FLOOD DAMAGE REDUCTION REPORT
WILMES LAKE SUBWATERSHED

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SOUTH WASHINGTON WATERSHED DISTRICT

FINAL - OCTOBER 2003

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SOUTH WASHINGTON
WATERSHED DISTRICT

October 2003

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ACRONYMS AND SHORT FORMS

BMP	Best Management Practices
BRA	Boonestro, Rosene, Anderlik & Associates
DNR	Department of Natural Resources
DSS	Decision Support System
EOR	Emmons & Olivier Resources, Inc.
GIS	Geographic Information System-based
GPS	Geographic Positioning System
LOS	Level of Service
MnDOT	Minnesota Department of Transportation
NGVD	National Geodetic Vertical Datum
SCS	Soil Conservation Service
SWWD	South Washington Watershed District
TKDA	Toltz, King, Duvall, Anderson and Associates, Inc.
TSS	Total Suspended Solids

1.0 INTRODUCTION

The South Washington Watershed District (SWWD) initiated a study of the Wilmes Lake Subwatershed (Figure 1) to quantify the flood risk and identify potential solutions to minimize flood damage potential. The study was initiated following completion of the 2002 minor plan amendment for the SWWD Plan. The technical work associated with preparing the minor plan amendment identified flooding potential in the Wilmes Lake Subwatershed. The purpose of this report is to provide information for use in the SWWD's major plan amendment currently being prepared by the SWWD.

2.0 SUMMARY OF ACTIVITIES

The analysis of the current hydrologic and hydraulic conditions for the Wilmes Lake Subwatershed consisted of the following:

- Creating a Geographic Information System-based (GIS) hydrologic/hydraulic model of the Wilmes Lake Subwatershed using input data such as year 2000 Washington County 2-foot topography/aerial photography National Geodetic Vertical Datum of 1929 (NGVD), detailed structure surveys, information provided by the communities, and grading plans for developments.

- Identifying subwatersheds that have a significant hydrologic/hydraulic impact on Wilmes Lake.

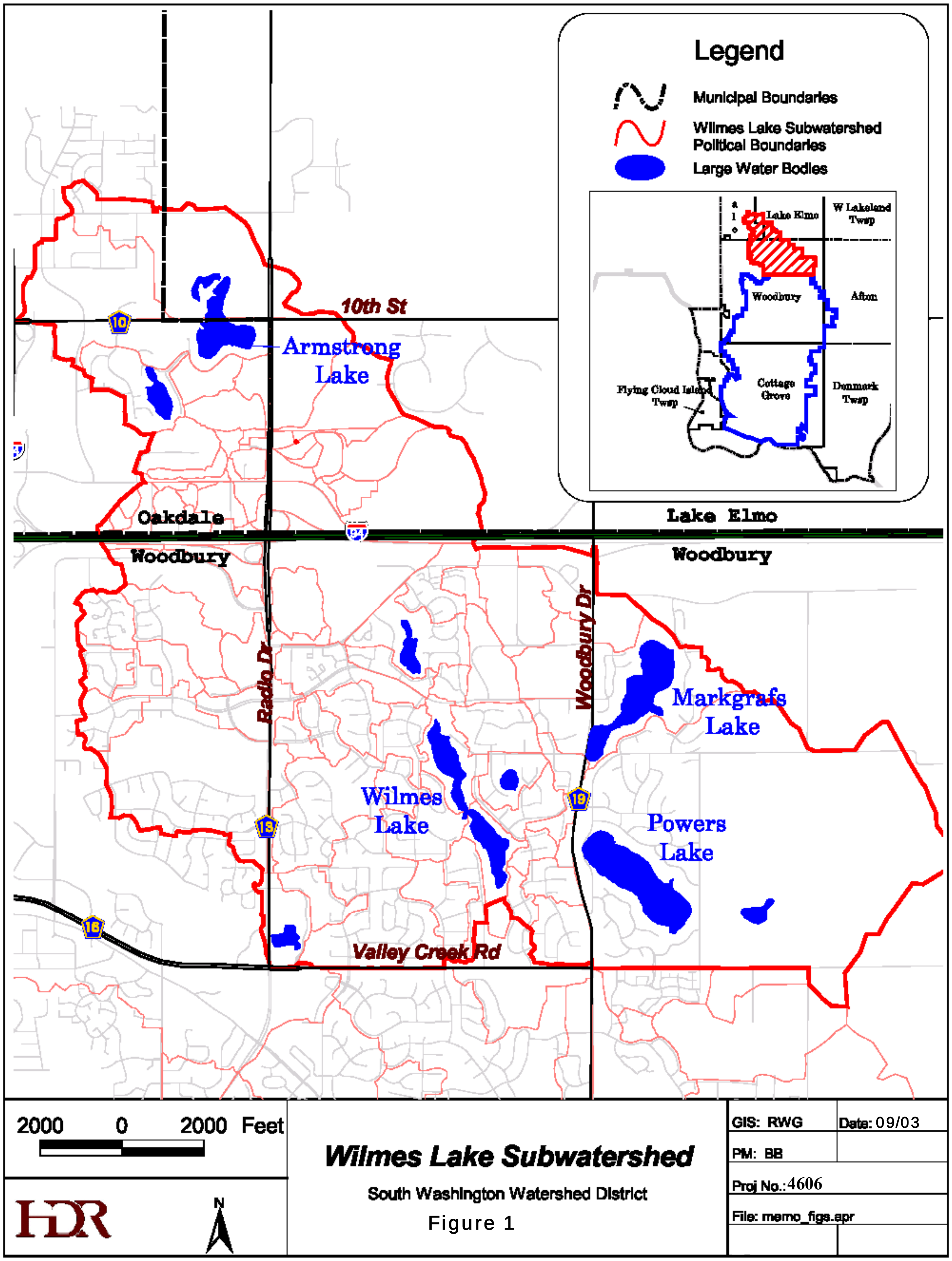
- Identifying locations where flooding poses a hazard to homes and property.

- Development of conceptual flood hazard mitigation solutions for the Wilmes Lake Subwatershed.

- Modeling and evaluation of the conceptual solutions.

- Preparation of report, implementation recommendations and cost estimate.

FIGURE 1 – WILMES LAKE SUBWATERSHED MAP



The base model used for the Wilmes Lake Subwatershed was taken from previous work done by the SWWD for the 2002 Minor Plan Amendment. The base model utilizes year 2000 aerial photographs and topography collected by Washington County and supplemented with site specific elevation and location surveys conducted by the SWWD to acquire additional information in key areas. A complete Arcview database was generated to track the source data and create a metadata file. A complete copy of all source data used in the analysis is available from the SWWD.

The SWWD chose to utilize the hydrologic and hydraulic model XP-SWMM version number 75, dated February 27, 2003, to develop the hydrologic and hydraulic information necessary for the Minor Plan Amendment. The non-linear reservoir method in XP-SWMM was used to estimate the runoff hydrographs from the land surface. These resultant hydrographs were then routed through the drainage system's network of ponds, pipes and channels using the EXTRAN block of XP-SWMM. A complete list of modeling parameters is provided in the "Engineer's Report for the Central Draw Project and Flood Storage Area Maps, June 2002" (June 2002 Engineer's Report).

2.1 GIS/MODEL DATA DEVELOPMENT

Data related to hydraulic structures was collected by HDR between October 2001 and October 2002. Structures were visited to determine structure type, size and condition. In most instances, digital photos were taken for subsequent inclusion in the GIS Database as supporting documentation. Elevation and spatial location data were then obtained from the following sources depending on the structure's hydrologic/hydraulic importance, data availability, and budgetary constraints:

- Folz, Freeman, Dupay, and Associates, February 2002 Total Station/Geographic Positioning System (GPS) Survey
  - Main stem structures
- City of Woodbury Storm Sewer Microsoft Access Database (populated from available city as-builts)
  - Woodbury Drive between Markgrafs and Wilmes Lake
  - Pendryn Hill area
  - Regatta/Clippership area
  - Sunshine/Wynstone area

- Tamarack/Hunters Area
- Interlachen/Hunters Area

➢ Minnesota Department of Transportation (Mn/DOT) Project 8282-37/38 (Interstate 94-392) Plan Sheets
  - I-94 & Radio Drive, Guardian Angels area

➢ Toltz, King, Duvall, Anderson and Associates, Inc. (TKDA) 4th Street Plan Sheet 12403-01
  - 4th Street/Hudson Boulevard in Oakdale/Lake Elmo

➢ 2000 Washington County 2-foot Contour Maps

➢ Emmons & Olivier Resources, Inc. (EOR) South Outlet Analysis (Oakdale) - HydroCad 03/02
  - Locations in Oakdale not covered by TKDA 4th Street Plan Sheet(s)

➢ HR Green Eagle Point Business Park Site Study – Hydrocad 04/02
  - Eagle Point Business Park

➢ Bonestroo Rosene Anderlik and Associates Northern Watershed Model 12/05/01
  - Only those locations where no other information could be retrieved at the time of model development

2.2 MODEL HISTORY

As new information has been obtained, the GIS Database and the base model for the 2002 Minor Plan Amendment have been updated. The following is a list of revisions:

➢ 03/27/2002 – Base model used for the June 2002 Engineer's Report

➢ 11/25/2002 – Model updated to include Eagle Point Business Park development and the City of Oakdale and Lake Elmo 4th Street/Hudson Boulevard improvements

➢ 12/26/2002 – Model updated to reflect additional I-94 & Radio Drive Interchange drainage structure details

- 02/19/2003 – Model updated to add additional drainage structure details:
  - Oak Marsh Golf Club to account for storage not included in previous models
  - Residential areas north of the Tamarack Reserve (added pipe network and storage)
  - Residential areas northwest of Wilmes Lake (added pipe network and storage)
  - Residential areas north of Brookview Drive and Clipper Way (added pipe network and storage)

In all instances the 24-hour, 100-year, 6.3-inch precipitation event was used by HDR as the Design Storm based on the Huff and Angel rainfall data utilized in the June 2002 Engineer's Report.

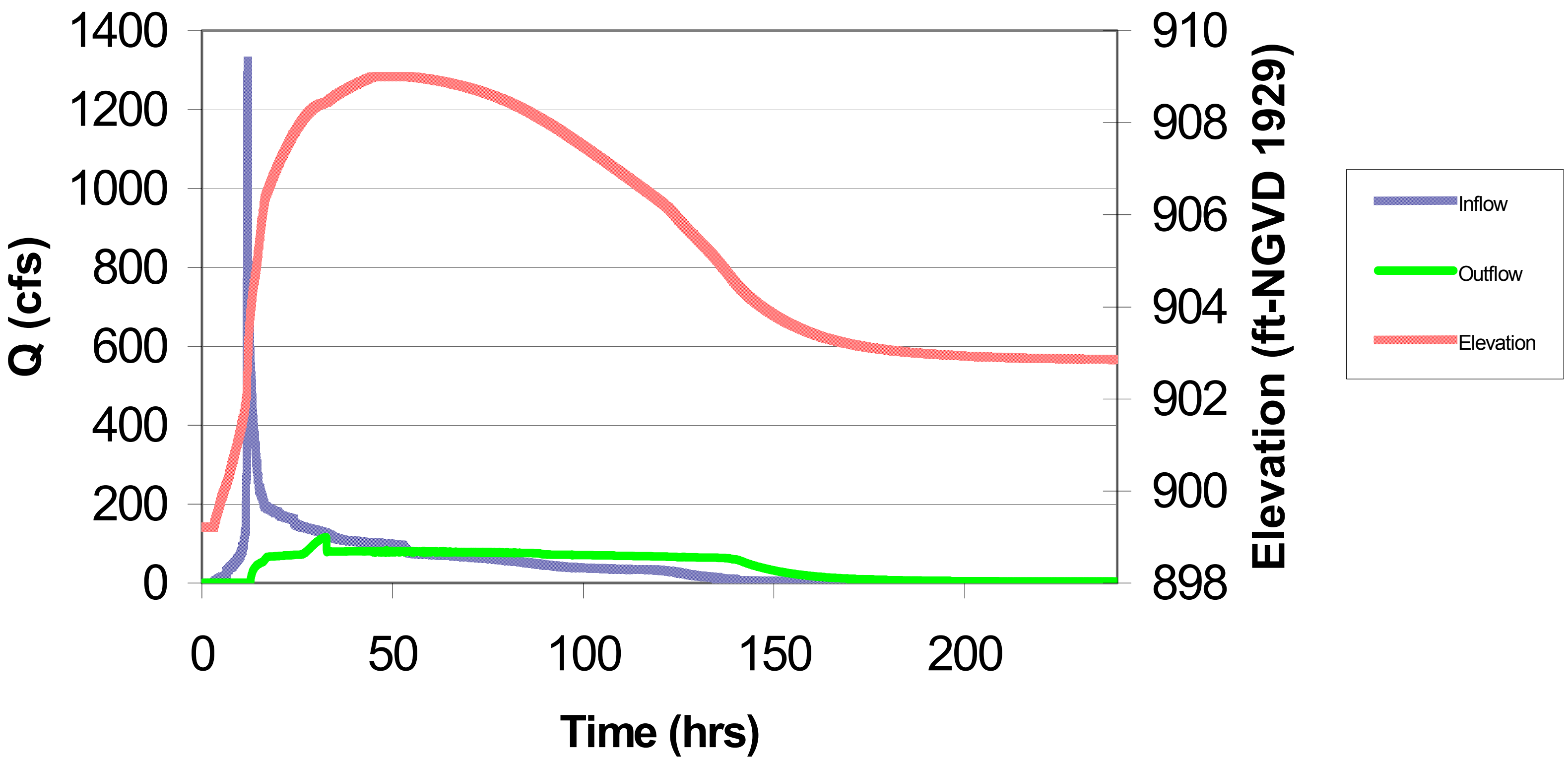
2.3 MODEL ERROR

The overall model continuity error of the base model is 88 acre-feet (ac-ft) net gain of water. This represents one percent of the total inflow to the model. The error occurs due to calculation and convergence errors at landlocked basins or where weir structures are present. For the purposes of this analysis, overall model continuity error is considered reasonable per accepted engineering practices.

3.0 PROJECT OVERVIEW

The Wilmes Lake Flood Damage Reduction study analyzed the rate, volume and timing of stormwater discharges into Wilmes Lake from its tributaries. The Storm Drainage Plan for the City of Woodbury, in a report dated 1979, has established a high water elevation of 906.5 feet NGVD 1929 for Wilmes Lake. The SWWD has not established a specific high water elevation for Wilmes Lake, but has focused on developing projects and management techniques that minimize flood risk due to increased urbanization and the landlocked nature of the watershed. The modeling has shown that for a 6.3-inch, 100-year, 24-hour design storm, using the 2/19/03 base model, Wilmes Lake high water elevations will reach elevation 909 NGVD 1929. According to Certificate of Survey information provided by the City of Woodbury, the low house elevation on Wilmes Lake is 909.3, leaving only 0.3 feet of freeboard. In addition, the high water elevation of Wilmes Lake causes tail water conditions that create flood damage potential in adjacent basins. Figure 2 presents the base model inflow and outflow hydrographs for Wilmes Lake as well as the lake elevation over the same timeframe.

FIGURE 2 – WILMES LAKE SUBWATERSHED HYDROGRAPH
INFLOW, OUTFLOW AND ELEVATION
(6.3-inch, 100-year, 24-hour Event)



4.0 NEED FOR PROJECTS

The base model predicts a flood risk within the City of Woodbury at Wilmes Lake and adjacent ponding locations. The flooding caused by the 6.3-inch, 100-year, 24-hour design event, could threaten approximately 18-25 homes and damage yard areas. The flood risk increases as the size of the design storm increases. As part of the Engineer's Report for the Minor Plan Amendment, HDR evaluated the Wilmes Lake watershed utilizing a 7.8-inch, 100-year, 24-hour event. Utilizing this storm event, the number of homes threatened by flooding increases to between 40 and 48. Given the potential risks of flooding in this watershed, there is a need for enhanced stormwater management practices. Figure 3 and Table 1 summarize the potential impacts.

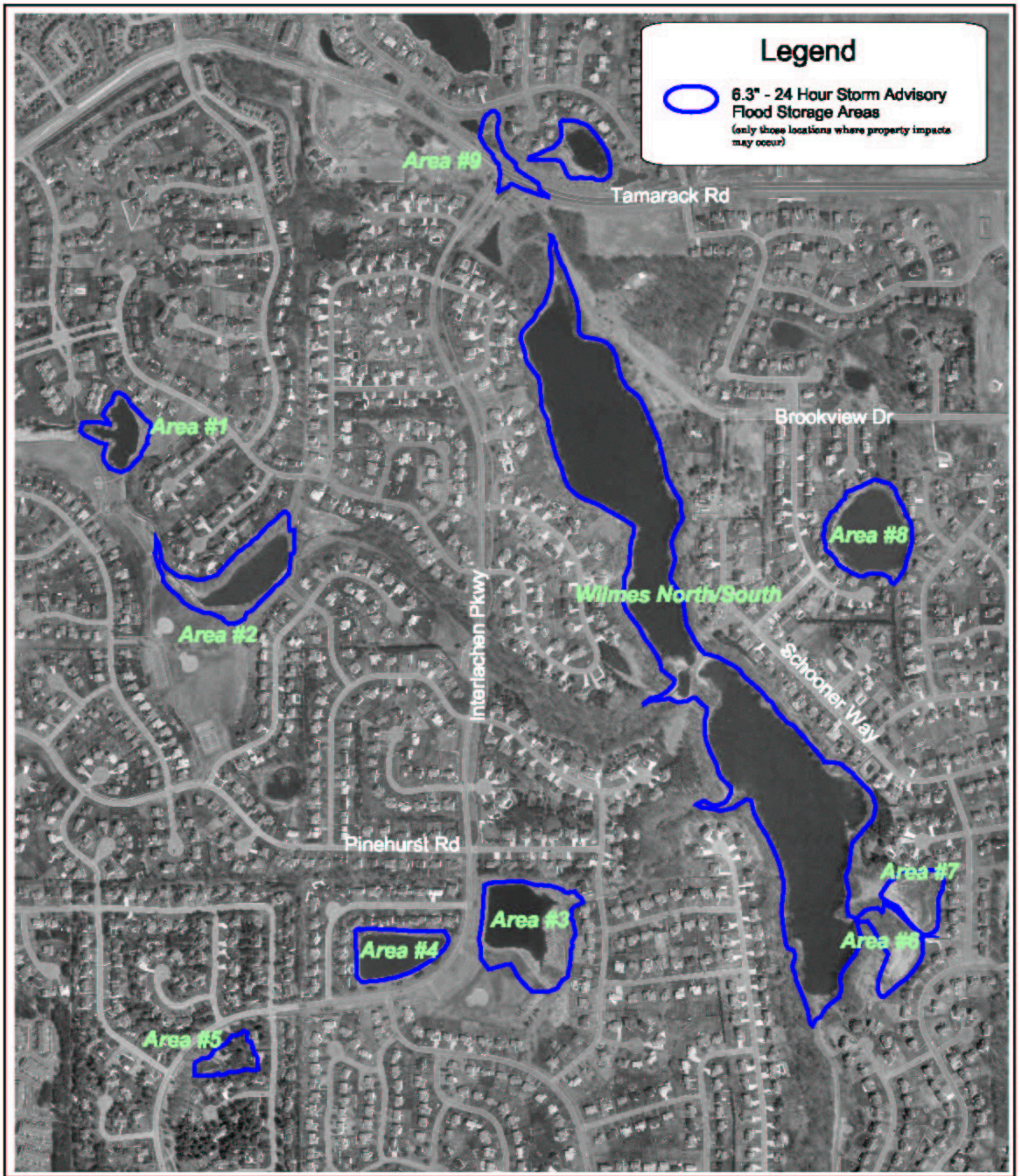
Subsequent modeling of the system using proposed improvements identified in this report provided modest changes in water surface elevations in these potential problem areas. Areas 1 and 2 are part of the Evergreen to Wilmes Lake drainage system. However, high water elevations are related to local stormwater inflows.

Areas 3, 4 and 5 are significantly higher then Wilmes Lake and flood potential is related to local drainage system inflows.

Areas 6, 7 and 9 are related to the Wilmes Lake elevation and will benefit from reductions in Wilmes Lake high water elevations. Of particular importance are Areas 6 and 7 near Wilmes Lake. These areas contain homes that under base model conditions represent the greatest potential to experience flood risk. Area 8 is an isolated ponding area under the influence of its local watershed.

The baseline modeling demonstrated that stormwater runoff hydrographs produced by the various Wilmes Lake Subwatershed reaches Wilmes Lake within the same timeframe. The coincidence of the hydrographs result in a rate of inflow that exceeds the combined capacity of the Wilmes Lake outlet to discharge stormwater and to utilize its storage volume. Therefore, the lake reaches an elevation that creates a risk for flood damages. The constructed detention basins located throughout the subwatershed in general utilized a similar design method and hence released runoff volume to Wilmes Lake over the same timeframe. These basins are effective at reducing the rate of runoff, but alone cannot manage the overall volume and timing of runoff. It is the timing of runoff volume that has the greatest potential adverse impact on Wilmes Lake. The initial analysis indicated a total of 241 ac-ft of runoff volume needs to be stored and the timing of release changed to achieve a meaningful level of flood risk reduction at Wilmes Lake.

FIGURE 3 - POTENTIAL PROBLEM AREA OF 6.3-INCH, 24-HOUR EVENT



300 0 300 600 Feet	**Potential Problem Areas of 6.3-Inch, 24-Hour Event** *South Washington Watershed District* **Figure 3**	GIS: RWG	Date: 04/09/03
HDR N		PM: BB	
		Proj No.: 10550009164	
		File: memo_figs.apr	
		Figure No. 3	

TABLE 1
SUMMARY OF POTENTIAL PROBLEM AREAS FOR 6.3-INCH, 24-HOUR EVENT

Node Name	Node Description	Summary of Potential Hazards
Area #1	Seasons Parkway Area (near Winterberry Dr cul-de-sac)	2 yards
Area #2	Seasons Parkway Area (near Autumn Bay cul-de-sac)	1 yard
Area #3	Summit Pointe Park (East Pond)	6 yards
Area #4	Summit Pointe Park (West Pond)	3 yards
Area #5*	Depression SW of Interlachen Pkwy and Hunters Trail Intersection	1 house, 1 yard
Area #6	Wilmes Lake overflow area NW of Clippership Dr. and Spinaker Dr. Intersection	2 yards
Area #7	Wilmes Lake overflow area SW of Clippership Dr. and Clippership Bay Intersection	6 yards
Area #8	Brookview Meadows Pond	9 yards, 4 houses
Area #9	Pond NE of Tamarack Rd. and Interlachen Parkway Intersection	1 yard, and partial overflow on Tamarack Rd

* Outlet pipe not modeled. Assumed only overflow occurs.

The initial phase of the project identified four structures/locations that offer opportunities to modify the timing of the runoff volume to Wilmes Lake and reduce its high water elevation, the high water duration and resultant tail water effects at adjacent basins. They are the Evergreen Wetland located west of Radio Drive, Armstrong Lake, Markgrafs Lake and Hudson Road (Figure 4). In addition to these structures, modifications are proposed to the design of future detention basins to create extended detention and retention of stormwater throughout the subwatershed. Table 2 summarizes the required storage volumes developed in the initial phase of the project to achieve the goals of reducing flood damage potential under existing conditions. The modifications in development design are intended to provide the required volume management under full development land use.

FIGURE 4 – TIMING/STORAGE LOCATIONS MAP

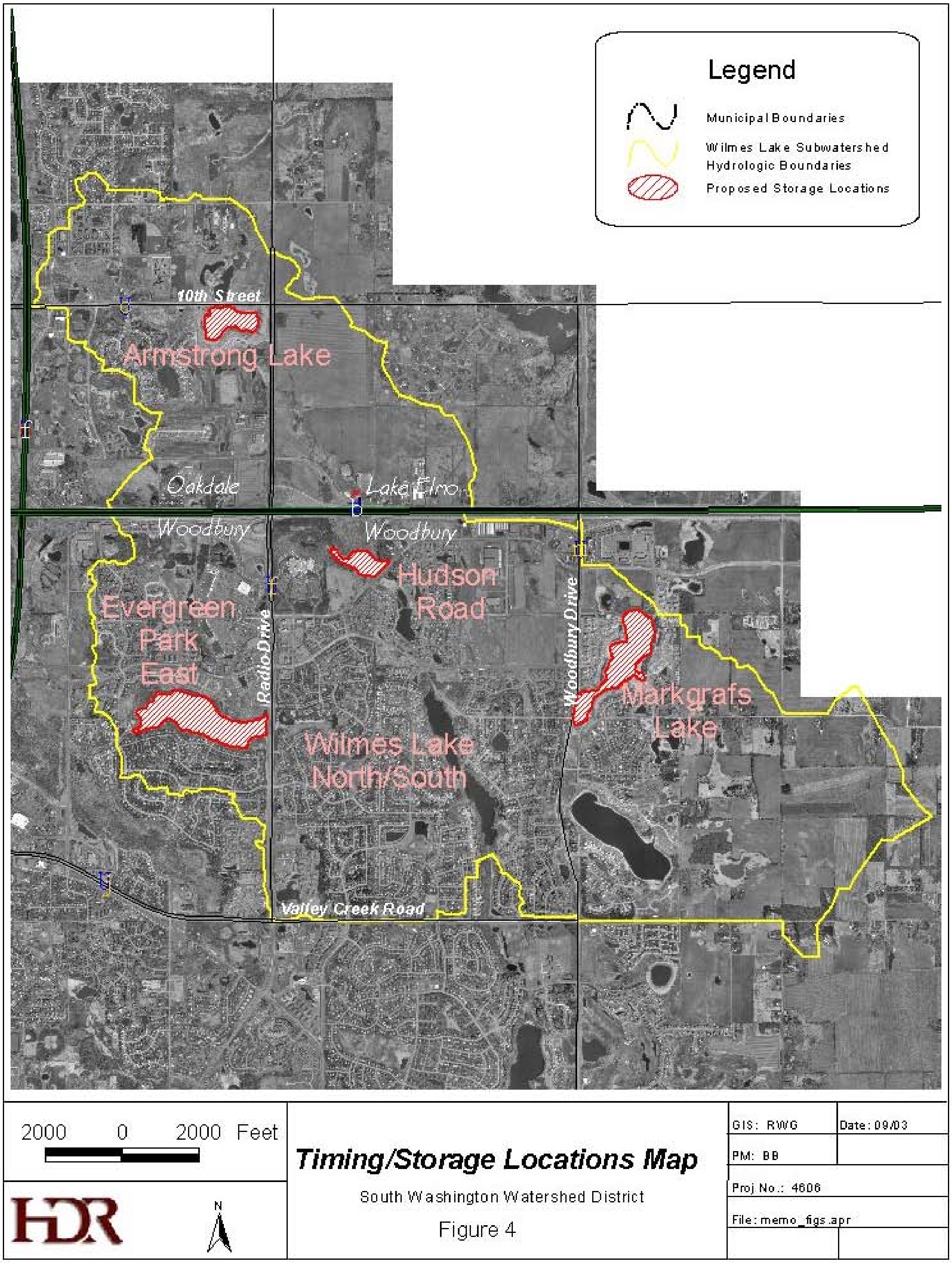


TABLE 2

WILMES LAKE ALLOCATION OF REQUIRED STORAGE

Location	Volume (ac-ft)
Hudson Road Structure	25
Armstrong Lake	42
Markgrafs Lake	65
Evergreen Wetland	69
Development Modifications	36

The study area also involves intra-community flow. The Wilmes Lake Subwatershed includes portions of Oakdale, Lake Elmo and Woodbury. The SWWD has the authority to manage stormwater across community boundaries and to implement the recommendations of the report on a watershed basis. Given the intra-community nature of the drainage system, and the flood risk potential, there is need for the SWWD to fulfill a central coordinating role.

5.0 PROJECT ALTERNATIVES, DESIGN AND MODELING CRITERIA

5.1 GENERAL PROJECT ALTERNATIVES

Numerous flood management alternatives have been considered by the SWWD for the Wilmes Lake Subwatershed. These have included complete storage concepts to various drainage concepts. The Wilmes Lake Subwatershed is approximately 49% developed when the Powers Lake Subwatershed is included. However, the Powers Lake Subwatershed is essentially landlocked and does not significantly influence Wilmes Lake. If the Powers Lake Subwatershed is excluded, the remaining watershed is 59% developed and is continuing to develop rapidly. Therefore, there are limited opportunities for large-scale stormwater storage sites. Previous studies such as the I-94 Ponding Study provided for a large impoundment north of I-94 on land within the City of Lake Elmo. The proposed impoundment location is currently under development and is not available for ponding without substantial costs to the SWWD. The potential project would have involved construction of a moderate to high hazard dam per Department of Natural Resources (DNR) regulations. Given the current land ownership, cost factors, current downstream flood risk and the development situation on the parcel, this option is not recommended.

In addition, the I-94 Ponding Study predicted a high water elevation of 910.2 feet NGVD 1929 for Wilmes Lake for a 5.9-inch, 100-year, 24-hour event. The modeling results in this report, using improved survey data, predicts a flood elevation that is 1.5 feet lower with the larger 24-hour, 100-year, 6.3-inch storm event. The conclusion of this study is that Wilmes is not as flood prone as indicated by the I-94 ponding study.

A factor in selecting a preferred alternative is that stormwater from upstream subwatersheds deliver a total of 890 ac-ft to Wilmes Lake through seven locations. Of these seven, two inflow hydrographs are the result of runoff due to the Armstrong-Eagle Point-Tamarack Village areas and no one inflow location contributes more than 50% of the total runoff volume to Wilmes Lake. Given the coincidence of hydrographs, it is necessary to distribute storage in locations that can accommodate the improvements and provide a meaningful reduction in flood risk.

5.1.1 Lake and Wetland Storage

The initial phase identified three lake and wetland locations for storage of runoff. These include Armstrong Lake in Oakdale, Evergreen Wetland in Woodbury and Markgrafs Lake in Woodbury. Figures 5 to 7 illustrate the existing inflow hydrographs and the outflow and elevation hydrograph modifications developed during the initial phase of the project.

The initial proposal called for installing gated outlets at each of these basins. The gates would remain in an open position and normally would allow the free flow of water from the basins. In the event of a design storm, the gates would be closed within 24 hours after the event to retain the floodwater until after the downstream flood risk had subsided. Evaluation of the modeling results indicates that the gates would have to remain closed for up to 96 hours in order to minimize flood risk to properties. It is anticipated under "normal antecedent conditions" that these basins would return to their normal elevations within 7-10 days after the storm event. In each case, the emergency outlets and spillways would continue to operate in the event of a follow-on storm.

5.1.2 Hudson Road Storage

The Hudson Road storage site lies between I-94 and Hudson Road in Woodbury. The storage site is created by Hudson Road, which forms a blockage across a topographic depression. There are currently two 72-inch reinforced concrete pipes that act as the outlet for this storage site. There are proposals by the City of Woodbury to raise and widen Hudson Road. The initial storage concept is to modify the existing outlet when road work is done, to create an extended detention pond at this location. Figure 8 shows the effect of the modification to the flow hydrograph.

FIGURE 5 – ARMSTRONG LAKE PROPOSED HYDROGRAPH INFLOW, PROPOSED OUTFLOW AND PROPOSED ELEVATION (6.3-inch, 100-year, 24-hour Event)

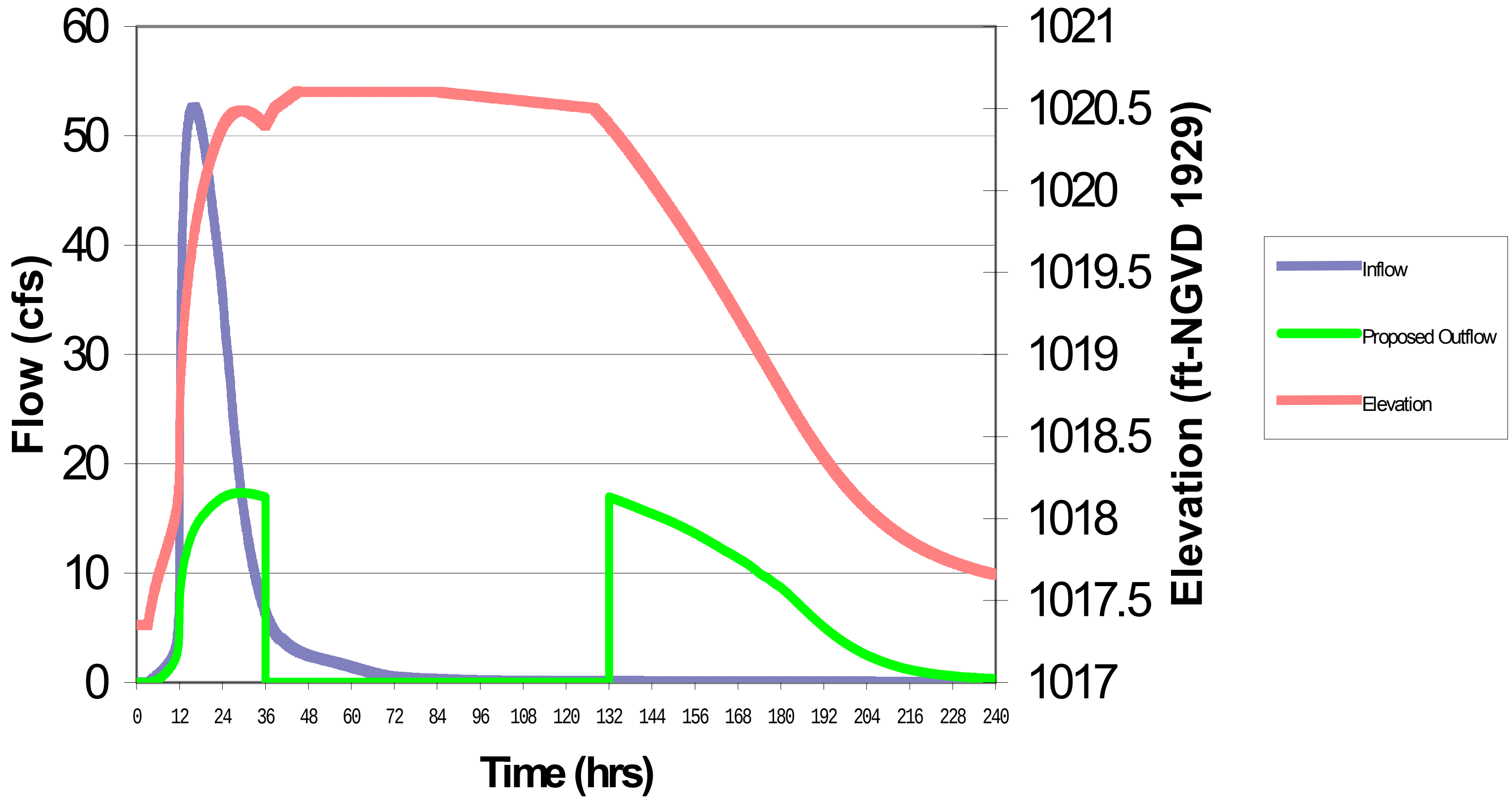


FIGURE 6 – EVERGREEN PROPOSED HYDROGRAPH
INFLOW, PROPOSED OUTFLOW AND PROPOSED ELEVATION
(6.3-inch, 100-year, 24-hour Event)

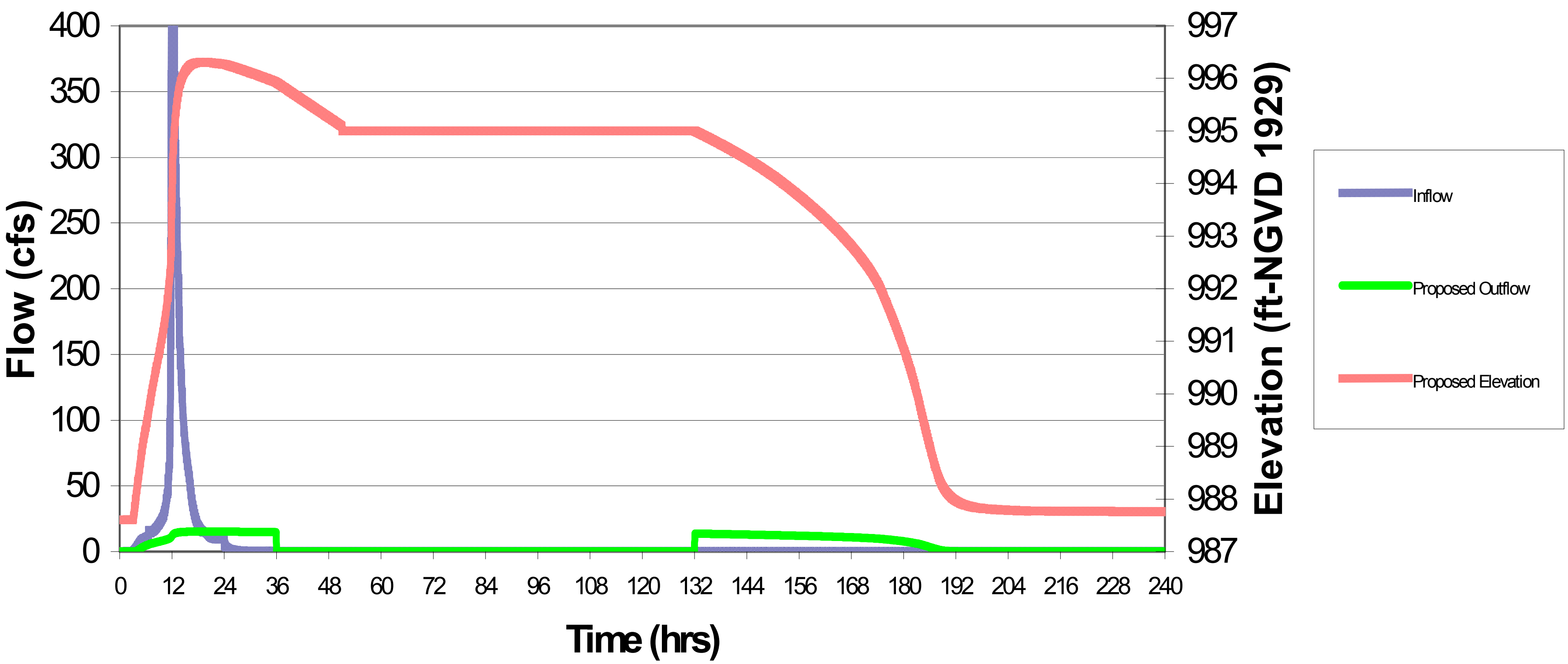


FIGURE 7 – MARGRAFS PROPOSED HYDROGRAPH
INFLOW, PROPOSED OUTFLOW AND PROPOSED ELEVATION
(6.3-inch, 100-year, 24-hour Event)

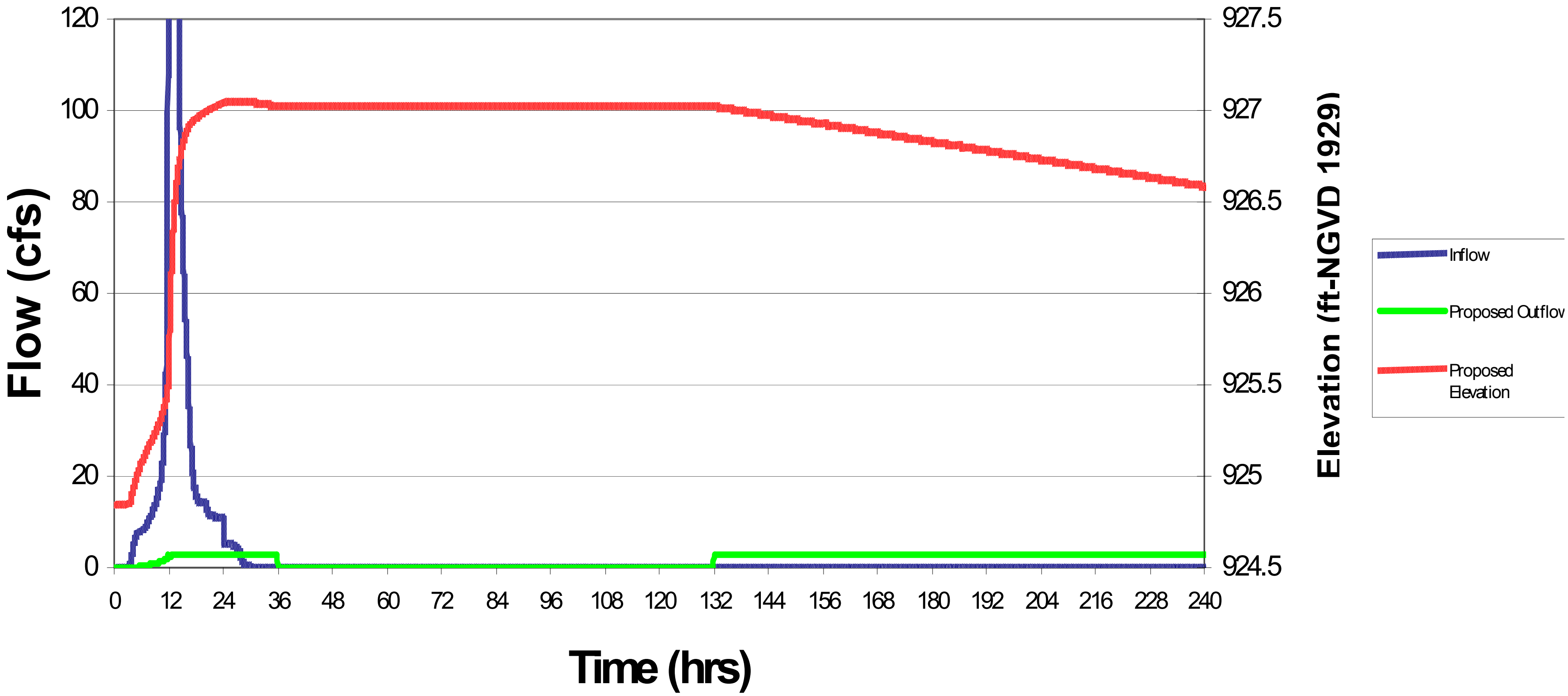
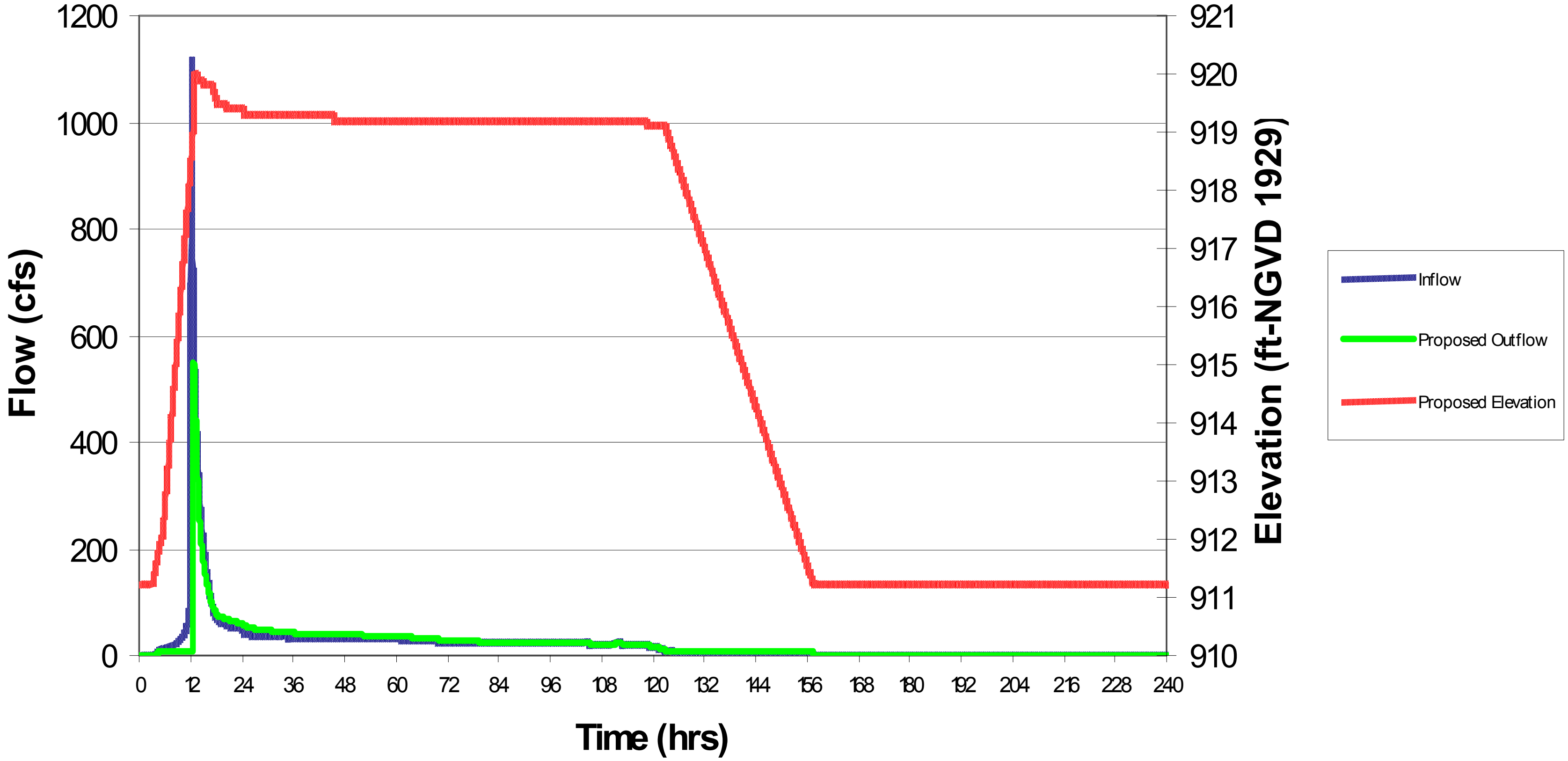


FIGURE 8 – HUDSON ROAD PROPOSED HYDROGRAPH
INFLOW, PROPOSED OUTFLOW AND PROPOSED ELEVATION
(6.3-inch, 100-year, 24-hour Event)



5.1.3 Development Standards and Detention Basin Retrofits

Analysis of the initial modeling results indicates that the current stormwater detention basin design standards are providing adequate control of discharge rate. However, the basins have all utilized the same basic design approach, therefore, they release their stormwater over the same time period. The coincidence of the outflow hydrographs is creating a volume management problem, especially at Wilmes Lake. Modifications in the design of new facilities is required in order to manage the timing of stormwater delivery to Wilmes Lake.

5.2 SWWD/CITY OF WOODBURY MEETING/DRAFT REPORT REVIEW

The initial phase of the project culminated with the preparation of a draft report and subsequent meeting between the City of Woodbury and the SWWD. The outcome of the meeting was identification of the following additional analysis.

1) Evaluation of gate operations. This task included:
    a) Determining frequency of gate operation
    b) Return interval of gate operation
    c) Priority of gate operation

2) Environmental change analysis based upon gate operations
    a) Evaluate SWWD wetland management plan
    b) Field inspect wetland areas
    c) Evaluate impacts resulting from gate operations

3) Hydrograph development
    a) Prepare and present 10-year, 25-year, 50-year, 75-year and 100-year hydrographs for Wilmes Lake in the existing conditions
    b) Present hydrographs for the proposed plan for similar events
    c) Evaluate proposed changes to future development

4) Cost estimate
    a) Provide cost estimate for the recommended improvements

5) Update Decision Support System (DSS) Database

5.2.1 Gate Operations

Gate operations were evaluated by utilizing the base model and running the 10-year, 25-year, 50-year, 75-year and 100-year 24-hour rainfall events to determine the high water elevation on Wilmes Lake. The results are summarized in Table 3. An elevation of 908 was chosen as the trigger elevation to begin gate operations. The modeling indicates that gates operations would need to begin during the 50-year event for the base model. A 50-year event has a 2% change of occurring in any given year.

The priority of gate operation was evaluated by adding different improvements and operational scenarios into the model and determining the resultant improvement in the level of service (i.e. increasing level of protection from 50-year to 75-year), reductions in Wilmes water levels and reduction in the duration of high water. Table 3 also summarizes the results of that analysis.

The results of the analysis indicate that water elevations at Wilmes Lake can be brought below elevation 908 for the 50-year event with the Hudson impoundment alone. Hudson Road also reduces the duration of the high water by 15 hours, from 65 to 50 hours. The addition of a gate at Armstrong provides modest reductions in peak water surface elevations at Wilmes, but reduces the duration of high water by another seven hours. Adding gate operations at Markgrafs and Evergreen reduce high water elevations by another 0.3 feet and flood durations by another six hours. The high water duration is reduced by 43% with all impoundments in place.

TABLE 3

PEAK EVALUATION AND ASSOCIATED STORAGE ABOVE ELEVATION 908 FOR DIFFERENT FLOOD REQUIREMENTS

Locations where treatments are applied	10-Yr 24-Hr	25-Yr 24-Hr	50-Yr 24-Hr		75-Yr 24-Hr			100-Yr 24-Hr		
	4.05-Inch	4.9-Inch	5.6 Inch		5.9-Inch			6.3-Inch		
	Peak Elev. (ft)	Peak Elev. (ft)	Peak Elev. (ft)	Peak Storage (above Elev. 908) (acre-ft)	Peak Elev. (ft)	Peak Storage (above Elev. 908) (acre-ft)	Duration above Elev. 908 (hr)	Peak Elev. (ft)	Peak Storage (above Elev. 908) (acre-ft)	Duration above Elev. 908 (hr)
Existing	905.56	906.63	908.14	5.9	908.45	18.9	39	909.00	42.0	65
Hudson			907.82	-	908.27	11.4	23	908.97	41.0	50
Hudson, Armstrong			907.82	-	908.27	11.4	20	908.95	40.0	43
Hudson, Armstrong, Evergreen			907.71	-	908.20	8.4	17	908.75	31.5	38
Hudson, Armstrong, Evergreen, Markgrafs			907.67	-	908.17	7.1	15	908.68	28.6	37

5.2.2 Environmental Change Analysis

HDR evaluated four wetland and lake basins for wetland quality and potential for alteration associated with utilizing the basins to store storm water during significant runoff events. HDR modeled storm water runoff for existing and proposed conditions for a 100-year, 24-hour rainfall event (1% chance of occurrence per year). The changes in stage and inundation period illustrated are summarized in Table 4. At Evergreen Wetland and Markgrafs Lake there is no change in maximum stage elevation (storm bounce), and at Armstrong Lake the maximum stage elevation increase is only 0.1 foot (ft). There is an increase in stage at Hudson Road of 1.0 ft for approximately 12 hours. Depending upon the basin, the inundation period for the basins increases under the proposed conditions from 2.9 to 4.4 days.

TABLE 4

WETLAND IMPACTS DUE TO PROPOSED PROJECT

Wetland Name	Evergreen Wetland	Hudson Road Wetland	Armstrong Lake	Markgrafs Lake
Increase in Maximum Stage Elevation	0 ft	1.0 ft	0.1 ft	0 ft
Duration of Increase in Maximum Stage	N/A	0.5 day	3.8 days	N/A
Change in Maximum Inundation Period	2.9 days	4.4 days	3.8 days	4.0 days

The four sites were previously evaluated for wetland functions by Boonestro, Rosene, Anderlik & Associates (BRA). This information was incorporated into a GIS database for the SWWD Comprehensive Wetland Management Plan by Emmons and Olivier Resources. The plan is a draft at this time and will eventually provide an inventory, functional assessment and management classification of all known wetlands in the watershed district, and will present management standards for those wetlands.

The four wetlands, their functional assessment and proposed management classification are presented in Table 5.

TABLE 5

WETLAND SUMMARY

Wetland Name	Evergreen Wetland	Hudson Road Wetland 1	Hudson Road Wetland 2*	Armstrong Lake	Markgrafs Lake
HDR Wetland ID	WL2W7-1	WLS-1		AL1-1	ML1-1
EOR Wetland ID	WL-3-15	WL-2-13	WL-4-3	AL-1-7	ML-1-4
DNR Public Water Inventory ID	435W	PWI stream	PWI stream	116W	89W
Wetland Area (Acres)	56.03	1.14	12.04	13.99	45.60
NWI Wetland Classification	PEM/SS1Bg	PEMB	PEMBd	L1UBH and PEMF	LIUBH and PEMC
Observed Wetland Type	Type 2 and 6	Type 2 and 1	Type 2 and 6	Lake	Lake
Proposed Management Classification	Protect	Manage 3	Manage 3	Manage 2	Lake
Wetland Water Quantity Function	Medium	Low	Medium/Low	Medium/Low	Low
Wildlife Function	Exceptional	Medium	Medium	High	Low
Storm Water Susceptibility Function	Medium	Low	Low	Low	Low
Storm Water Storage Function	Low/Medium	Excellent	High	Low	Low
Floral Diversity Function	Medium	Low	Medium/Low	Medium/Low	Low

* Only 1.04 acres of Hudson Road Wetland 2 are within the area of interest located north of Hudson Road.

The wetland sites were inspected on August 8, 2003 by HDR to review the functional assessment information and site characteristics. Photographs of inspected sites are included in Appendix A – Wetland Field Review Site Photographs.

Evergreen Wetland

The floral diversity and interspersion at Evergreen Wetland is the best of the inspected sites. The floral diversity and large green space (56-acre wetland) make this an area of high wildlife quality. Information is not available on potential rare species, colonial nesting areas, etc., that would elevate this wetland to an exceptional functional ranking for wildlife. Potential changes to wetland inundation due to stormwater retention are approximately an extra three days of inundation for a 100-year event. Based on MPCA Storm-Water and Wetlands guidelines, Evergreen Wetland would be considered a moderately susceptible wetland type and it potentially would tolerate an additional seven days of inundation for a 10-year precipitation event. The draft SWWD Comprehensive Management Plan identifies that Evergreen Wetland should receive protect status for management and that it has medium stormwater susceptibility. The primary concern with stormwater additions to the basin are that this will result in a reduction in floral diversity and hence reduce wildlife benefit. However, the management recommendations of the Comprehensive Management Plan are perhaps greater protection than are necessary when considering the MPCA recommendations. Therefore, HDR recommends that Evergreen Wetland may be used for stormwater storage, but only infrequently and after the other three basins have been fully utilized for storage.

Hudson Road Wetland

Hudson Road Wetland currently has high stormwater storage function and a low stormwater susceptibility function. The observed vegetation included reed canary grass, black willow, sandbar willow, cottonwood and silver maple. A large wetland buffer is present to the east, west and north of the wetland because the areas have not been developed to date. Based on MPCA Storm-Water and Wetlands guidelines, Hudson Road Wetland would be considered a slightly susceptible wetland type and it potentially would tolerate an additional 14 days of inundation for a 10-year precipitation event and an additional 1.0 ft of storm bounce. Based on the MPCA guidelines, the modeled hydrograph and observed site conditions, Hudson Road Wetland is suitable to be utilized for stormwater storage.

Armstrong Lake

Armstrong Lake is primarily a deepwater habitat and is not wetland. It is fringed by cattail along the southwest edge. Armstrong Lake is attached to a wetland basin that extends to the west and is dominated by cattail and reed canary grass. There is also a connection to a northern portion of Armstrong Lake through a culvert under 10th Street North (a four-lane divided road). The lake is bordered by residential housing to the south and west and by 10th Street North on the north side of the basin. Armstrong Lake and adjacent wetland areas are identified as having a low stormwater susceptibility function. Based on MPCA Storm-Water and Wetlands guidelines, Armstrong Lake and adjacent wetlands would be considered a slightly susceptible wetland type and it potentially would tolerate an additional 14 days of inundation for a 10-year precipitation event and an additional 1.0 ft of storm bounce. Based on the MPCA guidelines, the modeled hydrograph and observed site conditions, Armstrong Lake and adjacent wetlands are suitable to be utilized for stormwater storage.

Markgrafs Lake

Markgrafs Lake is primarily a deepwater habitat and is not wetland. It is fringed by cattail in isolated areas along the edge. Lake water quality appears poor with high levels of algae and milfoil. The site is rated as having low functional values on floral diversity, wildlife, stormwater susceptibility and stormwater storage. The lake is bordered by residential housing. Based on MPCA Storm-Water and Wetlands guidelines, Markgrafs Lake would be considered a slightly susceptible wetland type and it potentially would tolerate an additional 14 days of inundation for a 10-year precipitation event and an additional 1.0 ft of storm bounce. Based on the MPCA guidelines, the modeled hydrograph and observed site conditions, Markgrafs Lake and adjacent wetlands are suitable to be utilized for stormwater storage.

Conclusions

HDR has inspected Evergreen Wetland, Hudson Road Wetland, Armstrong Lake and Markgrafs Lake for wetland quality and potential for alteration associated with utilizing the basins to store stormwater during significant runoff events to minimize flooding on Wilmes Lake. In general, the 100-year storm event would increase the inundation period for the basins by 2.9 to 4.4 days. The 100-year event would have no, or minor, change to the storm bounce within the basins. Hudson Road Wetland, Armstrong Lake and Markgrafs Lake are slightly susceptible wetland type and would tolerate the potential change in hydroperiod without altering wetland function. Evergreen Wetland is a moderately susceptible wetland type that has been given a higher level of protection in the local plan. Therefore, Evergreen Wetland may be used for stormwater storage, but only infrequently and only after the other three basins have been fully utilized for storage.

5.2.3 Hydrograph Development and Changes in Development Standards

The base model hydrographs for the 10-year, 25-year, 50-year, 75-year and 100-year events are presented in Figure 9. Figures 10 to 12 also contain the proposed plan hydrographs for comparison purposes. The hydrographs illustrate that the proposed plan has a significant effect on the shape of the hydrograph, especially in reducing the duration of flood risk and improving the overall level of service in the system. The improvements increase the level of service (LOS) from a 25-year/50-year event to a 75-year event. Figure 13 and Figure 14 contain elevation/frequency and elevation/duration graphs for Wilmes Lake respectively. These graphs illustrate the improvements in level of service and the reduction in high water duration in Wilmes Lake as the result of the proposed improvements.

The hydrographs also demonstrate the impact of the immediately adjacent and mostly undeveloped watersheds upstream of Hudson Road and downstream of Armstrong Lake. Under the base model condition, this watershed area is largely unimpeded by stormwater ponds and directly contributes to the rapid rise in water surface elevation of Wilmes Lake.

The effect of this immediately contributing watershed was tested by eliminating the Armstrong Lake, Markgrafs Lake and Evergreen Wetland watersheds from the base model and running the 100-year 24-hour rainfall event. The results of the modeling indicate a high water elevation on Wilmes Lake of 908.4 feet. This points to the need to carefully manage the development of this critical portion of the watershed.

The SWWD has been actively promoting sustainable best management practices (BMP) for development projects within the watershed. Many of these practices have focused on the use of various infiltration methods to take advantage of the watershed's natural ability to infiltrate stormwater. To promote these practices, the SWWD has prepared a BMP brochure and conducted an ongoing infiltration management study. An unresolved question is whether these Best Management Practices can assist in a meaningful manner in flood damage reduction projects.

Table 6 provides a watershed runoff summary for the 6.3-inch, 100-year, 24-hour design storm for "typical" one-acre parcels in the Wilmes Subwatershed based on percent imperviousness. Table 6 illustrates the impact land use changes have on percent impervious and overall runoff volume for a design event. Therefore, from the standpoint of a design flood, limiting impervious surface values is one method the District can utilize to achieve its flood damage reduction goals.

FIGURE 9
STAGE HYDROGRAPHS FOR LAKE WILMES
FOR THE 100-YEAR EVENT

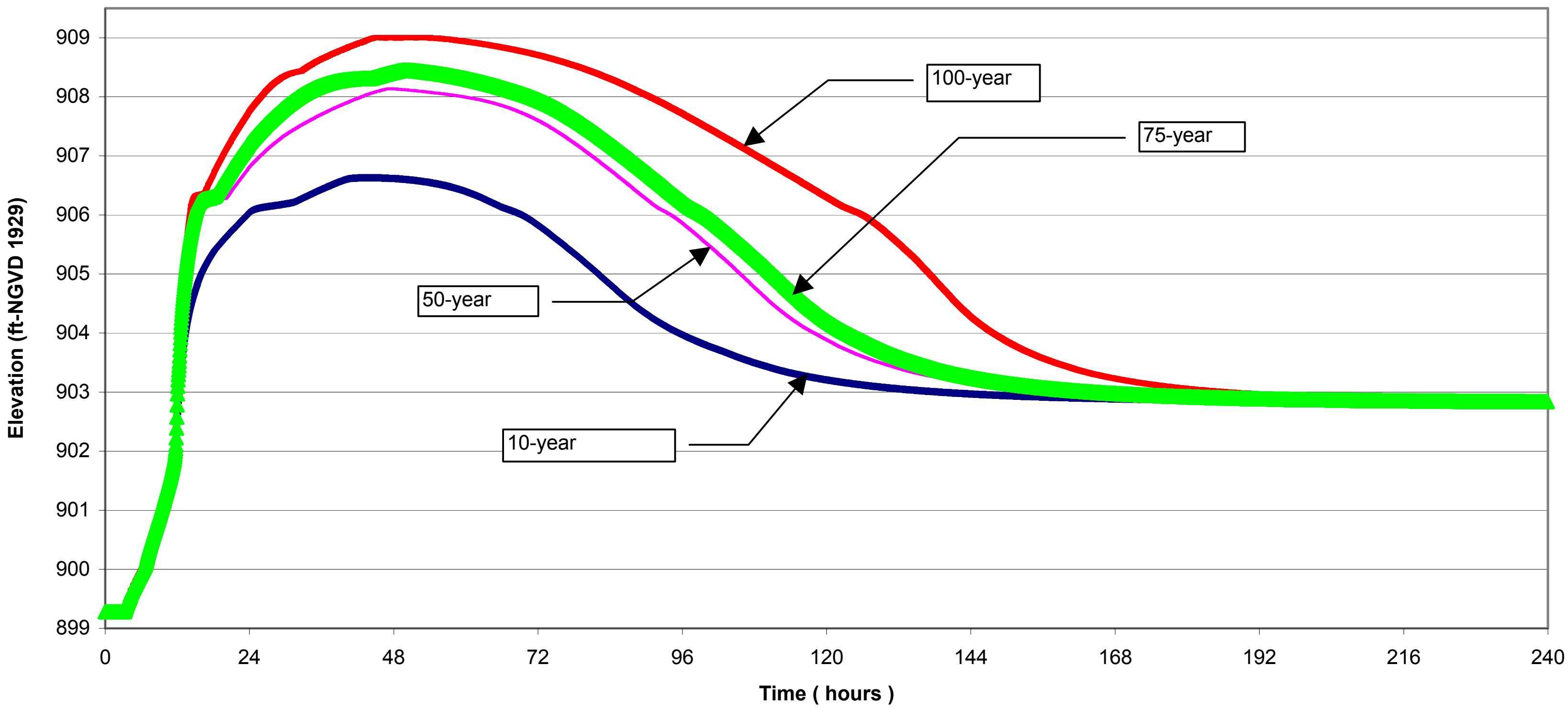


FIGURE 10
LAKE WILMES STAGE HYDROGRAPH COMPARISON
FOR THE 50-YEAR EVENT

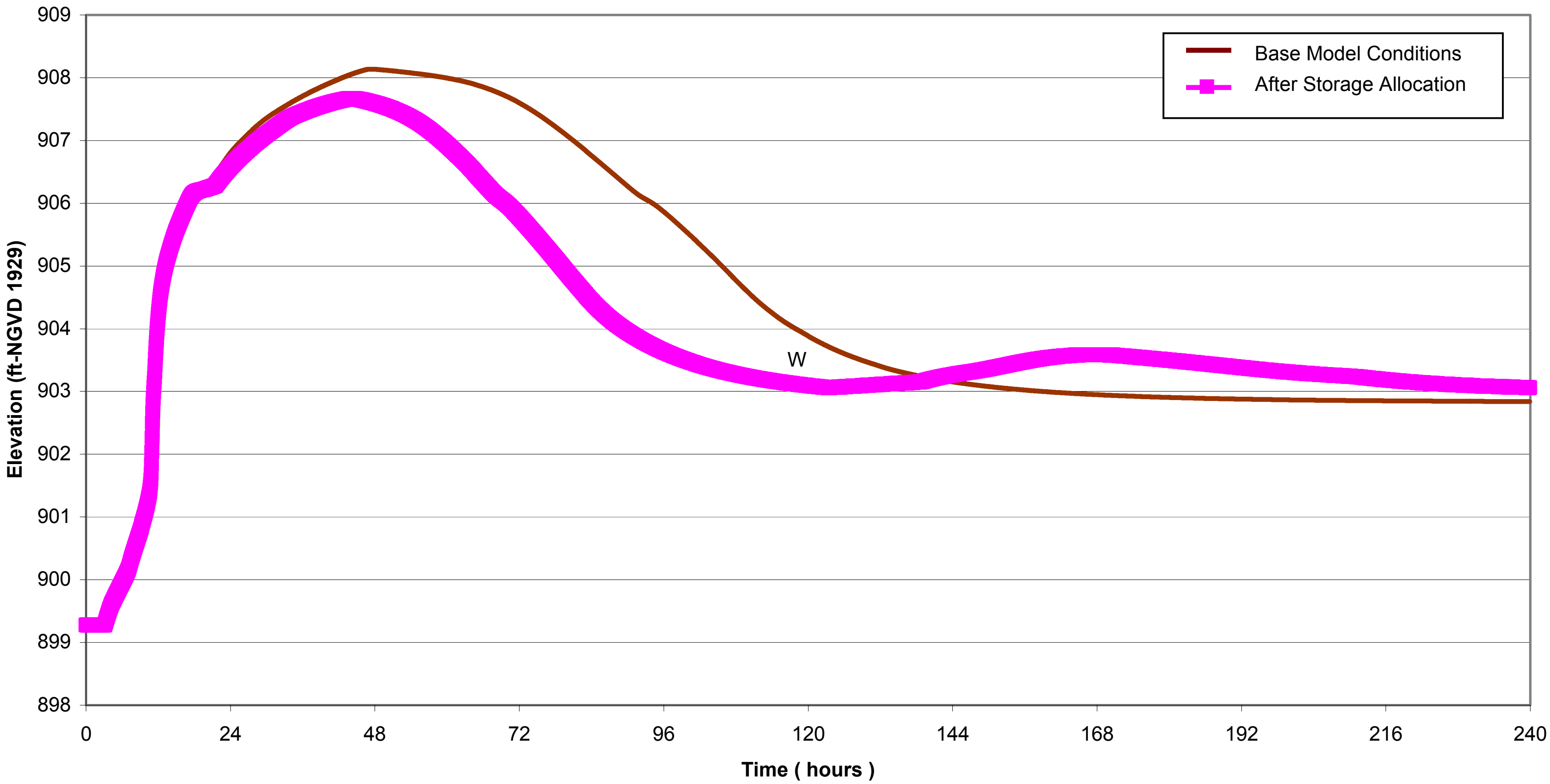


FIGURE 11
LAKE WILMES STAGE HYDROGRAPH COMPARISON
FOR THE 75-YEAR EVENT

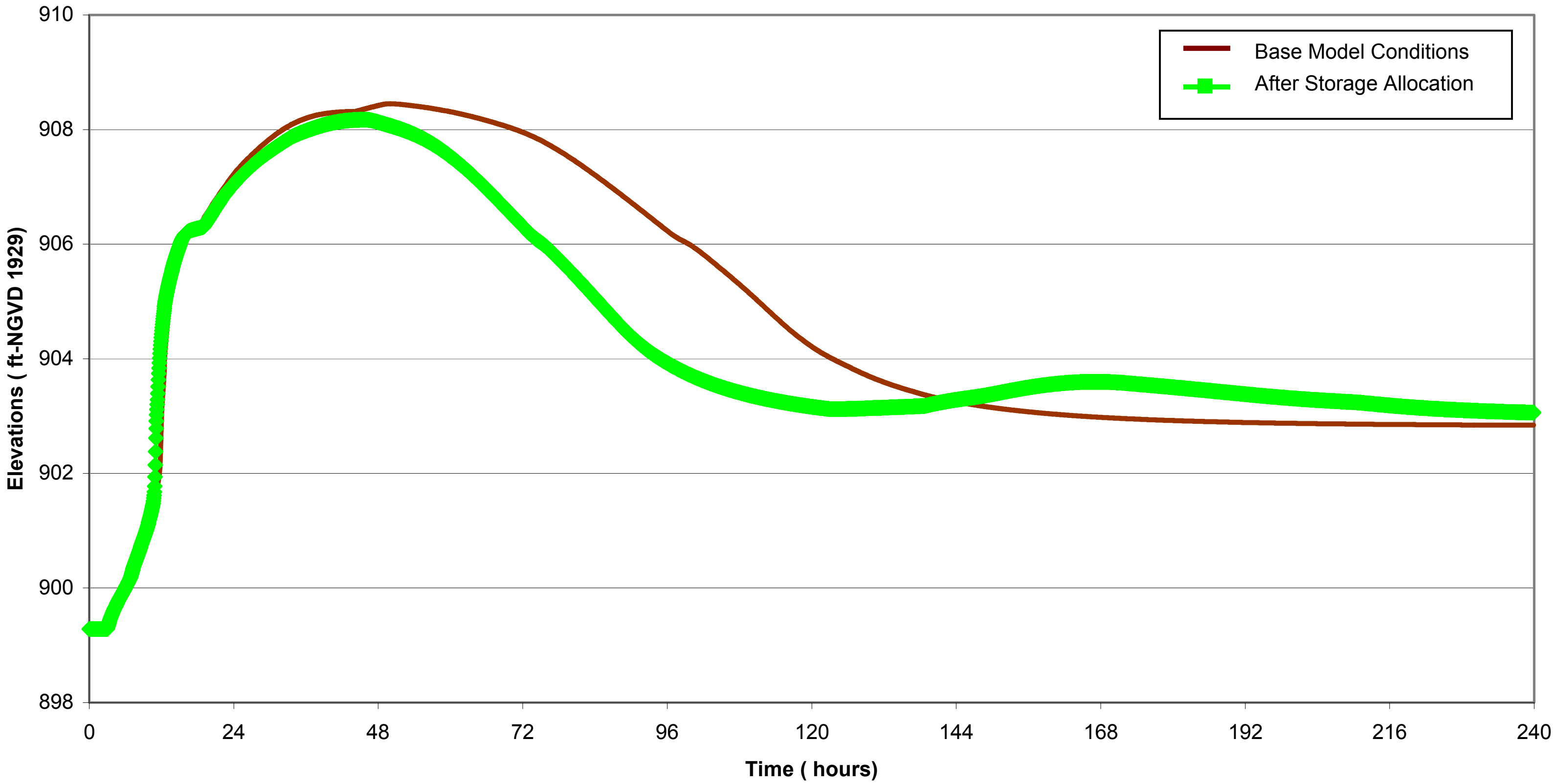


FIGURE 12
LAKE WILMES STAGE HYDROGRAPH COMPARISON
FOR THE 100-YEAR EVENT

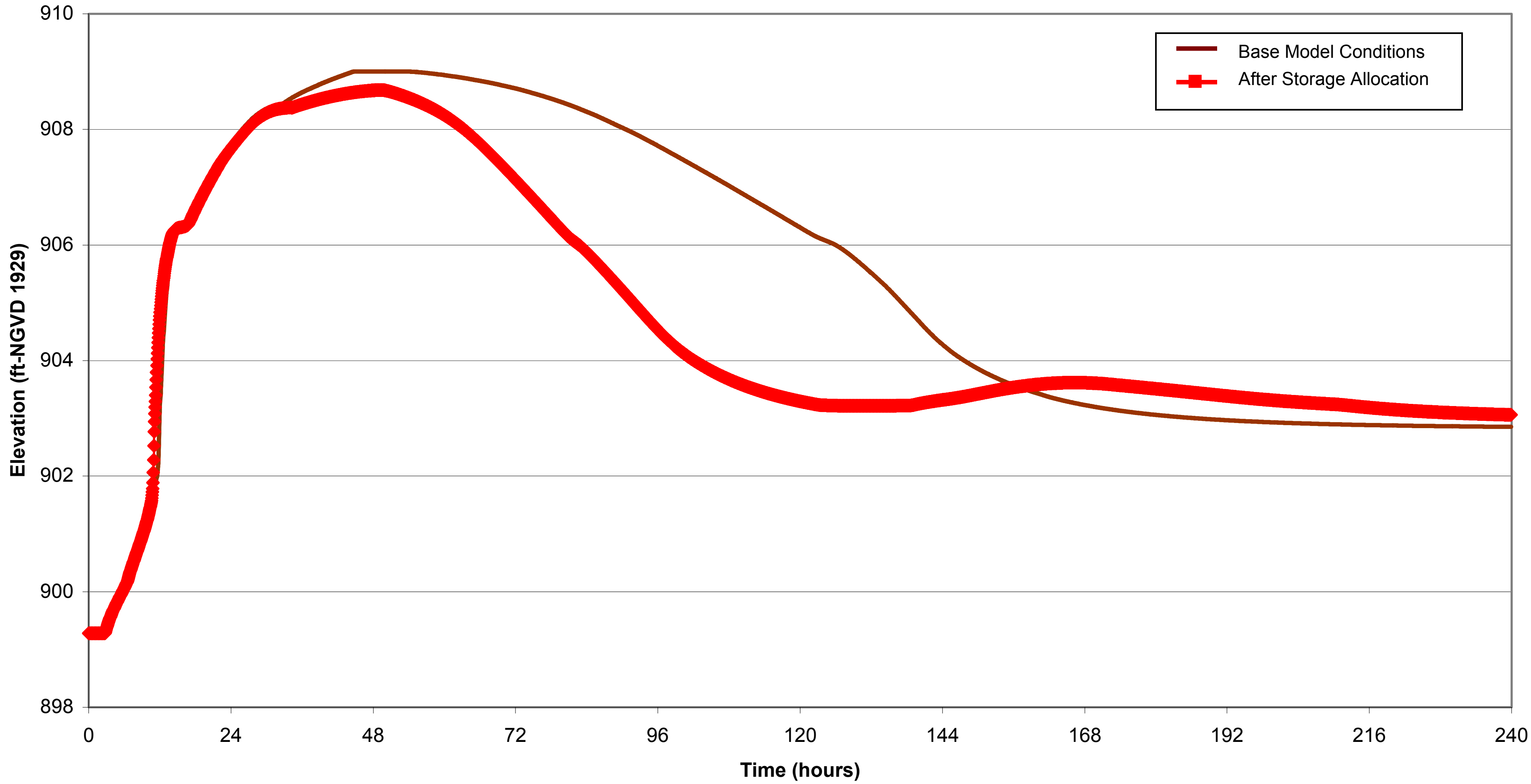


FIGURE 13
STAGE/FREQUENCY CHART FOR LAKE WILMES

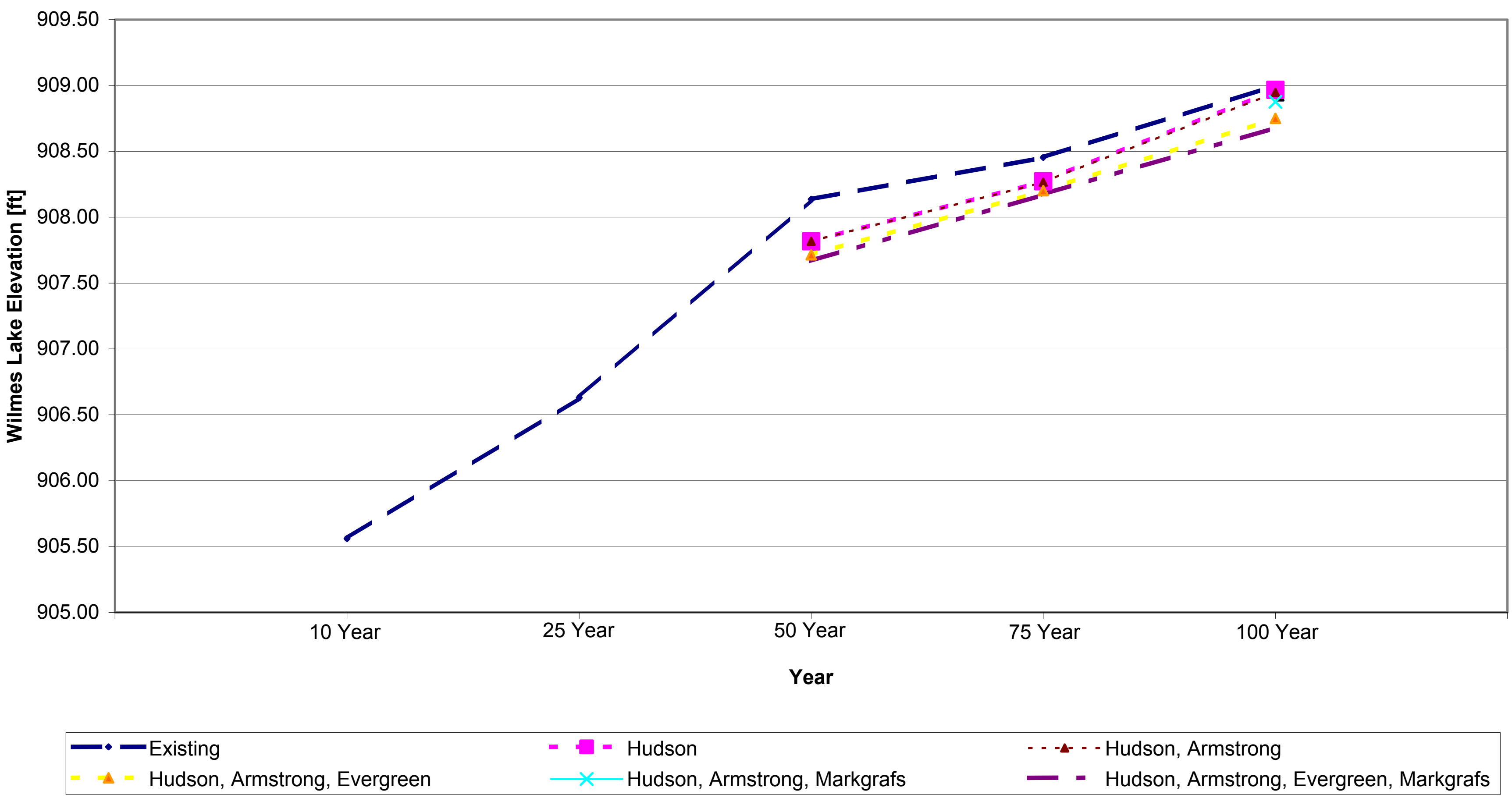


FIGURE 14
ELEVATION-DURATION CURVE AT LAKE WILMES
FOR THE 100-YEAR EVENT

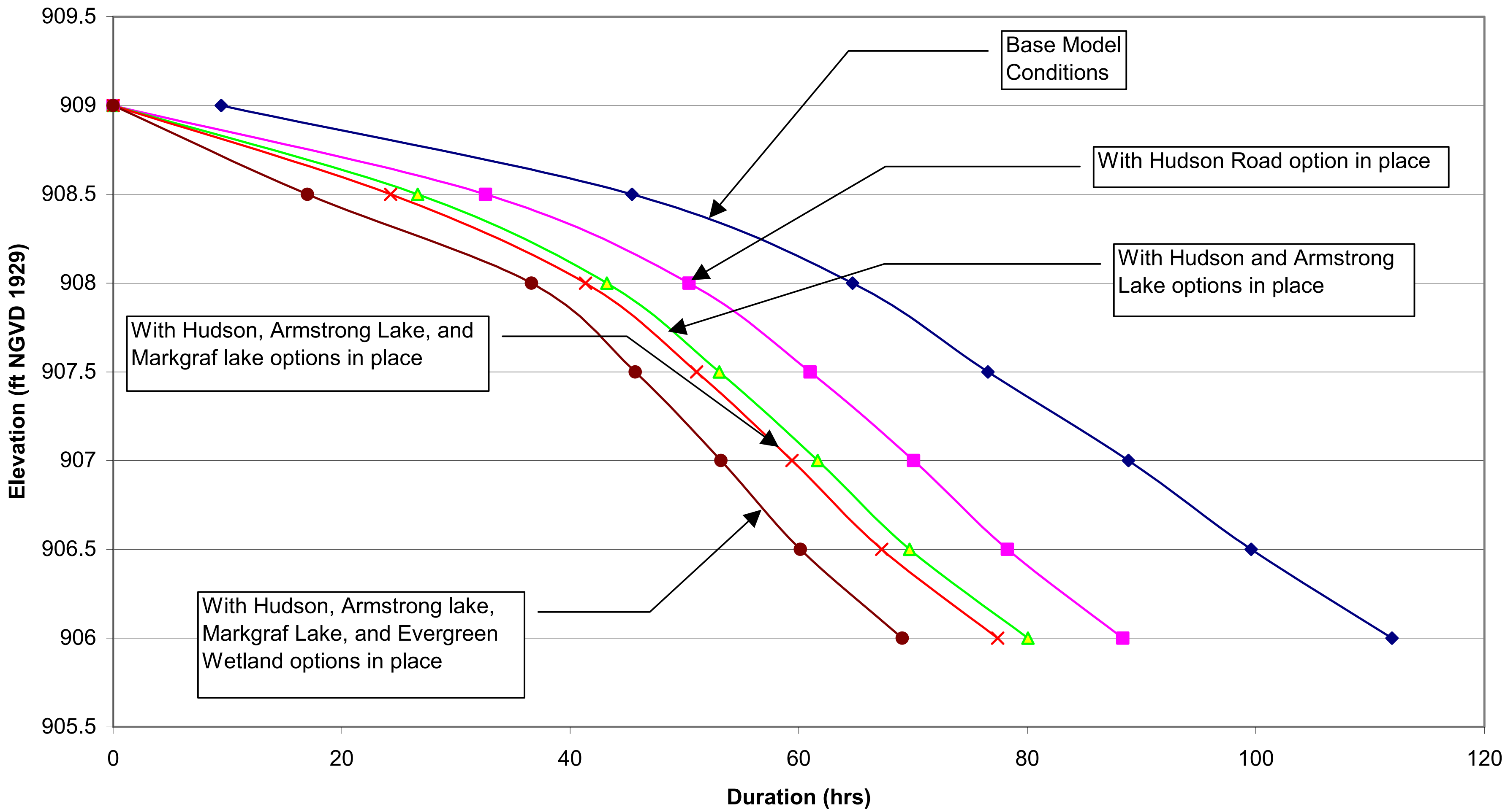


TABLE 6

COMPARISON OF RUNOFF FROM DIFFERENT LAND USES FOR A UNIT WATERSHED

Land Use	Percent Impervious	Rainfall	Depressional Storage	Evaporation	Infiltration over Storm	Net runoff ac-ft/ac
		Inches				
Single family residential	35	6.3	0.07	0.18	2.4	.30
Commercial	65	6.3	0.14	0.18	1.3	.39
Vacant / Agriculture	7	6.3	0.01	0.18	3.5	.22

Another way BMPs can assist in flood damage reduction for the Wilmes Lake Subwatershed is by reducing the need for wet detention basins for water quality treatment. The typical design in this subwatershed calls for a wet detention volume of 2.5 inches of runoff from the entire development site, plus the additional volume required for flood control. Figure 15 illustrates the ponding volume requirements if water quality treatment is achieved purely through ponding. The ponding area must accommodate sufficient volume and space for both water quality treatment and flood control. Figure 16 illustrates what happens if other BMPs are employed for water quality treatment. The ponding volume normally reserved for water quality treatment is allocated to flood control and hence lowers the overall ponding and space requirements on the site. The assumptions used to derive these figures are provided in Table 5.

The outlet structures for these basins will also have to be modified. Figure 17 illustrates how the new outlet structure could be designed to avoid/minimize maintenance issues. Based upon typical developments, outflow rates will be on the order of 0.1 to 0.5 cfs. This outlet design will also provide substantial water quality benefits. The low outflow rates create extended detention facilities that are very effective at removal of suspended solids and create additional infiltration opportunities.

FIGURE 15
REQUIRED STORAGE
WILMES LAKE STANDARD WQ REQUIREMENTS

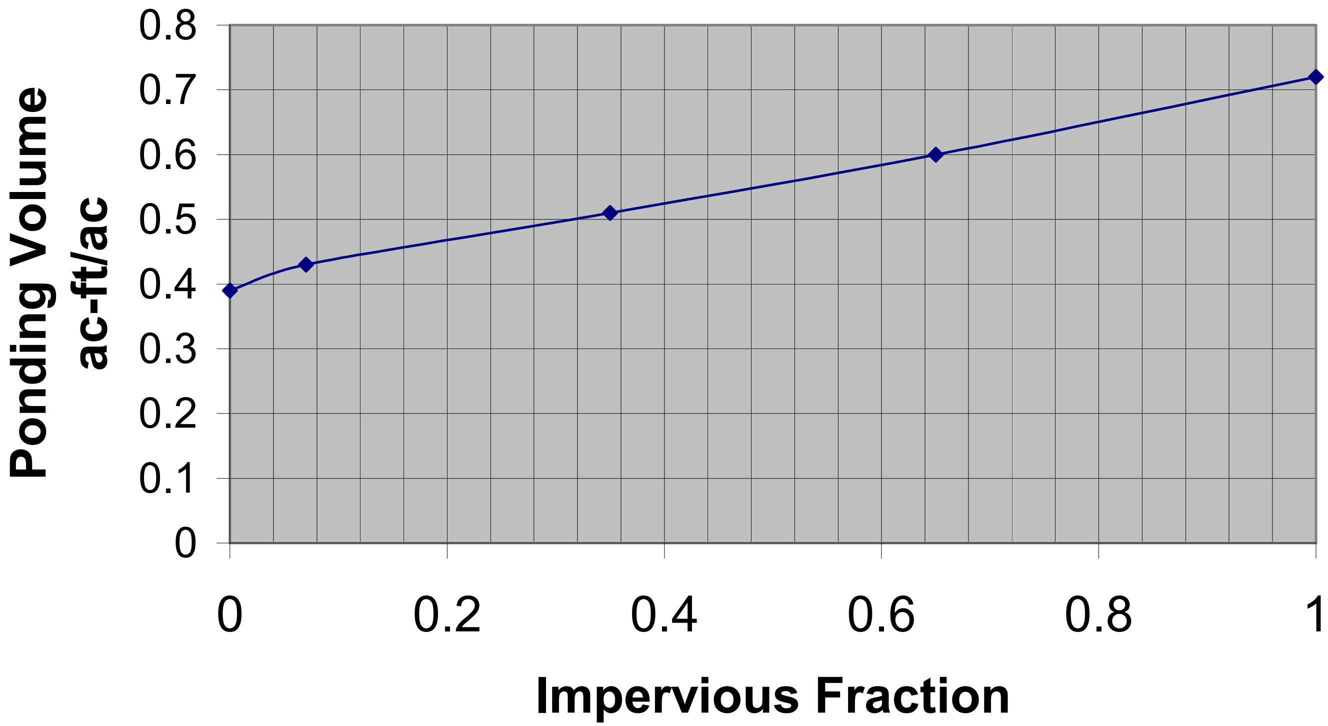


FIGURE 16
REQUIRED STORAGE
WILMES LAKE WQ REQUIREMENTS MODIFIED

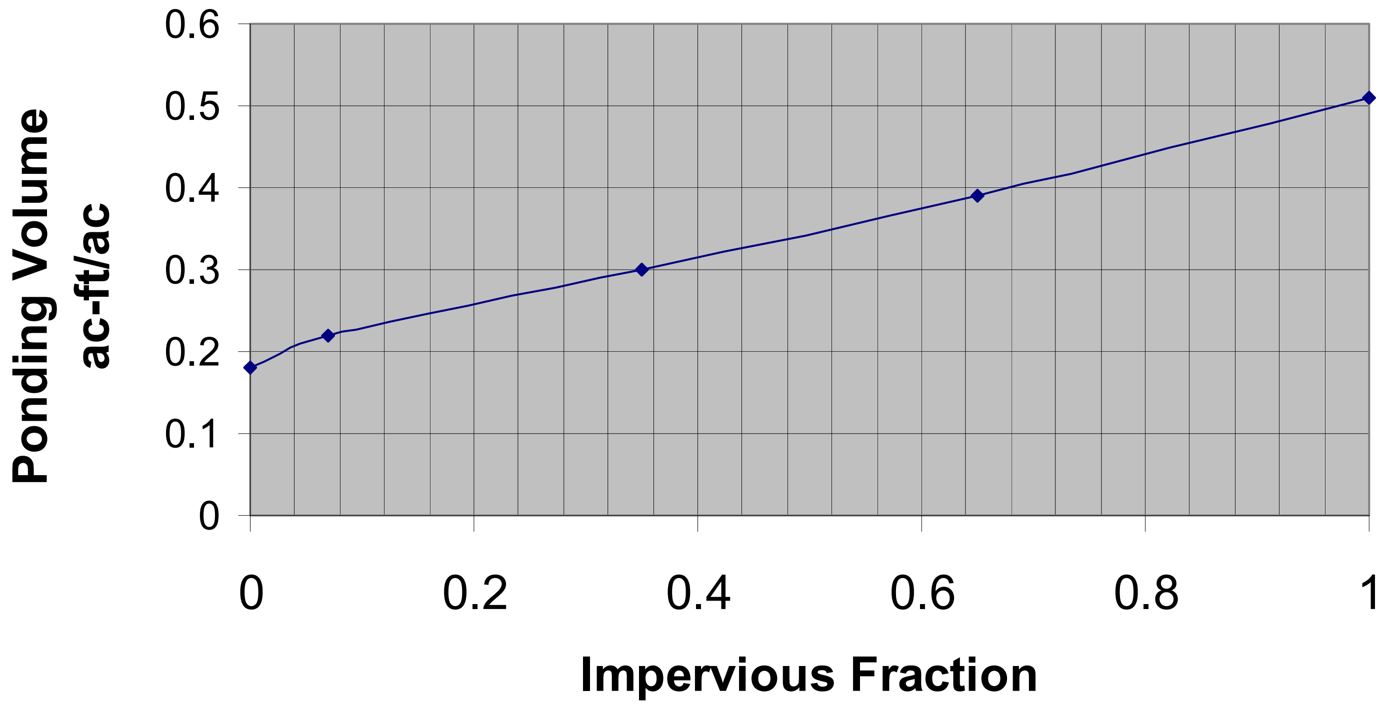


FIGURE 17
WILMES LAKE REPORT
EXAMPLE OF A LAKE OUTLET STRUCTURE

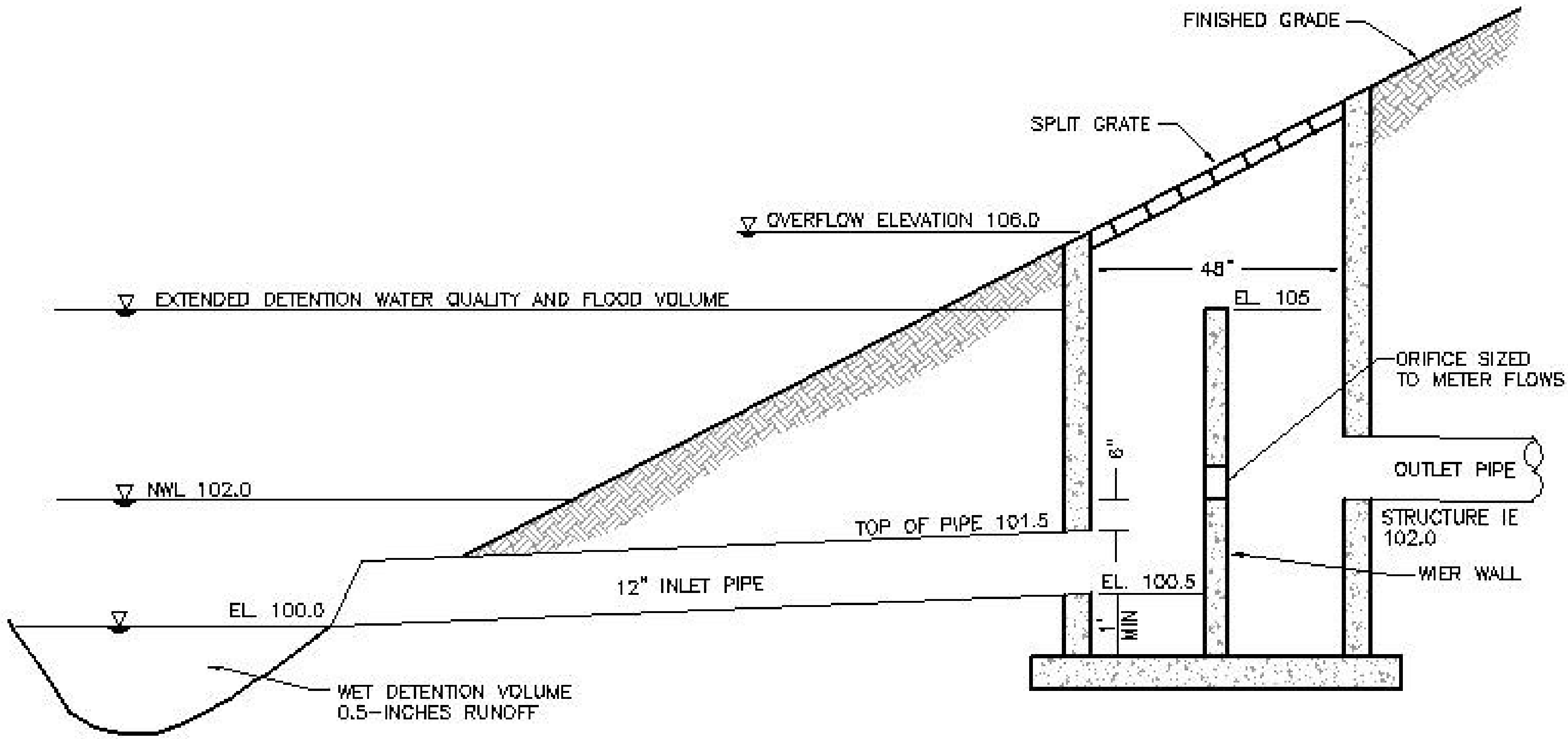


TABLE 7

POND DESIGN METHOD

Volume Determination	
Standard Volume	**Ac-ft** **ac**
Wet volume = 0.5” R.O. Extended Detention Volume 2.0” R.O.	0.042 0.167
Total Required	Determine % impervious of site. *(Go to Figure 10, select required total extended retention volume.)*
1. Select design volume.	
2. Normal outlet set at wet volume elevation.	
3. Divide design volume by 120-hour drawdown time to determine outflow rate: 10 ac site 50% impervious = 3.5 ac-ft Basin $\frac{3.5 \text{ ac-ft} \times 43560 \text{ ft}^2/\text{ac}}{120 \text{ hrs} \times 60 \text{ min} \times 60 \text{ sec}} = 0.35$ cfs outlet - Assume flood control ponding depth average of 4 feet deep - Pond surface area ≈ 1 ac for 10 ac development - 50% impervious	

5.2.4 Pond Design Method

The analysis assumes that if the proposed pond design is enacted, the extended detention basins will provide 70% TSS removal and 40% total phosphorus removal. Developers will then have to back calculate to determine whether any other BMPs are required to meet the SWWD water quality goals. The design method for flood control assumes the developer will start with a required wet value of 0.5 inches of runoff over the development and 2 inches runoff over the development for the extended detention volume. Table 7 summarizes the calculation.

5.2.5 Implementation Priorities

It is recommended that the SWWD begin implementing the development ponding and BMP requirements immediately. Immediate changes are needed in the manner that onsite ponds are designed in the subwatershed. The second priority is adding the gated structures at Armstrong Lake, Margrafs Lake and the Evergreen Wetland. The third priority is to modify the structure at Hudson Road. This culvert is along the main inflow of Wilmes Lake and would provide immediate benefits. However, it will be the most expensive of the projects.

6.0 ESTIMATED COSTS

The proposed development ponding changes should not result in significant additional costs. This is because the concept merely reallocates existing ponding requirements to another use and restricts outflow to better utilize the existing storage volumes. Implementation requires a policy change on the part of the SWWD for the Wilmes Lake Subwatershed. The modifications to the Hudson Road culverts will be the most expensive undertaking.

Based on conceptual estimates the weir at Hudson Road is estimated to cost approximately $75,000 for materials and construction (for a total length of weir of 60 feet). In addition, the associated road raise would cost approximately $200,000. This cost only addresses modifying the road to accommodate the drainage needs. It does not address all utilities, wetland impacts or other roadway needs for Hudson Road. Table 8 provides a conceptual level cost estimate.

The gates for the lakes will cost $15,000 - $30,000 each, for a total cost of $45,000 - $90,000 for materials and construction.

TABLE 8
WILMES LAKE OPERATIONAL PLAN
CONCEPTUAL LEVEL COST ESTIMATE

ITEM	UNIT	EST. QTY	EST. UNIT PRICE	AMOUNT
Road Raise associated with structure at Hudson Road				
Mobilization	LUMP SUM	1	$13,000	$13,000
Remove Bituminous Pavement	SQ YD	6200	$2.00	$12,400
Common Excavation	CU YD	11200	$3.50	$39,200
Aggregate Base (CV) Class 5	CU YD	1500	$14.00	$21,000
Aggregate Shouldering (CV) Class 2	CU YD	160	$25.00	$4,000
Type MV 3 wearing course mixture (F)	TON	600	$24.00	$14,400
Type MV 3 non wearing course mixture (F)	TON	600	$22.00	$13,200
Type LV3 non wearing course mixture (B)	TON	1000	$22.00	$22,000
Traffic Control	LUMP SUM	1	$393	$393
			Subtotal	$139,593
			Topo Survey and Base Map	$5,000
			Contingencies and Engineering	$50,608
			Total Probable Cost	$190,201
			USE A PROBABLE PROJECT COST	**$200,000**
Weir upstream of Hudson Road				
Concrete Wall	LF	60	$401.00	$24,060
Concrete Slab	LF	60	$272.00	$16,320
Excavation, Backfill, Compaction	LF	60	$155.00	$9,300
			Subtotal	**$49,680**
			Contingencies	$12,420
			Engineering	$9,315
			Total Probable Cost	$71,415
			USE A PROBABLE PROJECT COST	**$75,000**
Gates				
Armstrong Lake Outlet – two 18-inch gates	LUMP SUM			$20,000
Markgrafs Lake Outlet – one 12- inch gate	LUMP SUM			$15,000
Evergreen Wetland Outlet – one 12-inch gate	LUMP SUM			$15,000
			USE A PROBABLE PROJECT COST	**$50,000**
			TOTAL PROBABLE PROJECT COST	**$325,000**

APPENDIX A

WETLAND FIELD REVIEW SITE PHOTOGRAPHS

FIELD REVIEW SITE PHOTOGRAPHS – WILMES, SWWD
August 8, 2003

Photo 1 - Armstrong Lake. Photo taken at 10th St N. with a view to southwest of Armstrong Lake and surrounding homes. Lake has significant algae bloom and is ringed by cattails and reed canary grass with some purple loosestrife visible. Residential development is present along south and west shores.

Photo 2 - Armstrong Lake. Photo taken at 10th St N. with a view to southeast of Armstrong Lake and surrounding homes.

Photo 3 - Hudson Road Wetland. Photo taken from west side of site with a view to southeast of Wetland 2 located north of Hudson Road. Basin has significant reed canary grass area, but also shrub and forested wetland areas. Adjacent upland is not developed.

Photo 4 - Hudson Road Wetland. Photo taken from west side of site with a view to northeast of Wetland 1 located north of Hudson Road. Interstate 94 is located approximately 1000 feet north of the wetland.

Photo 5 - Markgrafs Lake. Photo taken from northwest side of lake with a view to south of lake and wetland fringe. Wetland fringe is dominantly reed canary grass and cattail with some arrow arum and other floating pond weeds. Water quality appears poor with high levels of algae and milfoil.

Photo 6 - Markgrafs Lake. Photo taken from southwest side of lake with a view to south of lake. Fringe vegetation is silver maple, box elder, black willow, and cottonwood. Residential development surrounds lake.

Photo 7 - Evergreen Wetland. Photo taken from northeast side of wetland with a view to southeast. Wetland has diverse emergent and scrub-shrub vegetation. Foreground is an excavated storm water pond for commercial development.

Photo 8 - Evergreen Wetland. Photo taken from northeast side of wetland with a view to southwest. Wetland has diverse emergent and scrub-shrub vegetation. Foreground is an excavated storm water pond for commercial development.