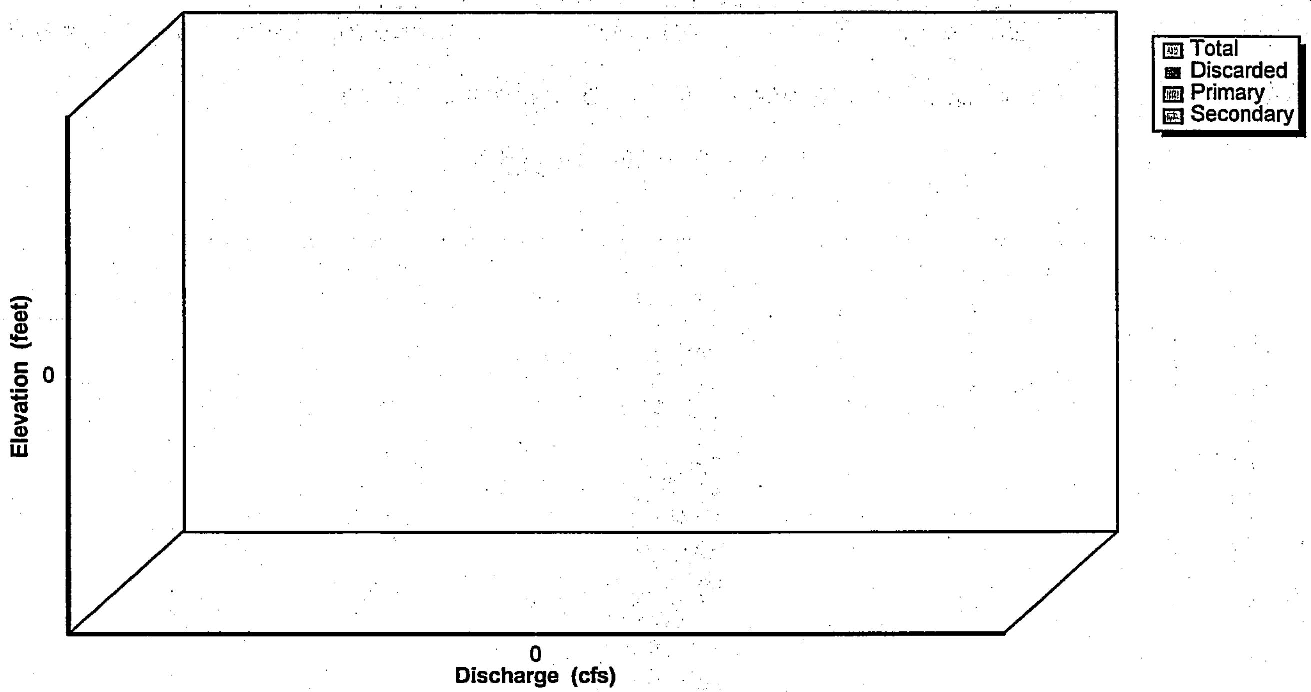
Inflow	=	41.23 cfs @	12.48 hrs, Volume=	8.606 af	
Primary	=	41.23 cfs @	12.48 hrs, Volume=	8.606 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

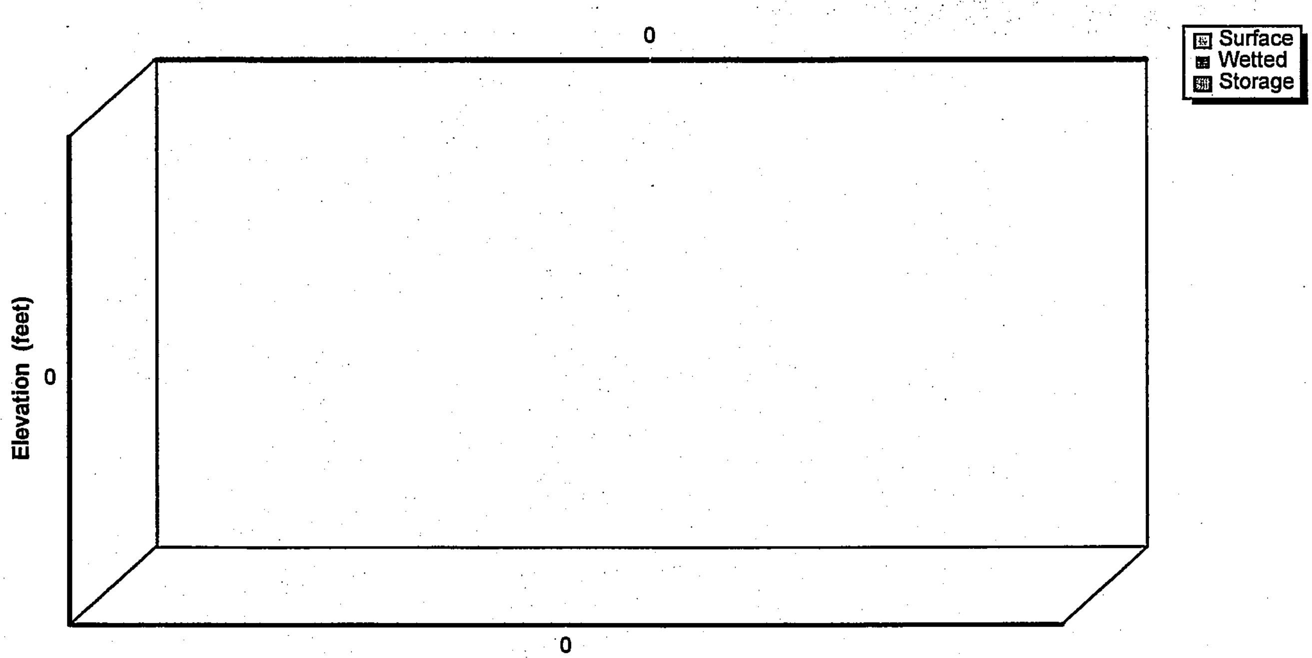
Pond 3P: Wetland



Pond 3P: Wetland



Pond 3P: Wetland



APPENDIX D

25-year Storm

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Type II 24-hr Rainfall=4.50" (25-yr storm)
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Existing Pervious Area
Tc=30.0 min CN=60 Area=92.400 ac Runoff= 67.69 cfs 7.761 af

Subcatchment 2S: Existing Impervious
Tc=15.0 min CN=100 Area=5.600 ac Runoff= 27.08 cfs 2.095 af

Subcatchment 3S: Proposed Urban Pervious
Tc=30.0 min CN=60 Area=87.000 ac Runoff= 63.73 cfs 7.307 af

Subcatchment 4S: Proposed Impervious
Tc=15.0 min CN=100 Area=11.000 ac Runoff= 53.19 cfs 4.116 af

Pond 1P: Wetland
Inflow= 78.26 cfs 9.856 af
Primary= 78.26 cfs 9.856 af

Pond 2P: Wet Pond
Peak Storage= 167,776 cf Inflow= 90.36 cfs 11.423 af
Primary= 58.44 cfs 10.721 af Outflow= 58.44 cfs 10.721 af

Pond 3P: Wetland
Inflow= 58.44 cfs 10.721 af
Primary= 58.44 cfs 10.721 af

Runoff Area = 196.000 ac Volume = 21.279 af Average Depth = 1.30"

Subcatchment 1S: Existing Pervious Area

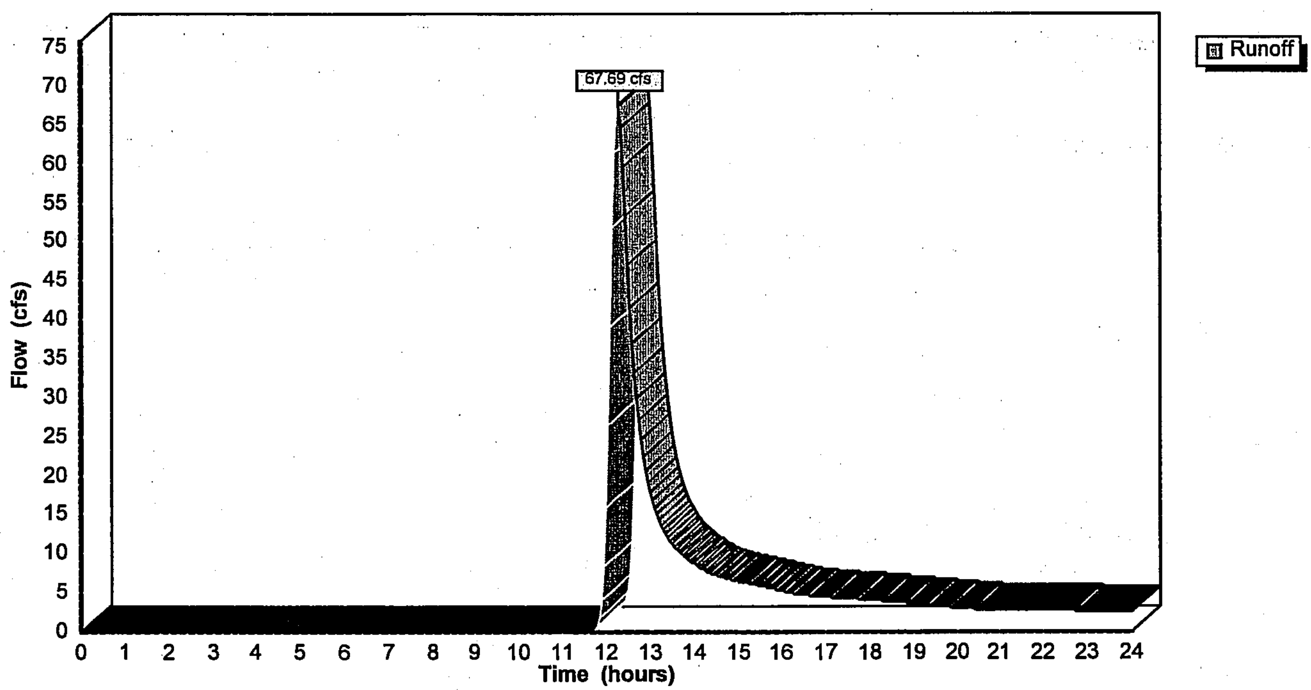
Runoff = 67.69 cfs @ 12.29 hrs, Volume= 7.761 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=4.50"

Area (ac)	CN	Description
9.700	60	Urban Development (pervious)
82.700	60	Non-Developed (pervious)
92.400	60	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, estimated Tc**

Subcatchment 1S: Existing Pervious Area



Subcatchment 2S: Existing Impervious

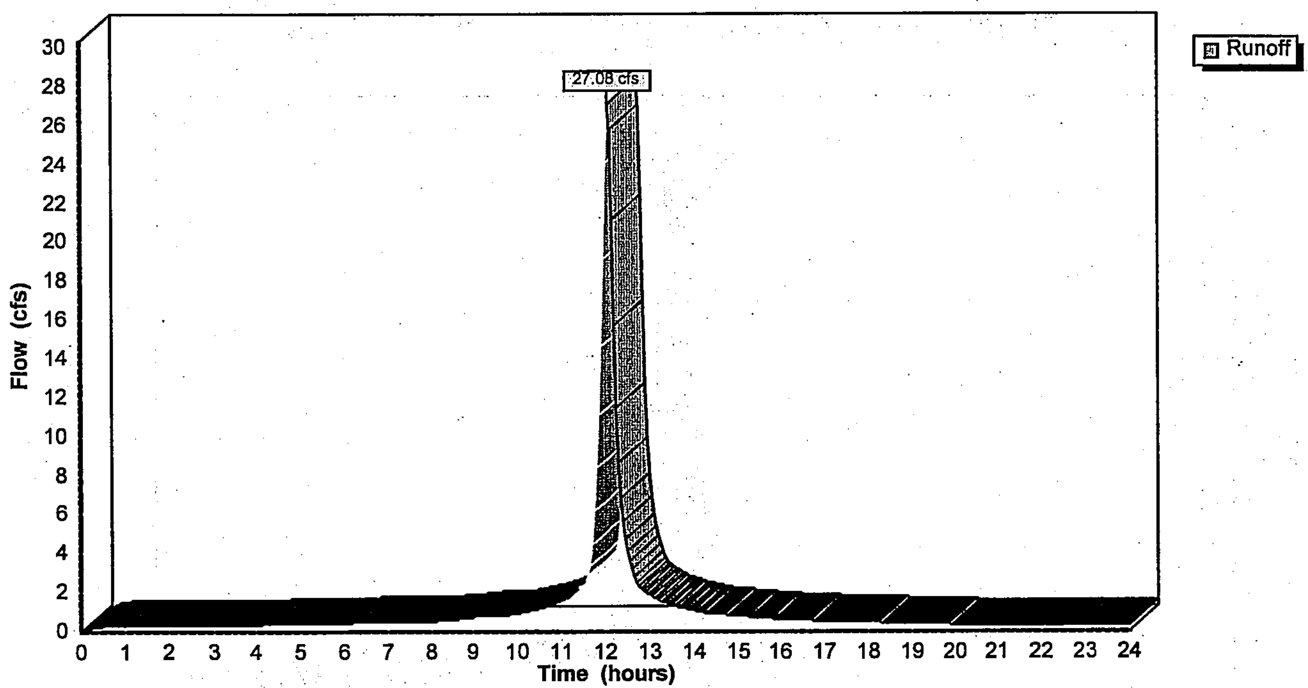
Runoff = 27.08 cfs @ 12.06 hrs, Volume= 2.095 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=4.50"

Area (ac)	CN	Description
5.600	100	Urban Development (Impervious)

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Assumed**

Subcatchment 2S: Existing Impervious



Subcatchment 3S: Proposed Urban Pervious

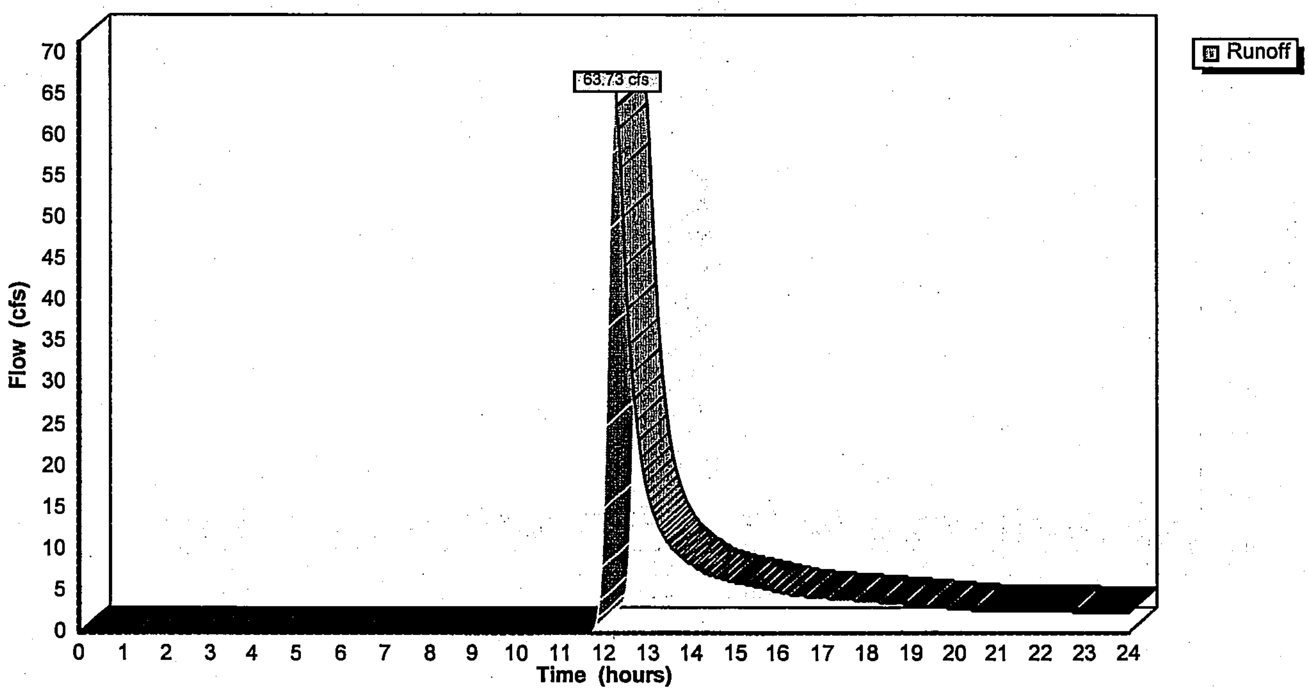
Runoff = 63.73 cfs @ 12.29 hrs, Volume= 7.307 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=4.50"

Area (ac)	CN	Description
19.000	60	Developed Pervious
68.000	60	Undeveloped
87.000	60	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, Assumed**

Subcatchment 3S: Proposed Urban Pervious



Subcatchment 4S: Proposed Impervious

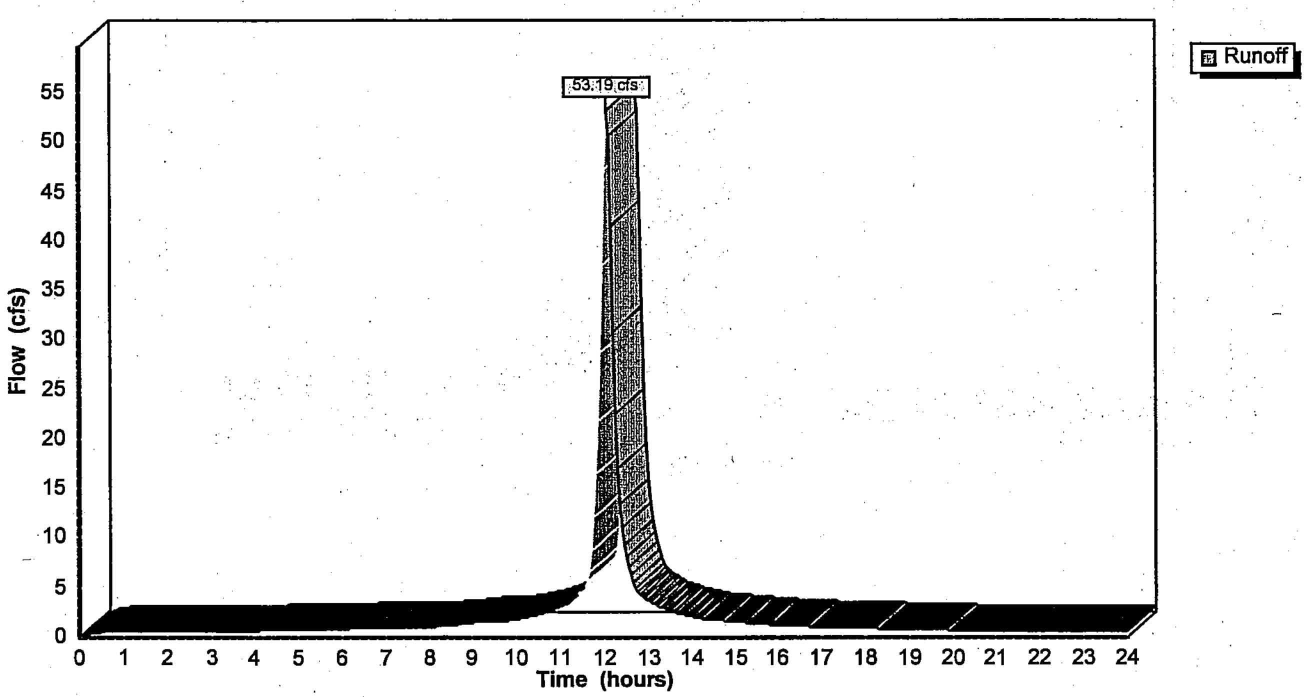
Runoff = 53.19 cfs @ 12.06 hrs, Volume= 4.116 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=4.50"

Area (ac)	CN	Description
11.000	100	Developed Impervious Areas

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Assumed**

Subcatchment 4S: Proposed Impervious

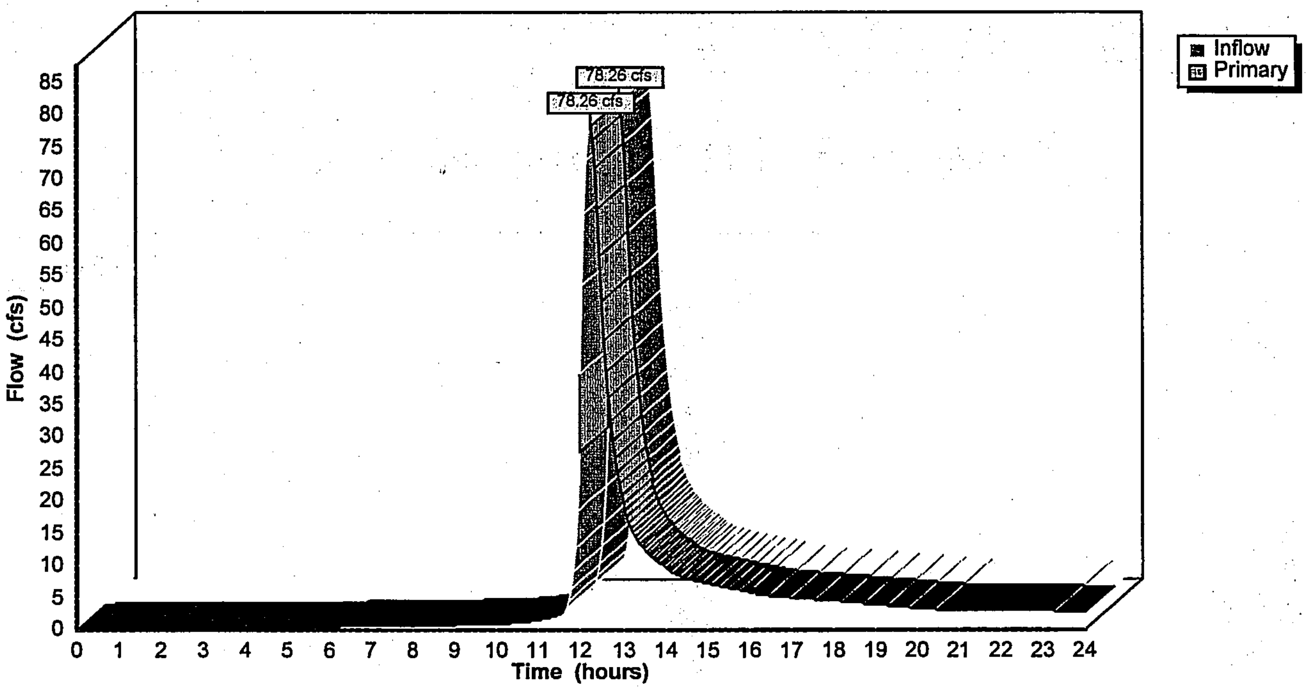


Pond 1P: Wetland

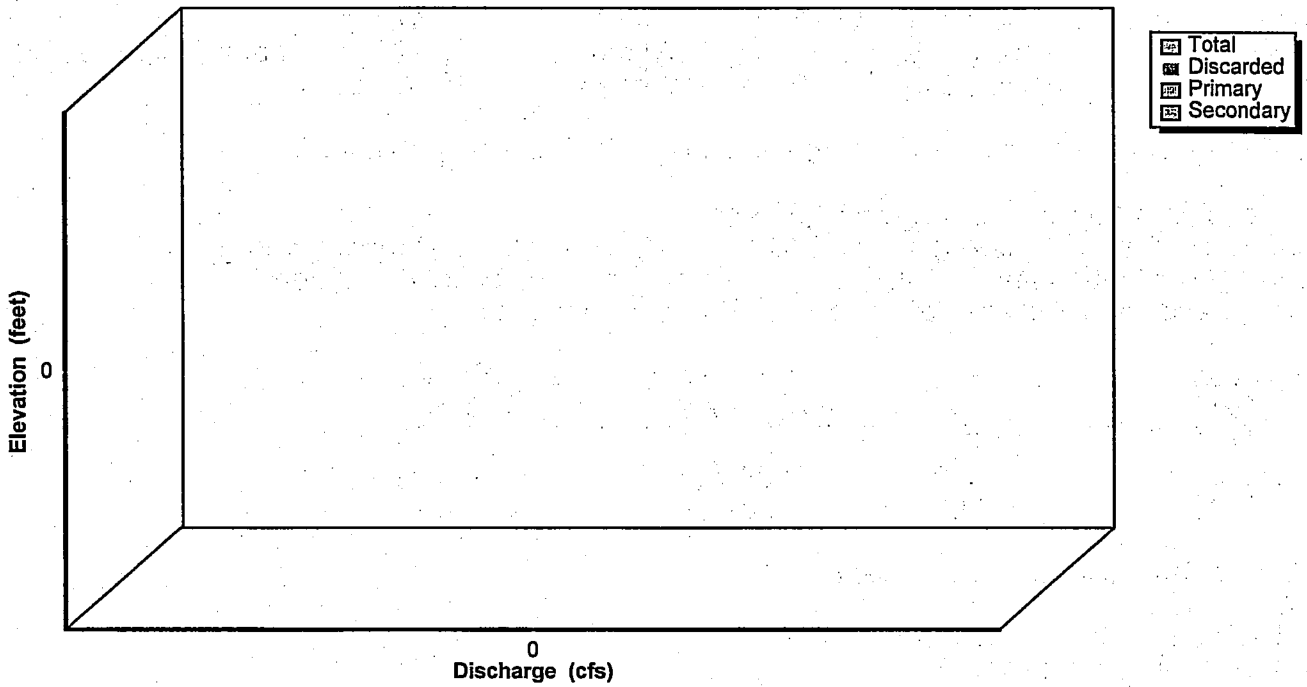
Inflow	=	78.26 cfs @	12.24 hrs,	Volume=	9.856 af
Primary	=	78.26 cfs @	12.24 hrs,	Volume=	9.856 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

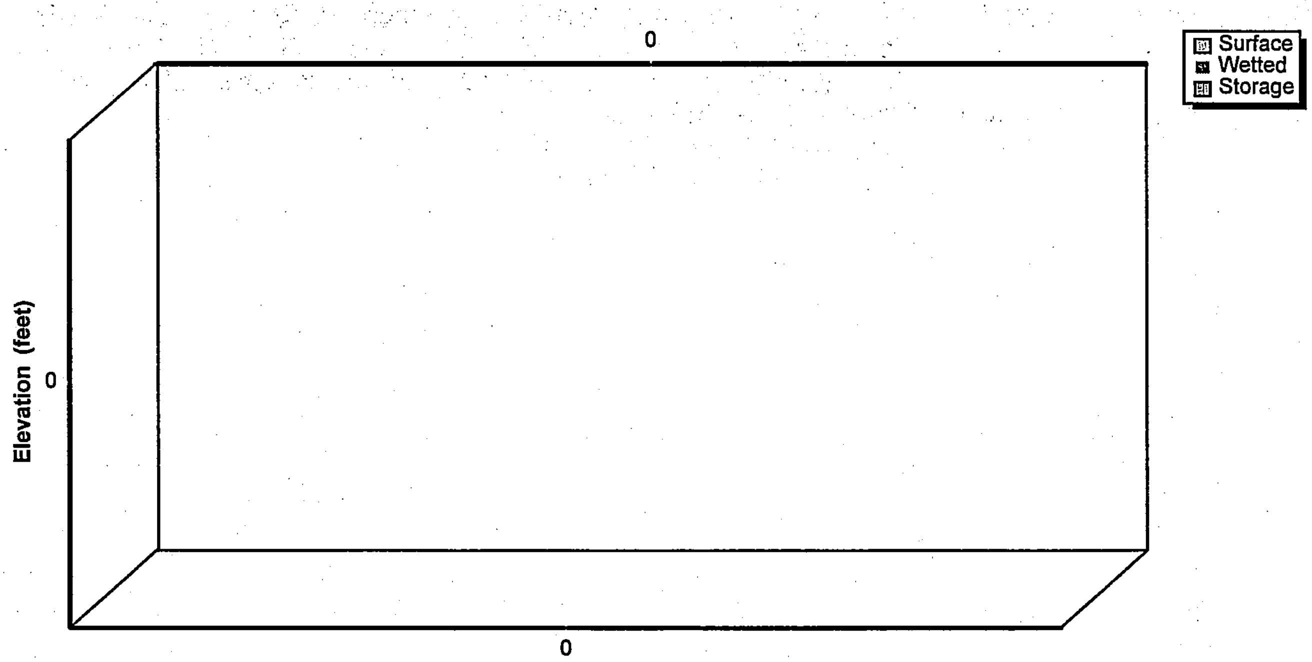
Pond 1P: Wetland



Pond 1P: Wetland



Pond 1P: Wetland



Pond 2P: Wet Pond

Inflow	=	90.36 cfs @	12.16 hrs,	Volume=	11.423 af
Outflow	=	58.44 cfs @	12.46 hrs,	Volume=	10.721 af, Atten= 35%, Lag= 18.1 min
Primary	=	58.44 cfs @	12.46 hrs,	Volume=	10.721 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5

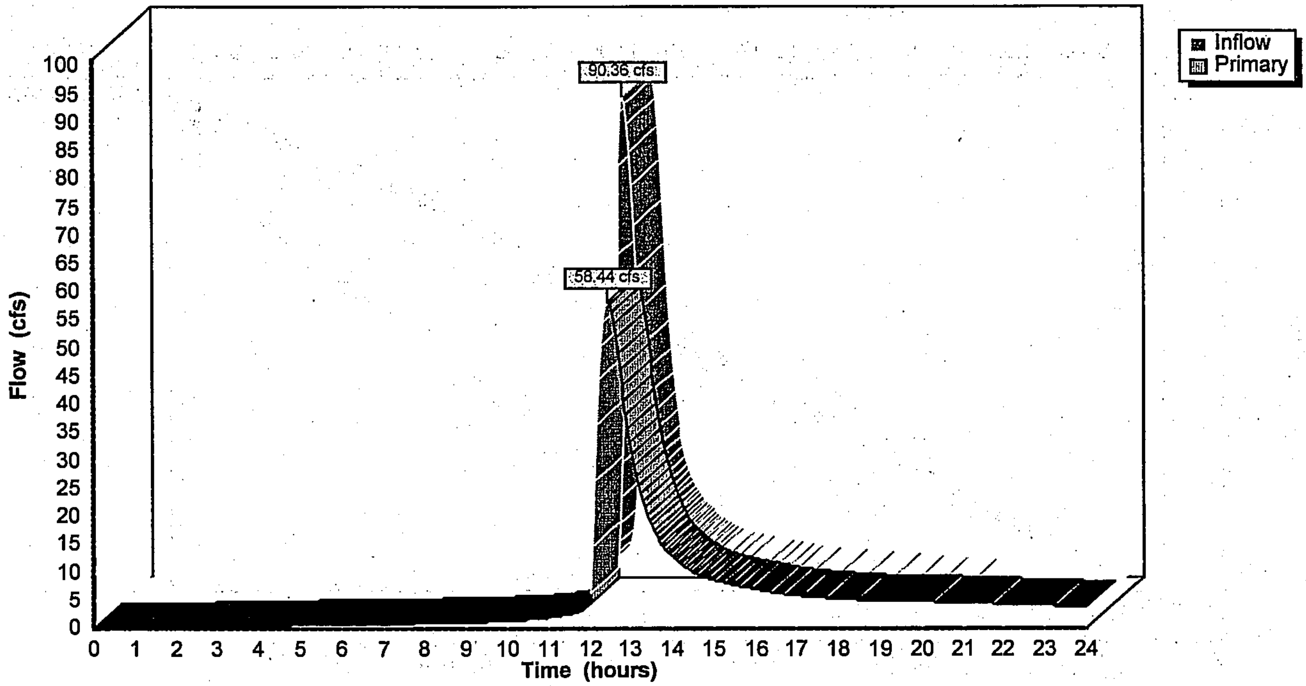
Starting Elev= 103.00' Storage= 52,500 cf
Peak Elev= 108.51' Storage= 167,776 cf (115,276 cf above starting storage)
Plug-Flow detention time= 174.7 min calculated for 9.516 af (83% of inflow)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
100.00	10,000	0	0
106.00	25,000	105,000	105,000
107.00	25,000	25,000	130,000

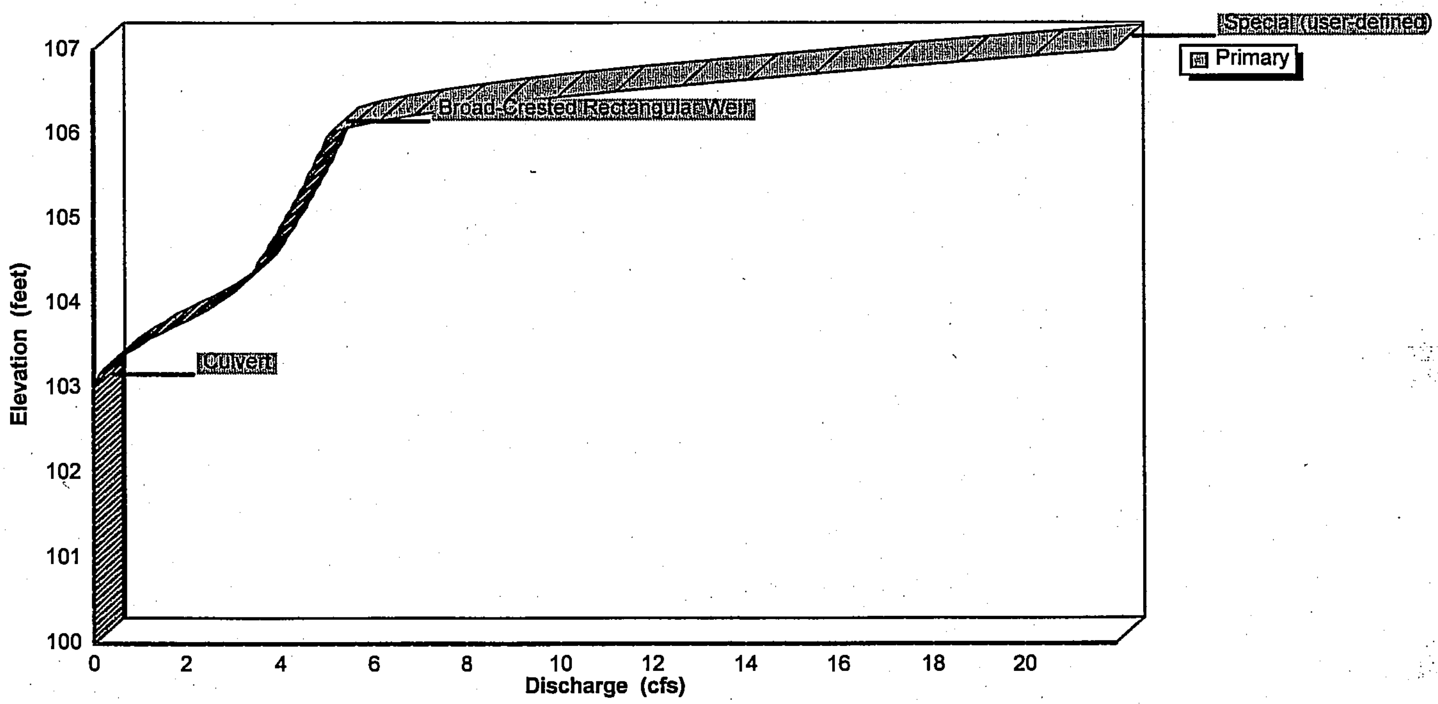
Primary OutFlow (Free Discharge)
↑—1=Culvert
—2=Broad-Crested Rectangular Weir
—3=Special (user-defined)

#	Routing	Invert	Outlet Devices
1	Primary	103.00'	**12.0" x 100.0' long Culvert** Ke= 0.500 Outlet Invert= 102.00' S= 0.0100 '/' n= 0.013 Cc= 0.900
2	Primary	106.00'	**6.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
3	Primary	107.00'	**Special (user-defined)** Head (feet) 0.00 1.00 Disch. (cfs) 0.00 200.00

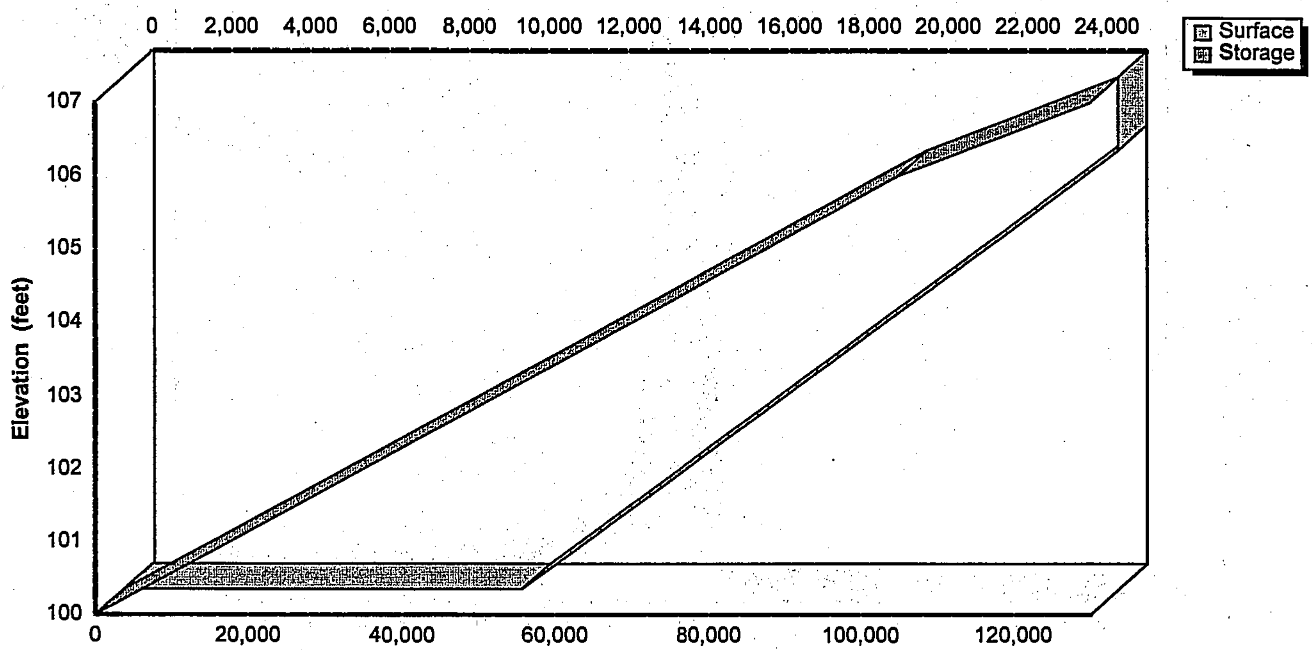
Pond 2P: Wet Pond



Pond 2P: Wet Pond



Pond 2P: Wet Pond

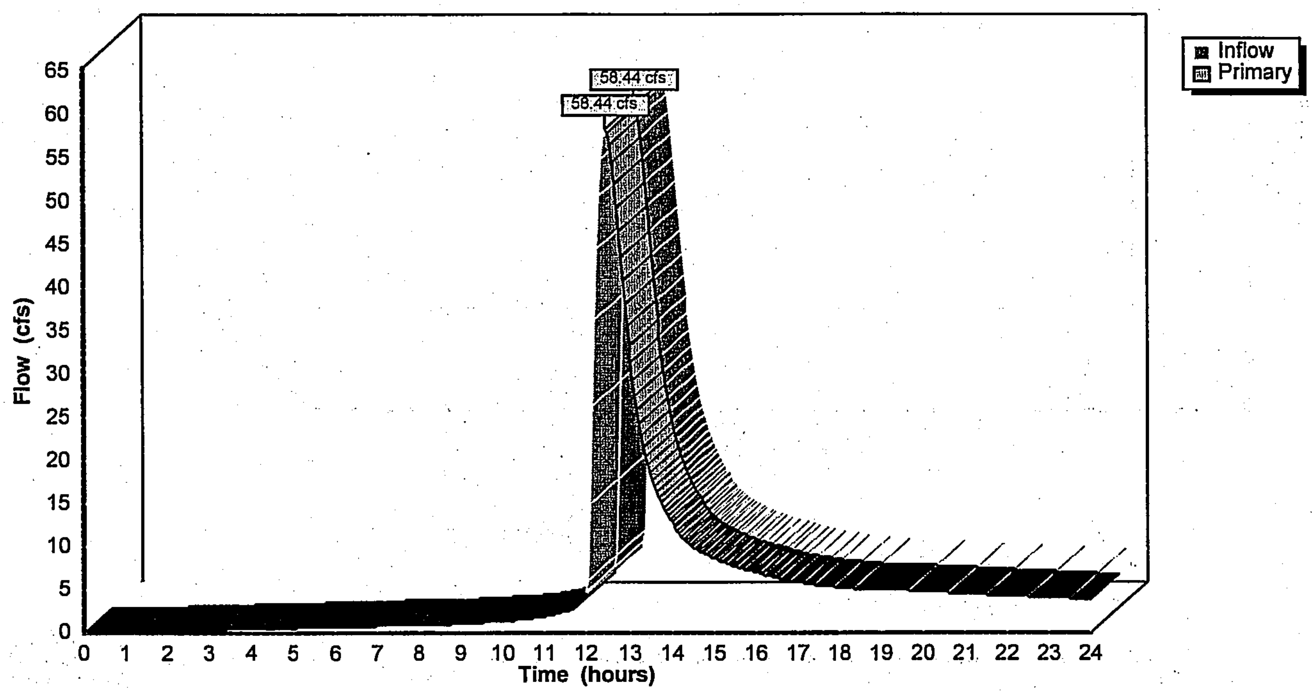


Pond 3P: Wetland

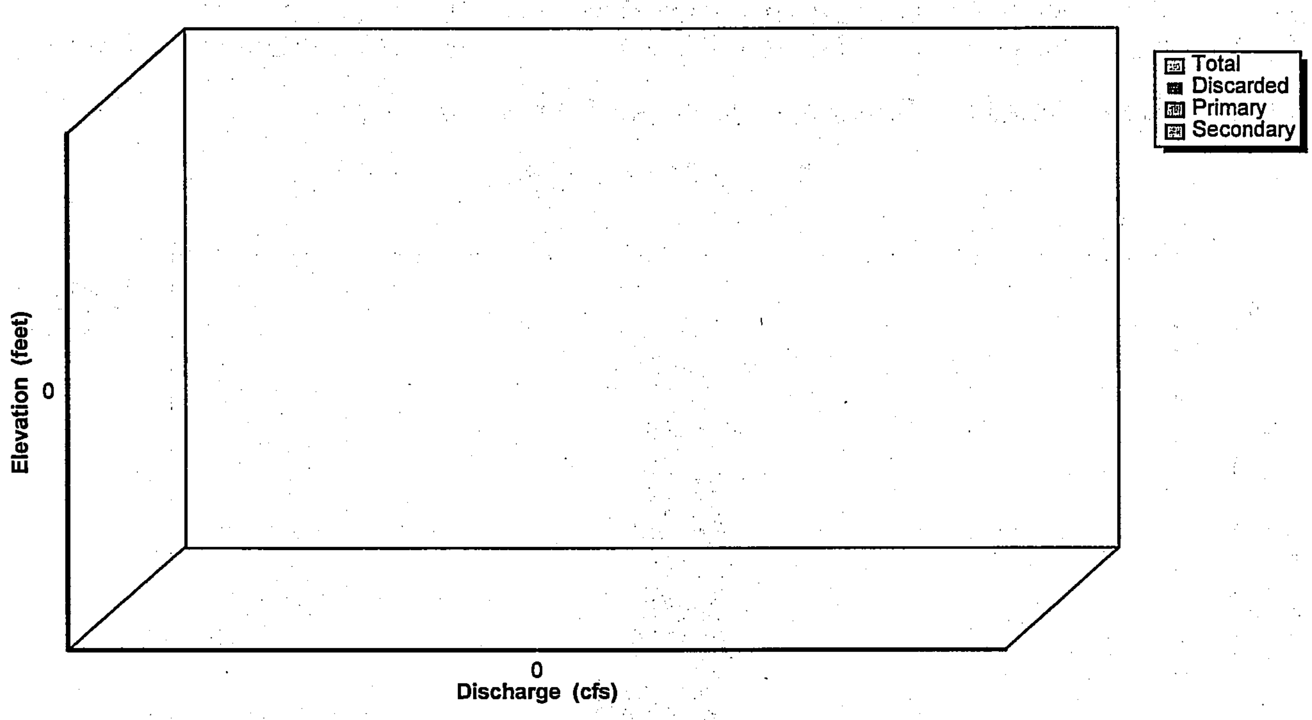
Inflow	=	58.44 cfs @	12.46 hrs,	Volume=	10.721 af
Primary	=	58.44 cfs @	12.46 hrs,	Volume=	10.721 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

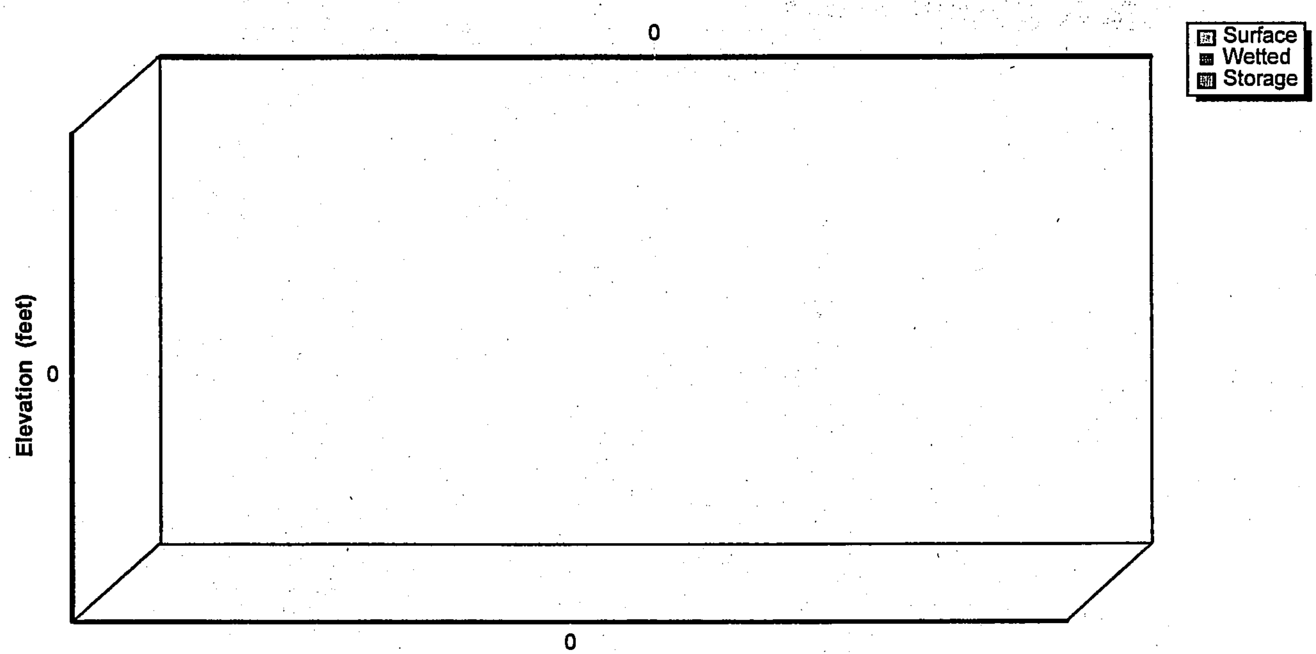
Pond 3P: Wetland



Pond 3P: Wetland



Pond 3P: Wetland



APPENDIX E

100-year Storm

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Type II 24-hr Rainfall=5.60"
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

(100-yr storm)

Subcatchment 1S: Existing Pervious Area
Tc=30.0 min CN=60 Area=92.400 ac Runoff= 121.45 cfs 12.689 af

Subcatchment 2S: Existing Impervious
Tc=15.0 min CN=100 Area=5.600 ac Runoff= 33.70 cfs 2.607 af

Subcatchment 3S: Proposed Urban Pervious
Tc=30.0 min CN=60 Area=87.000 ac Runoff= 114.36 cfs 11.947 af

Subcatchment 4S: Proposed Impervious
Tc=15.0 min CN=100 Area=11.000 ac Runoff= 66.19 cfs 5.122 af

Pond 1P: Wetland
Inflow= 135.29 cfs 15.296 af
Primary= 135.29 cfs 15.296 af

Pond 2P: Wet Pond
Peak Storage= 212,330 cf Inflow= 146.20 cfs 17.069 af
Primary= 101.49 cfs 15.995 af Outflow= 101.49 cfs 15.995 af

Pond 3P: Wetland
Inflow= 101.49 cfs 15.995 af
Primary= 101.49 cfs 15.995 af

Runoff Area = 196.000 ac Volume = 32.365 af Average Depth = 1.98"

Subcatchment 1S: Existing Pervious Area

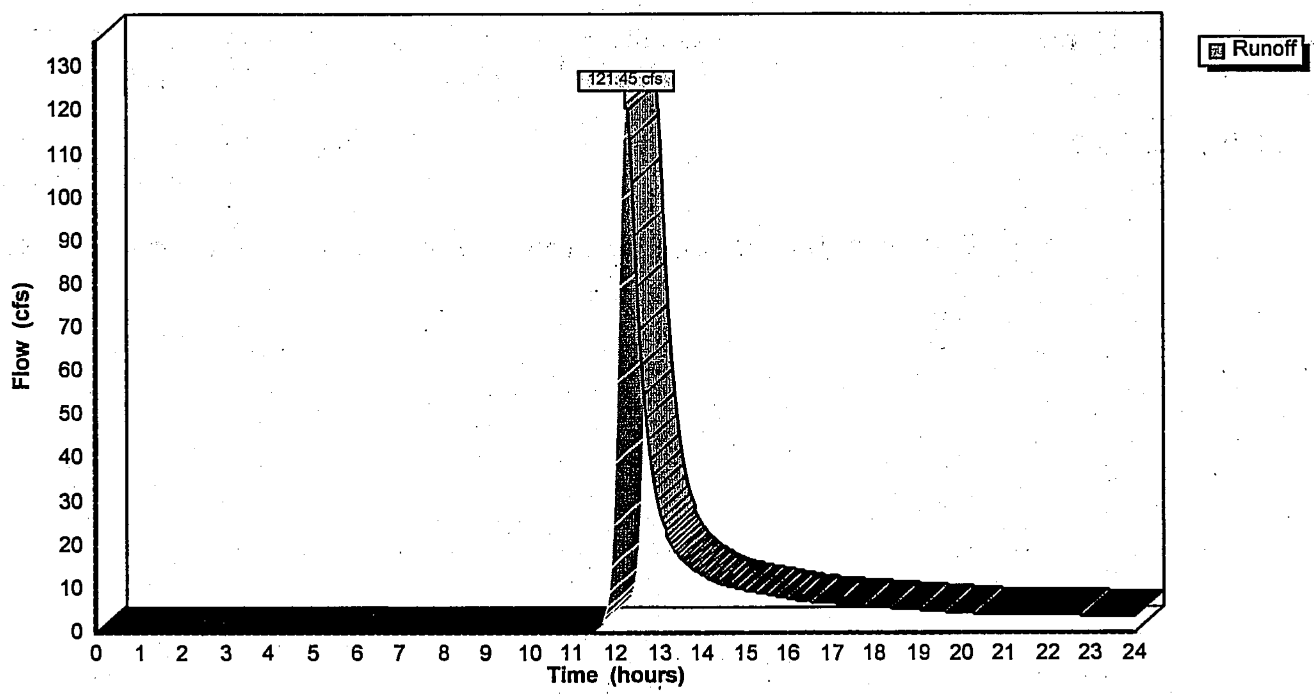
Runoff = 121.45 cfs @ 12.27 hrs, Volume= 12.689 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=5.60"

Area (ac)	CN	Description
9.700	60	Urban Development (pervious)
82.700	60	Non-Developed (pervious)
92.400	60	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, estimated Tc**

Subcatchment 1S: Existing Pervious Area



Subcatchment 2S: Existing Impervious

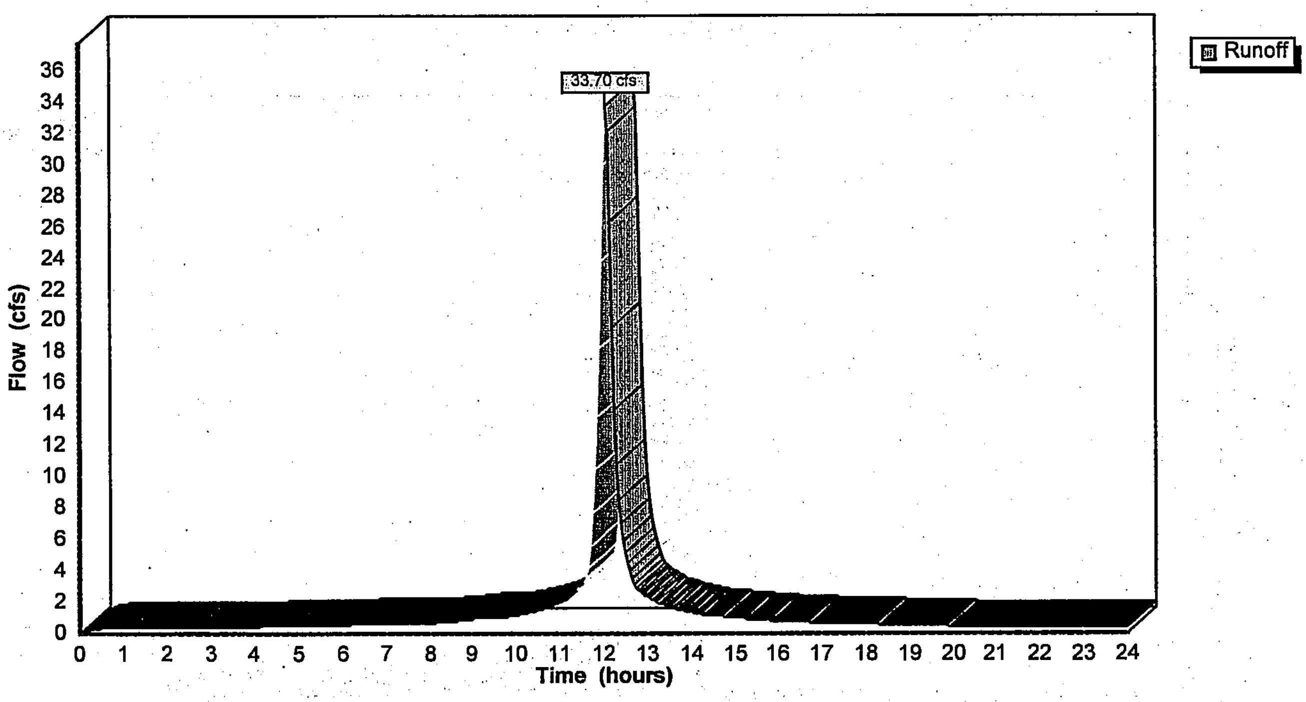
Runoff = 33.70 cfs @ 12.06 hrs, Volume= 2.607 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=5.60"

Area (ac)	CN	Description
5.600	100	Urban Development (Impervious)

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Assumed**

Subcatchment 2S: Existing Impervious



Subcatchment 3S: Proposed Urban Pervious

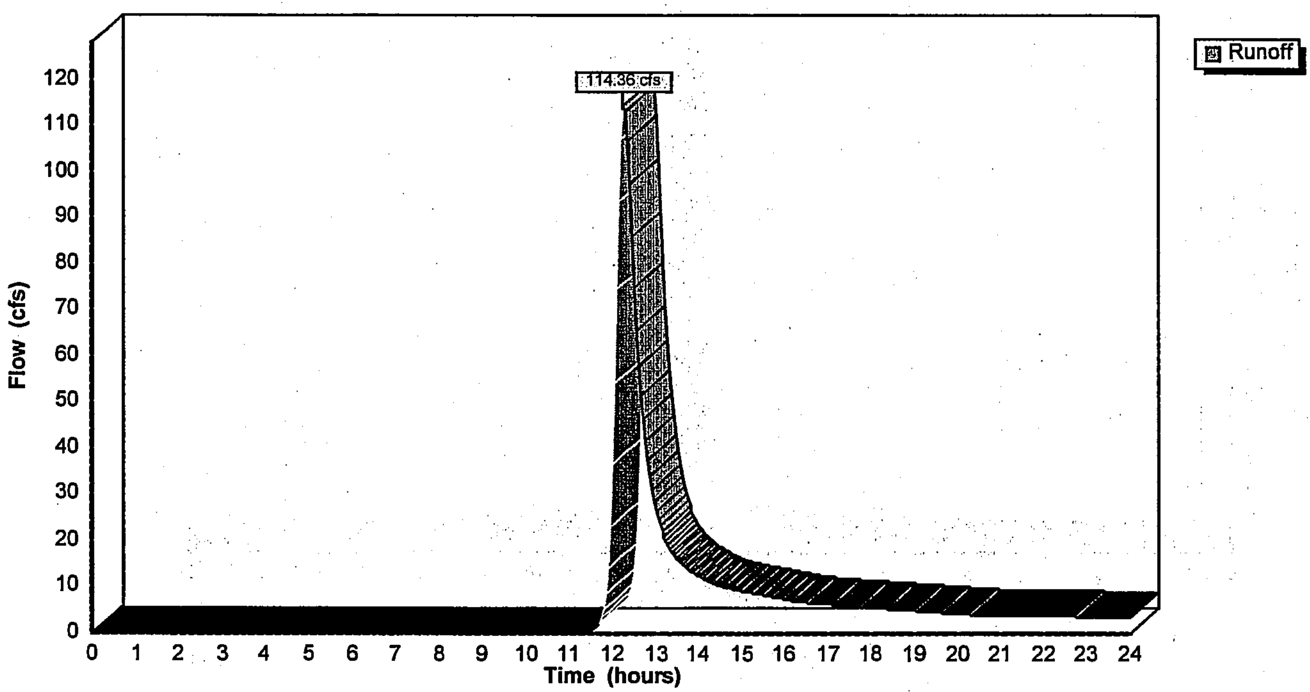
Runoff = 114.36 cfs @ 12.27 hrs, Volume= 11.947 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=5.60"

Area (ac)	CN	Description
19.000	60	Developed Pervious
68.000	60	Undeveloped
87.000	60	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, Assumed**

Subcatchment 3S: Proposed Urban Pervious



Subcatchment 4S: Proposed Impervious

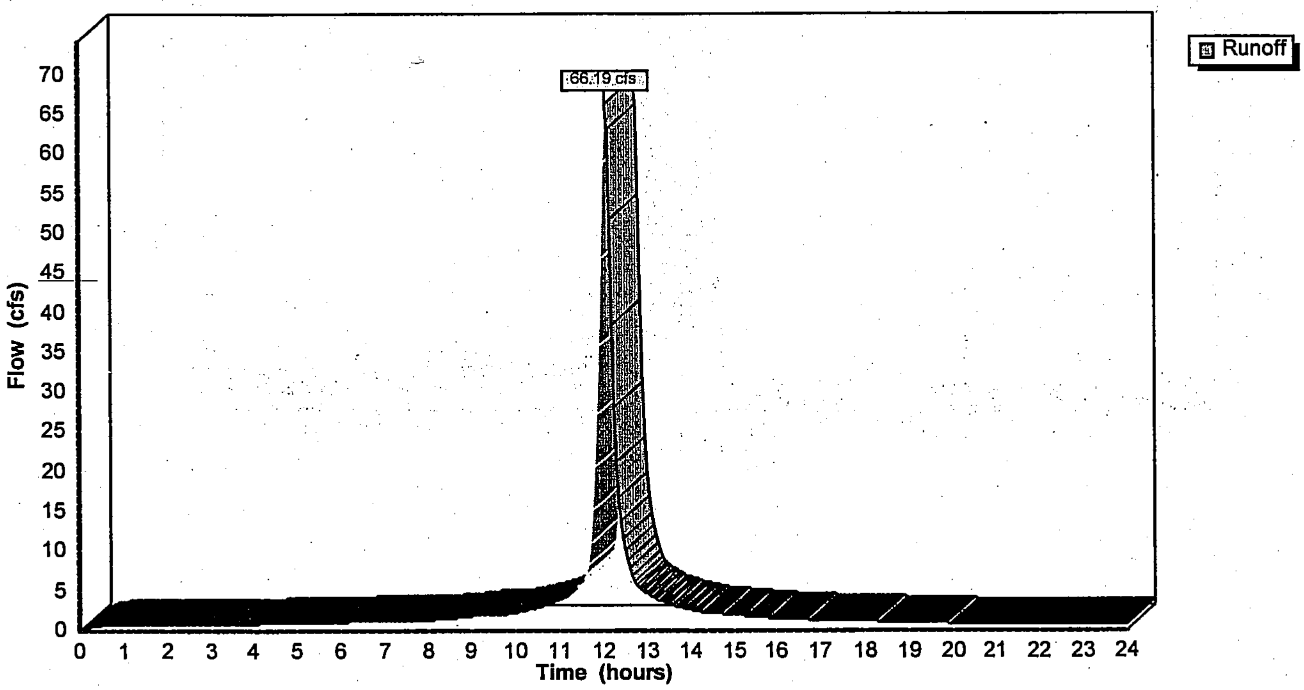
Runoff = 66.19 cfs @ 12.06 hrs, Volume= 5.122 af

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr Rainfall=5.60"

Area (ac)	CN	Description
11.000	100	Developed Impervious Areas

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Assumed**

Subcatchment 4S: Proposed Impervious

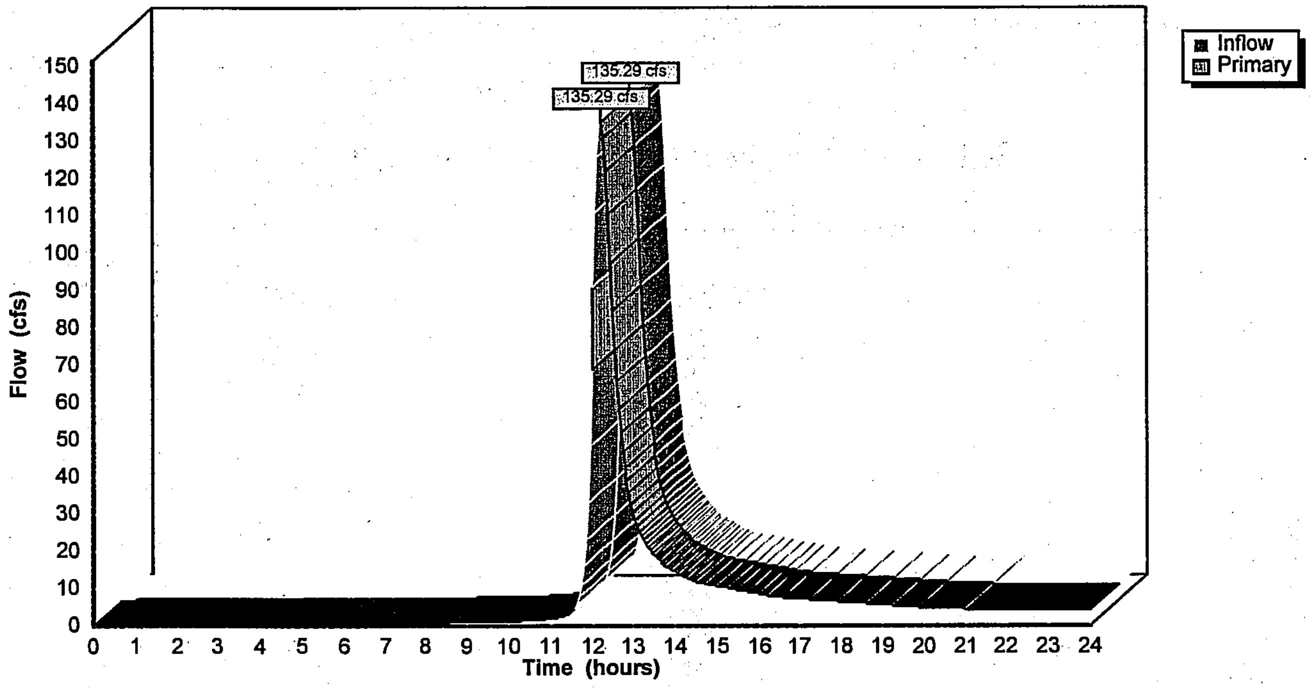


Pond 1P: Wetland

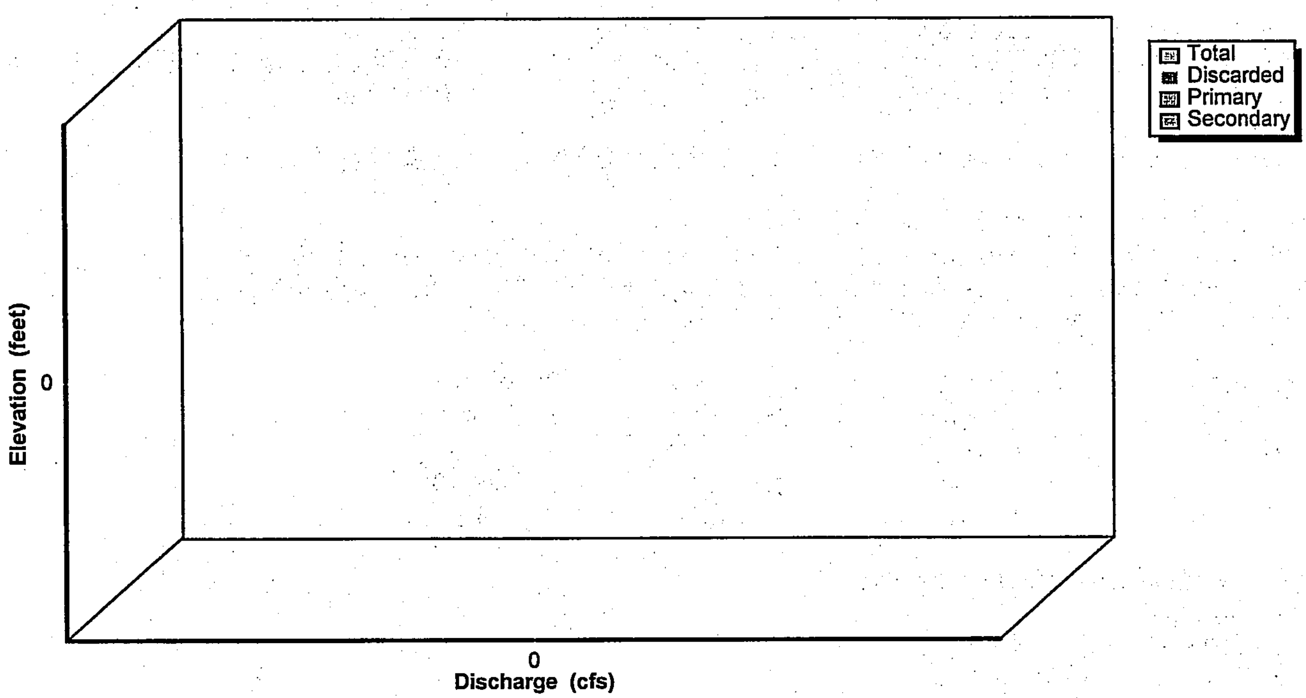
Inflow	=	135.29 cfs @	12.24 hrs,	Volume=	15.296 af
Primary	=	135.29 cfs @	12.24 hrs,	Volume=	15.296 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

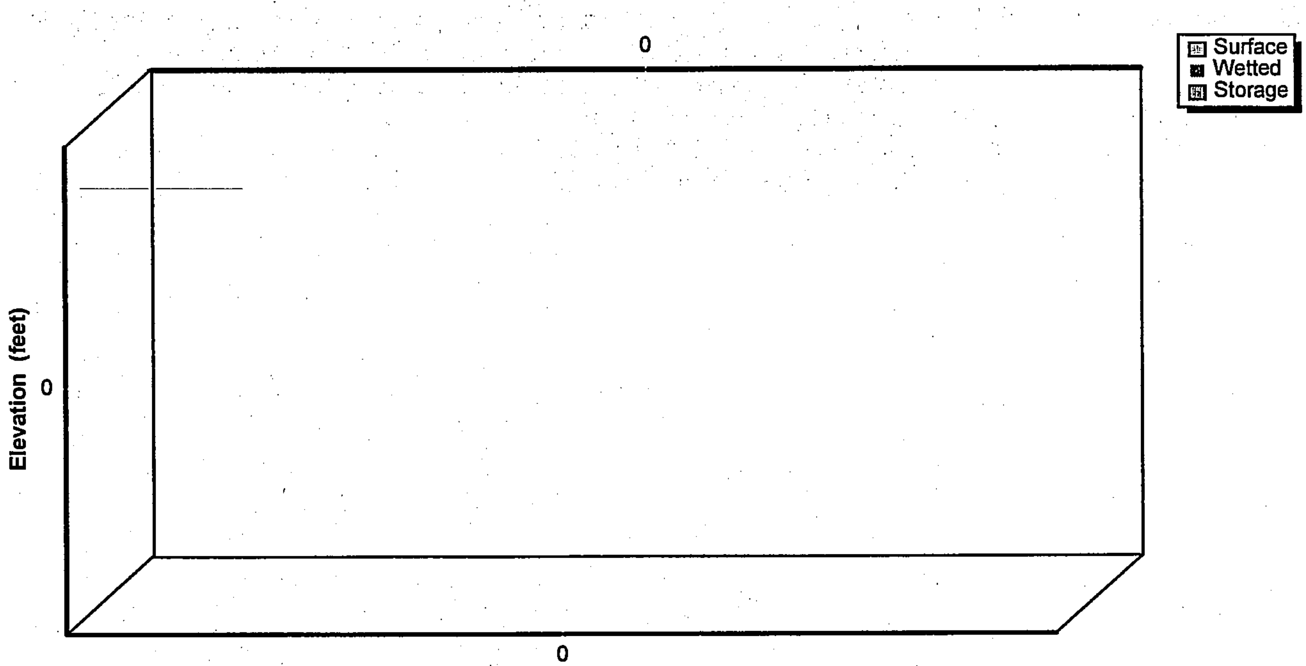
Pond 1P: Wetland



Pond 1P: Wetland



Pond 1P: Wetland



Pond 2P: Wet Pond

Inflow	=	146.20 cfs @	12.18 hrs, Volume=	17.069 af	
Outflow	=	101.49 cfs @	12.44 hrs, Volume=	15.995 af,	Atten= 31%, Lag= 15.3 min
Primary	=	101.49 cfs @	12.44 hrs, Volume=	15.995 af	

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5

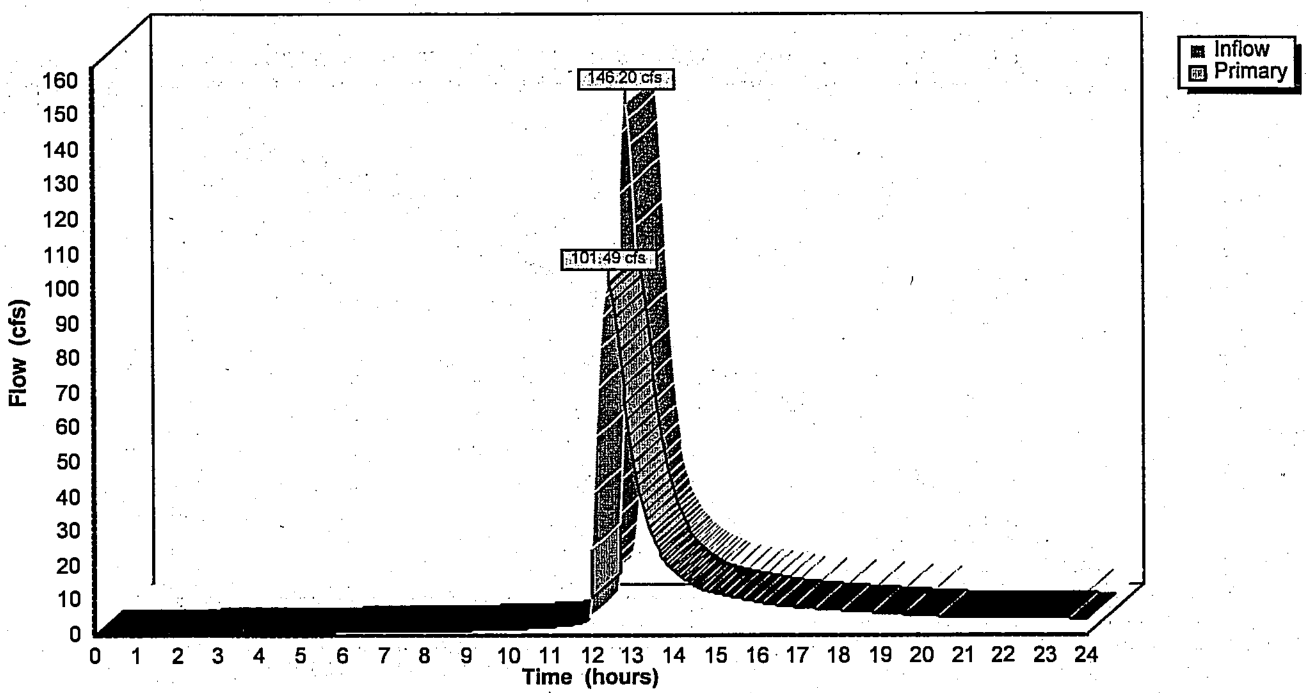
Starting Elev= 103.00' Storage= 52,500 cf
Peak Elev= 110.29' Storage= 212,330 cf (159,830 cf above starting storage)
Plug-Flow detention time= 128.4 min calculated for 14.790 af (87% of inflow)
Storage and wetted areas determined by Prismatic sections

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
100.00	10,000	0	0
106.00	25,000	105,000	105,000
107.00	25,000	25,000	130,000

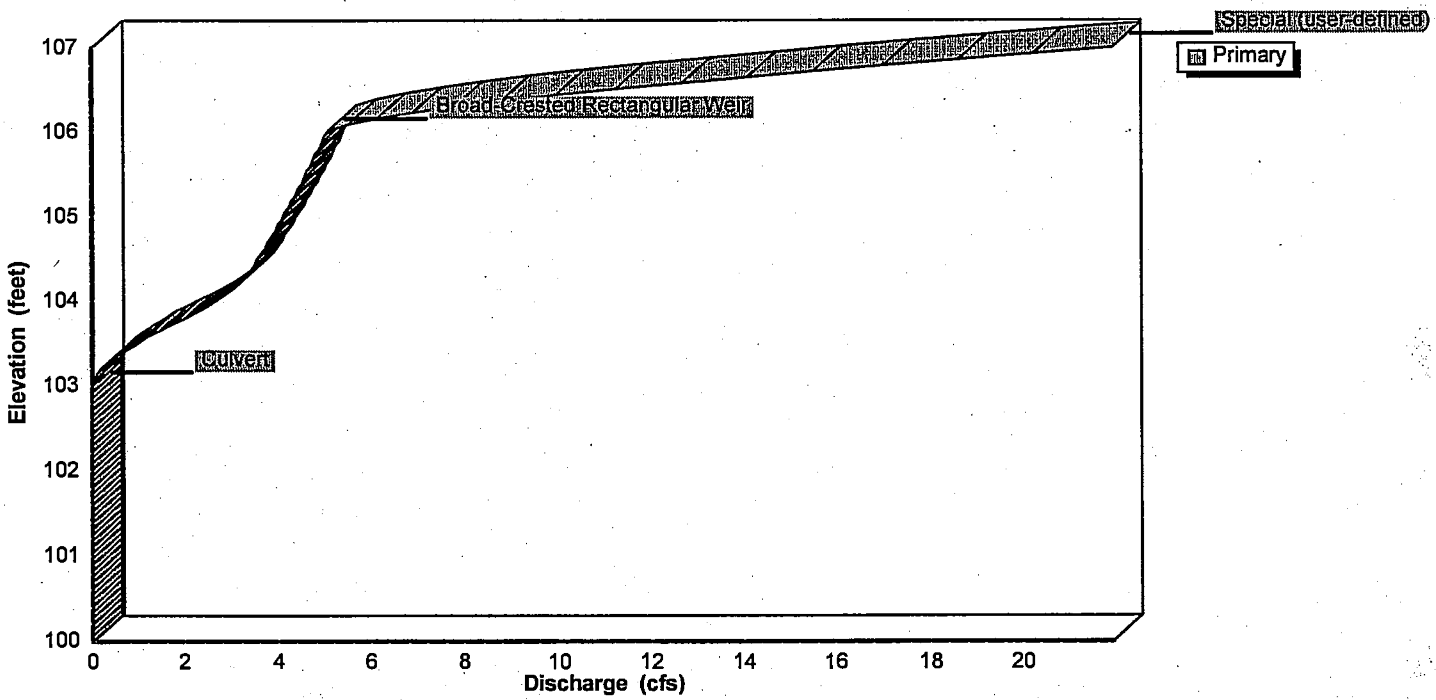
Primary OutFlow (Free Discharge)
↑—1=Culvert
—2=Broad-Crested Rectangular Weir
└—3=Special (user-defined)

#	Routing	Invert	Outlet Devices
1	Primary	103.00'	**12.0" x 100.0' long Culvert** Ke= 0.500 Outlet Invert= 102.00' S= 0.0100 '/' n= 0.013 Cc= 0.900
2	Primary	106.00'	**6.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
3	Primary	107.00'	**Special (user-defined)** Head (feet) 0.00 1.00 Disch. (cfs) 0.00 200.00

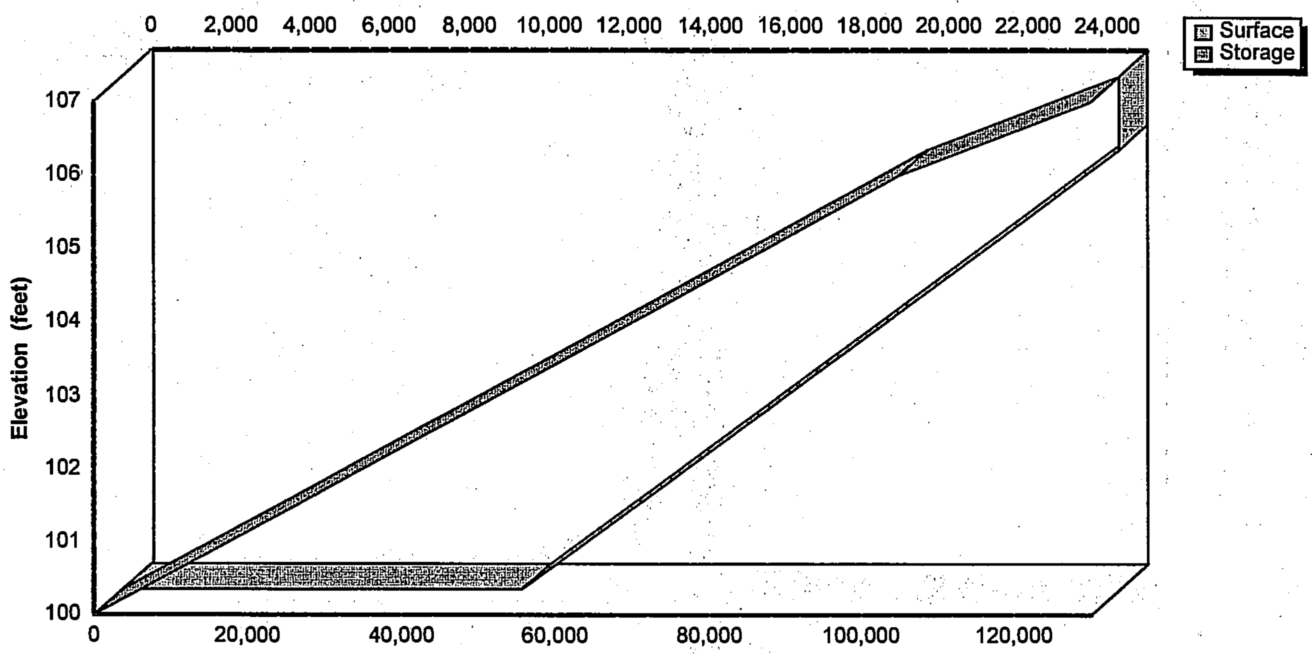
Pond 2P: Wet Pond



Pond 2P: Wet Pond



Pond 2P: Wet Pond

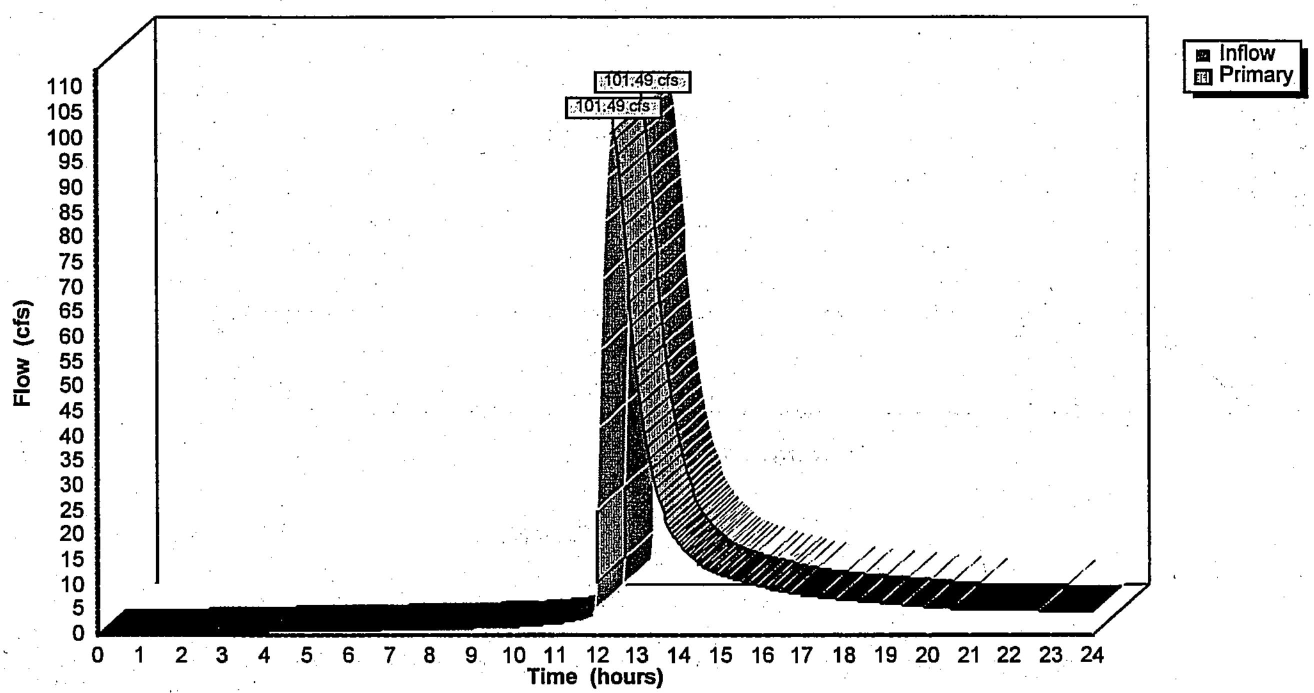


Pond 3P: Wetland

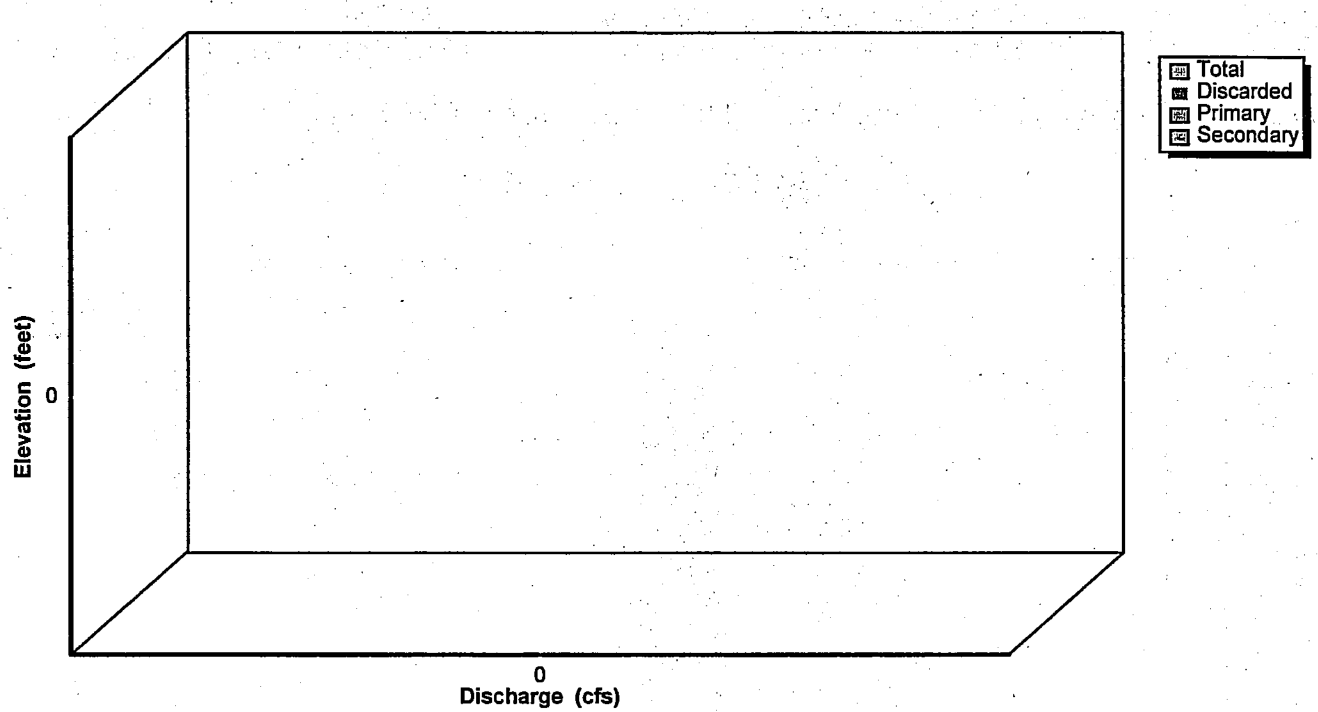
Inflow	=	101.49 cfs @	12.44 hrs,	Volume=	15.995 af
Primary	=	101.49 cfs @	12.44 hrs,	Volume=	15.995 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

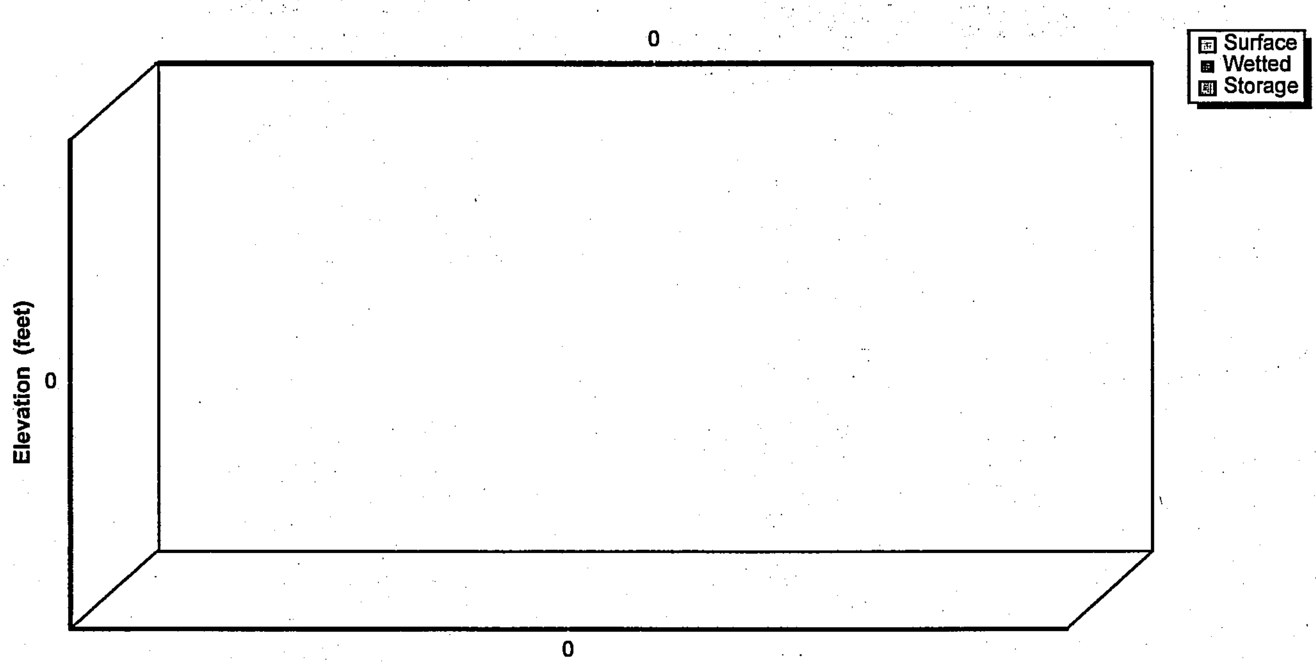
Pond 3P: Wetland



Pond 3P: Wetland



Pond 3P: Wetland



APPENDIX L

US Census Bureau Information

Table 1: Town of Stone Lake: Historical Population 1950-2000

	1950	1960	1970	1980	1990	2000
US Census	352	299	339	379	438	544

US Census Bureau
Source: www.doa.state.wi.us/dhir/boir/demographic/popinfo/2001co.xls

Table 2: Town of Stone Lake: Population Projections, 2005-2020

	2005	2010	2015	2020
[1]Historical Avg.	571	598	628	658
[2]Forecast (Linear Regression)	513	534	554	574
[3]20 Year Avg.	598	652	717	782

[1]NWRPC Projections based upon historical average
[2]NWRPC Projections based upon linear regression analysis
[3]NWRPC 20 year average

US Census Bureau
Source: www.doa.state.wi.us/dhir/boir/demographic/PPROJ1M.asp

Town of Stone Lake/Sand Lake Population Information

DOA Code	Location	4/1/00 Census	1/1/01 Estimate	Percent Change
66040 66	Town of Stone Lake Washburn County	544	554	1.84
58026 58	Town of Sand Lake Sawyer County	774	779	0.65

US Census Bureau Source: www.doa.state.wi.us/dhir/boir/demographic/popinfo/2001co.xls

1993 Census Projections

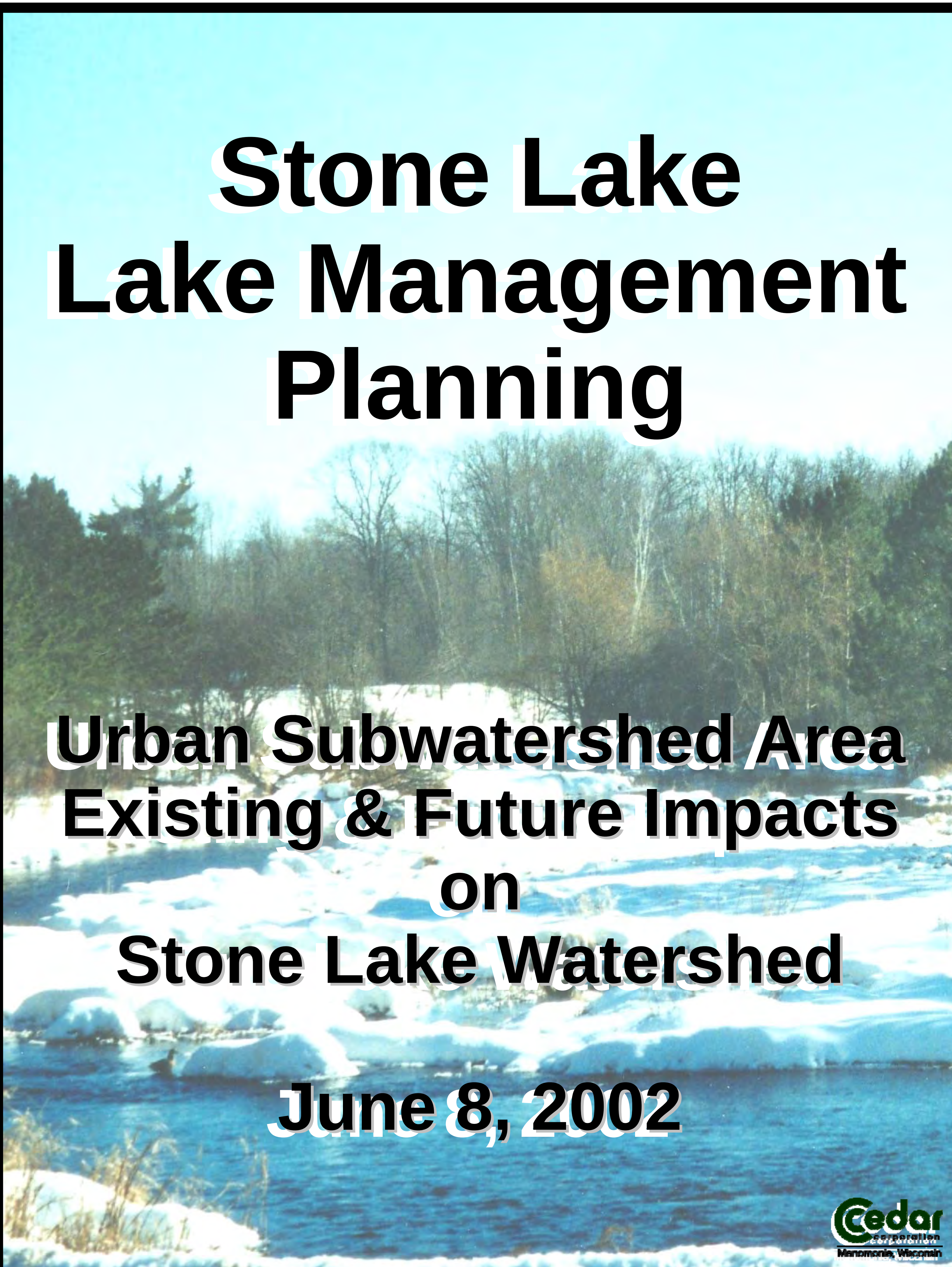
	1970	1970	1990	1995	2000	2005	2010	2015
Sand Lake	598	768	821	880	897	901	899	891
Stone Lake	339	379	446	491	512	528	539	546

US Census Bureau
Source: www.doa.state.wi.us/dhir/boir/demographic/PPROJ1M.asp

Appendix M

Stone Lake Management Planning
PowerPoint Presentation
For
Pre-Annual Meeting:
June 8, 2002

Stone Lake Lake Management Planning



Urban Subwatershed Area Existing & Future Impacts on Stone Lake Watershed

June 8, 2002

Cedar corporation
Menomonie, Wisconsin

PROJECT GOALS:

- Establish a watershed delineation.
  i.e. Create maps showing GIS database and land use for the watershed and sub-areas.

- Evaluate existing and future landuses on the lake and the impacts caused by them.

- Conduct water quality and quantity modeling analysis to determine what impacts the urban subwatershed area will have on Stone Lake.

- Provide educational opportunities to the general public through publication of project goals/results and public information presentation meetings.

Cedar corporation
Menomonie, Wisconsin

DATA COLLECTION:

<u>Stone Lake</u>

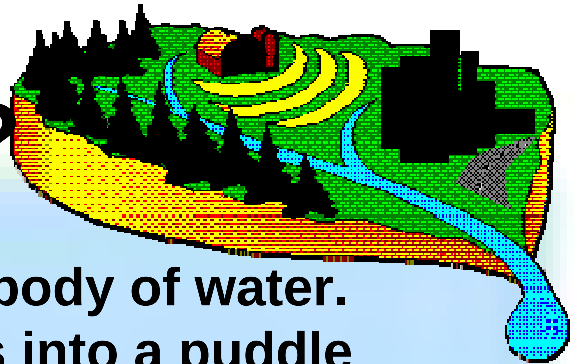
- 523-acres Surface Area
  (Little Stone Lake 30-acres)
- 40-feet Maximum Depth
- Storm water runoff conveyed from Town of Stone Lake, Town of Sand Lake, and surrounding watershed to Stone Lake
- Seepage Lake: no outlet or inlet (landlocked)
- Water source influenced mainly by: precipitation, runoff, and groundwater

WATERSHED DELINEATION:

- Q: What is the purpose of knowing your watershed boundary?

- A: You may be contributing increased storm water runoff and pollution to the lakes, the streams, or the groundwater even if you don't live on the lakeshore.

WHAT IS A WATERSHED?



- **Land area that drains into a body of water.**
  Example: Backyard drains into a puddle

- **The edge or boundary of your lake's watershed is defined by the highest points and ridges or land around the lake.**

- **Rainfall and snowmelt runoff inside the boundary flows to your lakes.**

- **A lake's watershed may include other water bodies such as streams, rivers, ponds, or wetlands. These water bodies have their own smaller watershed called a subwatershed and smaller areas within the watershed called sub-areas.**

OVERALL: The delineated area will enhance your knowledge and understanding of the lake's watershed conditions that affect or potentially affect the lake's ecosystem and water quality.

- ***Stone Lake watershed was divided into 3 major sub-areas to look into the issue on how the urban sub-areas directly affects Stone Lake and it's watershed.***

Cedar corporation
Menomonie, Wisconsin

LAND USE—Existing & Proposed:

Table 1 (FIG 4): Existing Landuse in Urban Stone Lake Sub-area		
	Acres	%
Urban	15	16
Agriculture	2	2
Forest	65	67
Grassland	13	13
Wetland	2	2
Total:	98	100

Table 2 (FIG 4): Existing Landuse in Wetland		
	Acres	%
Wetland	2	29
Forest	6	70
Barren	0	1
Total:	8	100

Table 3 (FIG 3): Existing Landuse in Stone Lake Watershed		
	Acres	%
Urban	15	1
Agriculture	40	2
Forest	919	53
Grassland	119	7
Wetland	51	3
Barren	16	1
Water	571	33
Total:	1732	100

Table 4 (FIG 4): Proposed Landuse in Urban Stone Lake Sub-area		
	Acres	%
Urban	30	31
Agriculture	2	2
Forest	51	52
Grassland	13	13
Wetland	2	2
Total:	98	100

Cedar corporation
Menomonie, Wisconsin

WATER QUANTITY:

- <u>Storm water runoff</u>—portion of precipitation that flows over ground surface during and after a storm event

- Quantity Modeling Program: HydroCAD

- Modeled storm events: 24-hour 1-inch (First Flush) rainfall, 2-, 10-, 25-, & 100-year 24-hour frequency storm events

Example: A ten year storm has a 10 % probability for occurring of being exceeded; 100-year storm has 1 % probability for occurring or being exceeded

- *NOTE: Town of Stone Lake's and Town of Sand Lake's storm water runoff for the 47-acres currently discharges in to a 2.4-acre wetland area.*

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WATER QUANTITY MODELING RESULTS—

Peak Runoff Rates & Total Runoff Volume

Table 5: Existing Landuse Condition: Sub-area A (98-ac): Run-off Analysis Results		
Storm Frequency	Peak Run-off Rate (cfs)	Total Run-off Volume (ac-ft)
24-hour/ 1 in.	6.0	0.5
2-years/24-hr	16.6	2.7
10-years/24-hr	55.7	7.7
25-years/24-hr	78.3	9.9
100-years/24-hr	135.3	15.3

Table 5 shows that Current Conditions result in an increase in storm water runoff rates and volume with increased storm frequency.

Table 6 shows that Future Conditions result in an almost doubling runoff quantity from current conditions (Urban development proposed to increase from 15-ac to 30-ac.)

Table 6: Future Landuse Condition: Sub-area A (98-ac): Run-off Analysis Results		
Storm Frequency	Peak Run-off Rate (cfs)	Total Run-off Volume (ac-ft)
24-hour/ 1 in.	11.8	0.9
2-years/24-hr	31.6	3.8
10-years/24-hr	68.8	9.1
25-years/24-hr	90.4	11.4
100-years/24-hr	146.2	17.1

Table 7: Future Landuse Condition: Sub-area B: Run-off Analysis Results --Pond Treatment		
Storm Frequency	Peak Run-off Rate (cfs)	Total Run-off Volume (ac-ft)
24-hour/ 1 in.	2.8	0.9
2-years/24-hr	5.8	3.8
10-years/24-hr	41.2	9.1
25-years/24-hr	58.4	11.4
100-years/24-hr	101.5	17.1

Table 7 shows that adding a pond before the wetland will reduce runoff rates by 4.2 times alone in a first flush or 24hr/1 in storm event, with the same amount to volume that has to travel off the Towns.

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Menomonie, Wisconsin

WATER QUALITY:

- **Quality Modeling Program: P8 Urban Catchment Model**

- **P**rogram for **p**redicting **p**olluting **p**article **p**assage through **p**its**, p**uddles**,** and **p**onds**.**

- **Program is primarily used for evaluating watersheds (like Stone Lake) for compliance with a treatment objective.**

- **Water Quality Pollutant Loading Removal efficiency: 85% Total Suspended Solids (sediment, TSS), Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), Copper (Cu), Lead (Pb), & Zinc (Zn)**

- **Modeled storm events: 1-inch Type2 Storm (First Flush) loading and annual loading.**

- **Rainfall and precipitation data obtained from the Minneapolis/St. Paul Airport.**

- **Pollutant constituent event mean concentration data obtained from EPA's Nation Wide Urban Runoff Pollution (NURP) data base.**

- ***NOTE: Future conditions are represented after structural BMP implementation of an approximate 250-foot long by 100-foot wide by 6-foot deep pond.***

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WATER QUALITY MODELING RESULTS—Existing Conditions (after first flush):

Table 8: Existing Conditions: Sub-area A Loading onto 98+/- acres after 1 inch Type2-Storm		
Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	119	3
Total Phosphorus	0.38	--
Total Kjeldahl Nitrogen	2	--
Copper	0.04	--
Lead	0.02	--
Zinc	0.18	--

Loading from the Town.

Table 9: Existing Conditions: Sub-area B Loading 2.4 +/- acres after 1 inch Type2-Storm		
Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	119	49
Total Phosphorus	0.38	--
Total Kjeldahl Nitrogen	2	1
Copper	0.04	--
Lead	0.02	--
Zinc	0.18	--

Loading to Wetland (same as above).

Table 10: Existing Conditions: Sub-area C Loading after 1 inch Type2-Storm		
Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	3	--
Total Phosphorus	0.07	--
Total Kjeldahl Nitrogen	0.38	--
Copper	0.01	--
Lead	0	--
Zinc	0.04	--

Estimated discharge to Stone Lake.

Cedar corporation
Menomonie, Wisconsin

WATER QUALITY MODELING RESULTS—Future Conditions *without* Treatments:

Table 11: Future Conditions: Sub-area A Increased Urban Area *without* Treatment Loading onto 98 +/- acres after 1 inch Type2-Storm		
Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	270	3
Total Phosphorus	0.86	--
Total Kjeldahl Nitrogen	4	--
Copper	0.09	--
Lead	0.05	--
Zinc	0.41	--

Loading from the Town.

Loading to Wetland (same as above).

Table 12: Future Conditions: Sub-area B Increased Urban Area *without* Treatment Loading 2.4 +/- acres after 1 inch Type2-Storm		
Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	270	112
Total Phosphorus	0.86	--
Total Kjeldahl Nitrogen	4	2
Copper	0.09	--
Lead	0.05	--
Zinc	0.41	--

Table 13: Future Conditions: Sub-area C Increased Urban Area *without* Treatment Loading after 1 inch Type2-Storm		
Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	16	--
Total Phosphorus	0.25	--
Total Kjeldahl Nitrogen	1	--
Copper	0.03	--
Lead	0.01	--
Zinc	0.15	--

Estimated discharge to Stone Lake.

Cedar corporation
Menomonie, Wisconsin

WATER QUALITY MODELING RESULTS— Future Conditions WITH Treatments:

Table 14: Future Conditions: Sub-area A & *Wet Pond* Increased Urban Area *with* Treatment Loading onto 98 +/- & 0.57 +/- acres after 1 inch Type2-Storm		
Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	270	3
Total Phosphorus	0.86	--
Total Kjeldahl Nitrogen	4	--
Copper	0.09	--
Lead	0.05	--
Zinc	0.41	--

Loading from the Town.

Table 15: Future Conditions: Sub-area B Increased Urban Area *with* Treatment Loading onto 2.4 +/- acres after 1 inch Type2-Storm		
Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	38	67
Total Phosphorus	0.35	1
Total Kjeldahl Nitrogen	2	3
Copper	0.04	--
Lead	0.01	--
Zinc	0.19	--

Loading to wetland with wet pond treatment installed.

Table 16: Future Conditions: Sub-area C Increased Urban Area *with* Treatment Loading after 1 inch Type2-Storm		
Pollutant	Loading (lbs/1 inch storm)	Loading (lbs/acre/1 inch storm)
Total Suspended Solids	4	--
Total Phosphorus	0.15	--
Total Kjeldahl Nitrogen	0.89	--
Copper	0.02	--
Lead	0	--
Zinc	0.1	--

Estimated discharge to Stone Lake.

Cedar corporation
Menomonie, Wisconsin

WATER QUALITY MODELING RESULTS— Existing Conditions (now annual loading):

Table 17: Existing Conditions: Sub-area A Loading onto 98 +/- acres after **annual storms**		
Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/acre/year)
Total Suspended Solids	140	1
Total Phosphorus	--	--
Total Kjeldahl Nitrogen	2	--
Copper	0.05	--
Lead	0.03	--
Zinc	--	--

Loading from the Town.

Table 18: Existing Conditions: Sub-area B Loading onto 2.4 +/- acres after **annual storms**		
Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/acre/year)
Total Suspended Solids	140	1
Total Phosphorus	--	--
Total Kjeldahl Nitrogen	2	--
Copper	0.05	--
Lead	--	--
Zinc	--	--

Loading to Wetland (same as above).

Table 19: Existing Conditions: Sub-area C Loading after **annual storms**		
Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/acre/year)
Total Suspended Solids	5	--
Total Phosphorus	--	--
Total Kjeldahl Nitrogen	1	--
Copper	0.01	--
Lead	--	--
Zinc	--	--

Estimated discharge to Stone Lake.

Cedar corporation
Menomonie, Wisconsin

WATER QUALITY MODELING RESULTS—Future Conditions *without* Treatment:

Table 20: Future Conditions: Sub-area A Increased Urban Area *without* Treatment Loading onto 98 +/- acres after **annual storms**		
Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/year)
Total Suspended Solids	6838	70
Total Phosphorus	22	--
Total Kjeldahl Nitrogen	97	1
Copper	2	--
Lead	1	--
Zinc	10	--

Loading from the Town.

Loading to Wetland (same as above).

Table 21: Future Conditions: Sub-area B Increased Urban Area *without* Treatment Loading onto 2.4 +/- acres after **annual storms**		
Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/year)
Total Suspended Solids	6838	2849
Total Phosphorus	22	9
Total Kjeldahl Nitrogen	97	40
Copper	2	1
Lead	1	1
Zinc	10	4

Table 22: Future Conditions: Sub-area C Increased Urban Area *without* Treatment Loading after **annual storms**		
Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/year)
Total Suspended Solids	322	--
Total Phosphorus	7	--
Total Kjeldahl Nitrogen	38	--
Copper	0.85	--
Lead	0.17	--
Zinc	4	--

Estimated discharge to Stone Lake.

Cedar corporation
Menomonie, Wisconsin

WATER QUALITY MODELING RESULTS— Future Conditions WITH Treatment:

Table 23: Future Conditions: Sub-area A & *Wet Pond* Increased Urban Area *with* Treatment Loading onto 98 +/- & 0.57 +/- acres after **annual storms**		
Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/year)
Total Suspended Solids	6806	69
Total Phosphorus	22	--
Total Kjeldahl Nitrogen	97	1
Copper	2	--
Lead	1	--
Zinc	10	--

Loading from the Town.

Table 24: Future Conditions: Sub-area B Increased Urban Area *with* Treatment Loading onto 2.4 +/- acres after **annual storms**		
Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/year)
Total Suspended Solids	779	1367
Total Phosphorus	9	15
Total Kjeldahl Nitrogen	45	79
Copper	1	2
Lead	0.25	0
Zinc	5	8

Loading to wetland with wet pond treatment installed.

Table 25: Future Conditions: Sub-area C Increased Urban Area *with* Treatment Loading after **annual storms**		
Pollutant	Annual Loading (lbs/year)	Annual Loading (lbs/year)
Total Suspended Solids	98	--
Total Phosphorus	5	--
Total Kjeldahl Nitrogen	32	--
Copper	0.72	--
Lead	0.12	--
Zinc	3	--

Estimated discharge to Stone Lake.

Cedar corporation
Menomonie, Wisconsin

BEST MANAGEMENT RECOMMENDATIONS:

- The Town of Stone Lake and Town of Sand Lake should consider working with their counties to prepare a Master Land Use/Comprehensive Plan.

- Design and construct a wet detention pond or storm water treatment to reduce sediment and excess nutrient discharges from urban sub-area storm water runoff in area adjacent to existing wetland.

- The Town of Stone Lake and Town of Sand Lake should consider preparation of a Lake Management/Master Plan for the entire remaining watershed area including field sampling and monitoring data.

- The Town of Stone Lake and Town of Sand Lake and Counties should prepare and adopt a Comprehensive Storm Water Runoff Management Ordinance.

- Change the winter de-icing chemical from rock salt to a different alternative.

- Implement regular parking lot street sweeping program in urban watershed area.

Cedar corporation
Menomonie, Wisconsin

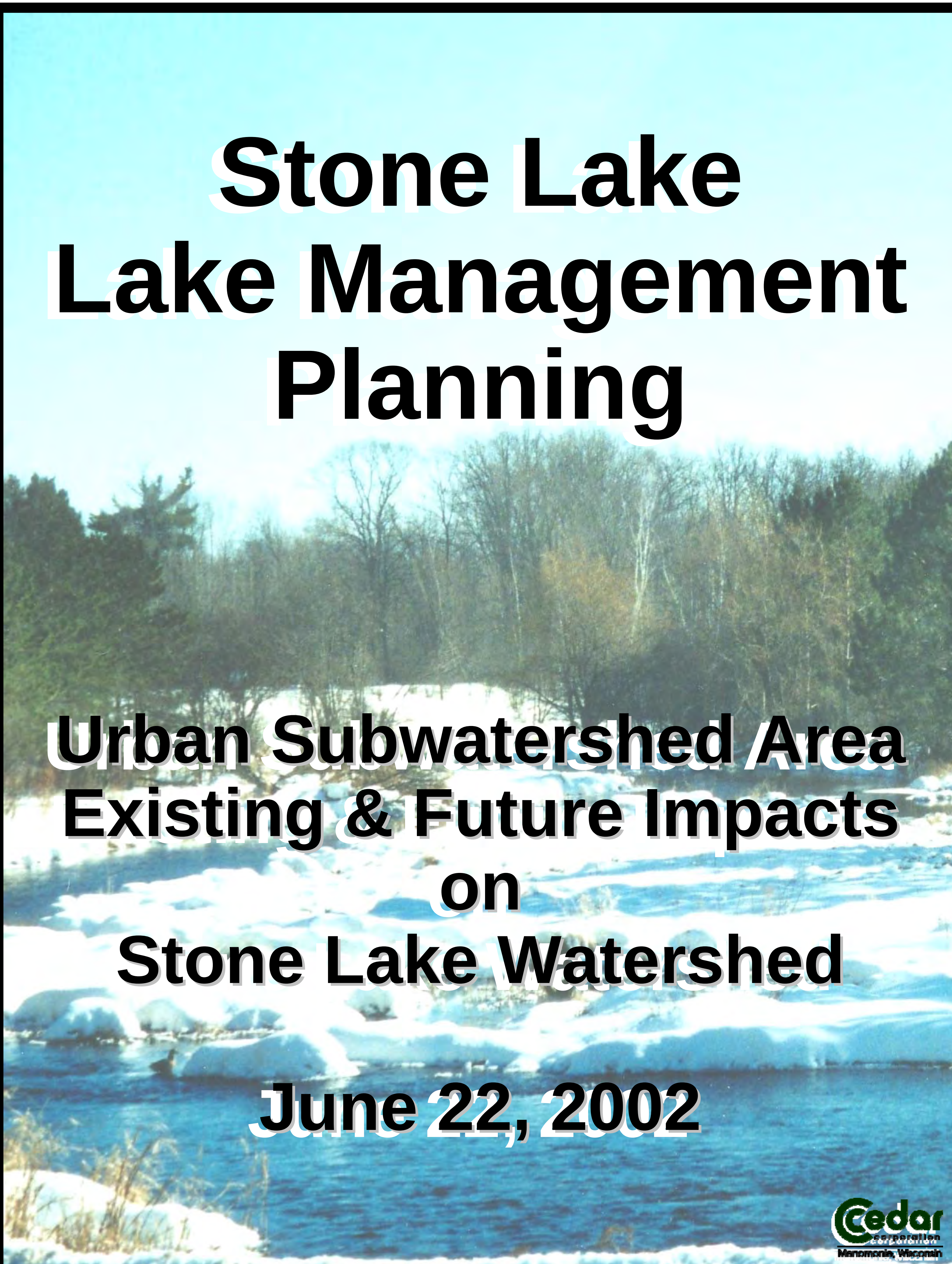
BEST MANAGEMENT RECOMMENDATIONS:

- Incorporate a Storm Drain Stenciling Program.
- Establish shoreland buffer zones with native vegetative plantings.
- Promote grass swale and ditch storm water conveyance systems where practical and feasible.
- Pro-active lawn care practices.
- Establish construction site erosion control ordinance and practices.
- Implement public education and information programs.
- Prohibit waste pumping in storm sewers.
- Promote agricultural land best management practices

Cedar corporation Menomonie, Wisconsin

APPENDIX N

Stone Lake Management Planning
PowerPoint Presentation
For
Annual Meeting:
June 22, 2002



Stone Lake
Lake Management
Planning

Urban Subwatershed Area
Existing & Future Impacts
on
Stone Lake Watershed

June 22, 2002

Cedar
corporation
Menomonie, Wisconsin

PROJECT GOALS:

- Establish a watershed delineation.
  i.e. Create maps showing GIS database and land use for the watershed and sub-areas.

- Evaluate existing and future landuses on the lake and the impacts caused by them.

- Conduct water quality and quantity modeling analysis to determine what impacts the urban subwatershed area will have on Stone Lake.

- Provide educational opportunities to the general public through publication of project goals/results and public information presentation meetings.

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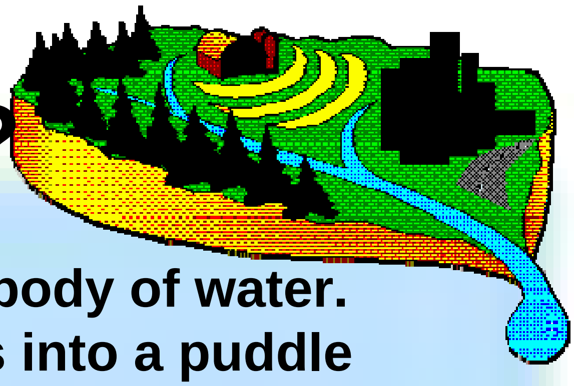
WHAT IS A WATERSHED?



- Land area that drains into a body of water.
  Example: Backyard drains into a puddle

- The edge or boundary of your lake's watershed is defined by the highest points and ridges or land around the lake.

- Rainfall and snowmelt runoff inside the boundary flows to your lakes.

- A lake's watershed may include other water bodies such as streams, rivers, ponds, or wetlands. These water bodies have their own smaller watershed called a subwatershed and smaller areas within the watershed called sub-areas.

OVERALL: The delineated area will enhance your knowledge and understanding of the lake's watershed conditions that affect or potentially affect the lake's ecosystem and water quality.

- *Stone Lake watershed was divided into 3 major sub-areas to look into the issue on how the urban sub-areas directly affects Stone Lake and it's watershed.*

Cedar corporation
Menomonie, Wisconsin

DATA COLLECTION:

Stone Lake

- **523-acres Surface Area**
  (Little Stone Lake 30-acres)
- **40-feet Maximum Depth**
- **Storm water runoff conveyed from Town of Stone Lake, Town of Sand Lake, and surrounding watershed to Stone Lake**
- **Seepage Lake: no outlet or inlet (landlocked)**
- **Water source influenced mainly by: precipitation, runoff, and groundwater**

WATERSHED DELINEATION:

- **Q: What is the purpose of knowing your watershed boundary?**
- **A: You may be contributing increased storm water runoff and pollution to the lakes, the streams, or the groundwater even if you don't live on the lakeshore.**

LAND USE—
Existing & Proposed:

Table 1 (FIG 4): Existing Landuse in Urban Stone Lake Sub-area		
	Acres	%
Urban	15	16
Agriculture	2	2
Forest	65	67
Grassland	13	13
Wetland	2	2
Total:	98	100

Table 4 (FIG 4): Proposed Landuse in Urban Stone Lake Sub-area		
	Acres	%
Urban	30	31
Agriculture	2	2
Forest	51	52
Grassland	13	13
Wetland	2	2
Total:	98	100

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WATER QUANTITY MODELING RESULTS—
Peak Runoff Rates:

Storm Frequency	Peak Run-off Rate (cfs)		
	Existing Landuse Sub-area A 98-acres	Future **without** Treatment Sub-area A 98-acres	Future **with** Treatment Sub-area A 98-acres
24-hour/ 1 in.	6.0	11.8	2.8
2-years/24-hr	16.6	31.6	5.8
10-years/24-hr	55.7	68.8	41.2
25-years/24-hr	78.3	90.4	58.4
100-years/24-hr	135.3	146.2	101.5

Current conditions result in increase runoff rates with increased storm frequency.

With doubling land area in the future, the runoff quantity also doubles in the first flush or 24 hour/1 in. rain events.

Adding a detention pond before the wetland will help reduce runoff rates.

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WATER QUALITY MODELING RESULTS:

Pollutant	Annual Loading Existing Landuse (lbs/year)		
	Sub-area A 98-acres	Sub-area B (Loading to wetland area)	Sub-area C (Loading from sub-area A & B to Stone Lake)
Total Suspended Solids	140	140	5
Total Phosphorus	--	--	--
Total Kjeldahl Nitrogen	2	2	1
Copper	0.05	0.05	0.01
Lead	0.03	0.03	--
Zinc	--	--	--

Pollutant	Annual Loading Future Landuse (lbs/year)		
	Sub-area A (98-acres)	Sub-area B (Loading to 2.4-Ac wetland area)	Sub-area C (Loading from sub-area A & B to Stone Lake)
Total Suspended Solids	6838	6838	322
Total Phosphorus	22	22	7
Total Kjeldahl Nitrogen	97	97	38
Copper	2	2	0.85
Lead	1	1	0.17
Zinc	10	10	4

Pollutant	Annual Loading Future Landuse with Treatment (lbs/year)		
	Sub-area A 98-acres	Sub-area B1 (Loading from 0.57-ac pond to wetland area B)	Sub-area C (Loading from sub-area A, B1, & B to Stone Lake)
Total Suspended Solids	6838	779	98
Total Phosphorus	22	9	5
Total Kjeldahl Nitrogen	97	45	32
Copper	2	1	0.72
Lead	1	0.25	0.12
Zinc	10	5	3

Cedar corporation
Menomonie, Wisconsin

BEST MANAGEMENT RECOMMENDATIONS:

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Menomonie, Wisconsin

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