Appendix A—LakeLand Village Stormwater Facility Information

LAKELAND VILLAGE STORM DRAINAGE REPORT

December 6th, 2006

By: Pat McCullough, PE

INTRODUCTION:

This report is being prepared at the request of the Mason County Planning Department for submittal to the Washington State Growth Management Board.

The purpose of this report is threefold:

1. To describe the existing storm drainage facilities in LakeLand Village.
2. To evaluate conveyance and water quality performance of the existing storm drain system in LakeLand Village.
3. To propose design criteria for the future development of LakeLand Village that complies with the current Mason County storm water ordinance and preserves the water quality of Anderson Lake and Lake Deveraux.

(Authors Note: Lake Deveraux can be spelled Lake Devereaux.)

EXISTING CONDITIONS:

Area Description: LakeLand Village in located on the western boundary of the Allyn Urban Growth Area. The development includes approximately 775 acres of land, of which 649 acres is developed. LakeLand Village is currently approved for a total of 942 residential units. As of December, 2006 approximately 750 residential units have been constructed in the development. The development is served water by the LakeLand Village Water Company. Sewer is provided by Mason County via the North Bay Sewer System. The development includes and 27 hole golf course and numerous other community facilities. Table 1 below presents a time table of the development of the property from 1966 to present. Figures 1 and 2 presents a 2005 the watershed boundaries, areas, and topography.

TABLE 1
LAKELAND VILLAGE DEVELOPMENT HISTORY

DIVISION NO.	DATE PLATTED	NO. OF LIVING UNITS	REMARKS
1	5/2/1966	150	Lot 151 - Lake
2	7/18/1967	27	
3	7/24/1967	10	
4	7/17/1969	37	
5	4/22/1970	115	Lot 116 - Canal
Generation 1 Golf Course - 9 Holes	1970		Lot 89 - Clubhouse
6	7/27/1970	88	
7	11/17/1975	84	Lot 41- Dam
8	8/27/1979	14	
9	4/28/1980	21	Lots A Tennis
10	1/18/1982	19	Lot B Stables
Generation 2 Golf Couse - 9 Holes	1985		
11	1/10/1985	134	Lot 136 Pro Shop, Lot 135 Condo Site
11A	1/22/1991	28	
Generation 3 Golf Course - 9 Holes	1995		
12-A	1995	137	Phase 1
12-B	2000	78	Phase 2
Subtotal		942	Living Units 94 Condominiums 848 Residential Lots

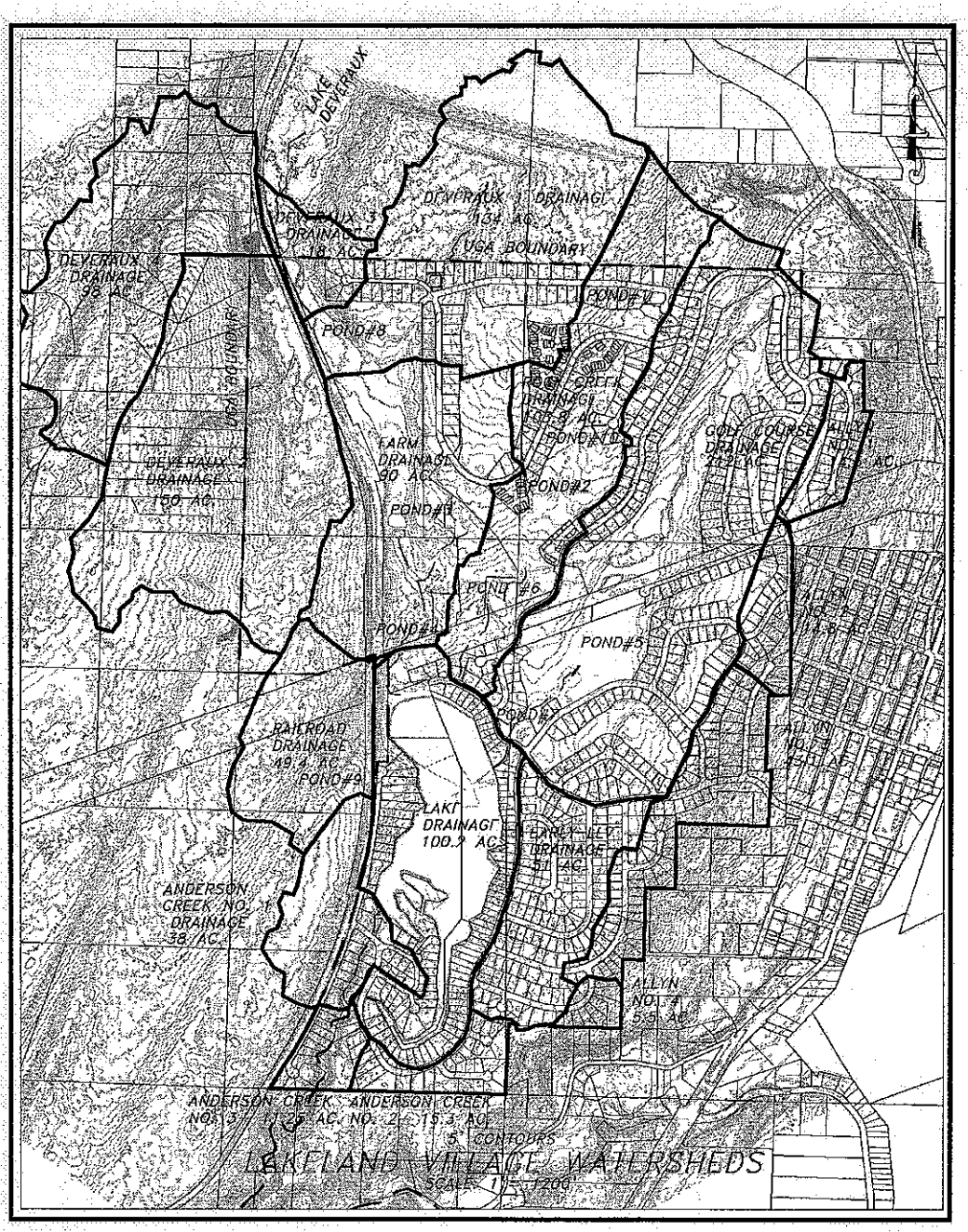


FIGURE 2: LAKELAND VILLAGE WATERSHED AND 5' COUNTOURS

LakeLand Village Soils: The surface soils of the Anderson Lake Watershed and the Southern portion of the Lake Deveraux watershed are shown in Figures 3 and Figures 4. This information was taken from a site specific soils study done by the Soil Conservation Service (SCS) in 1959 prior to construction of the dam. A description of these soil types taken from the SCS report is as follows:

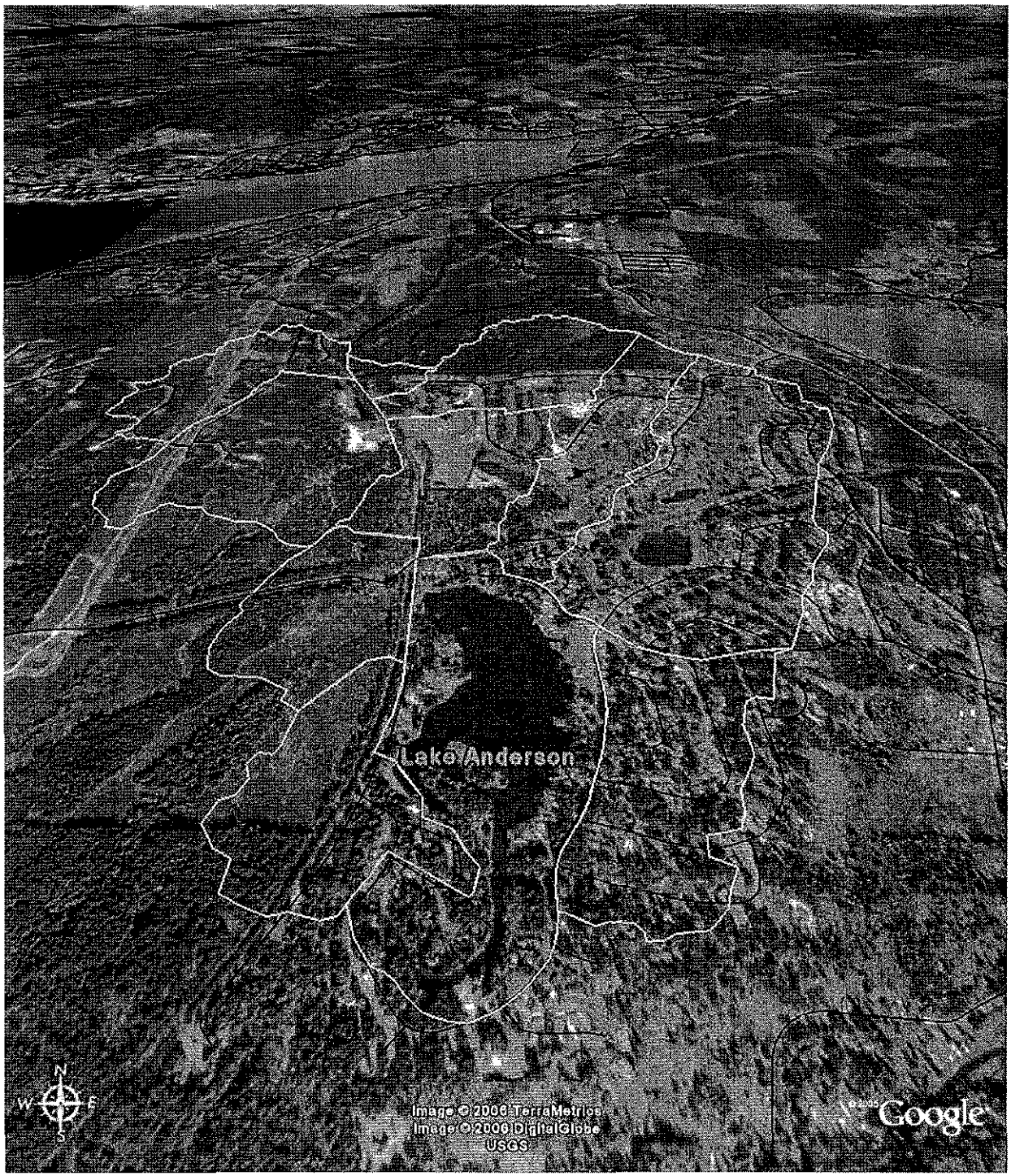


FIGURE 1; LAKELAND VILLAGE WATERSHEDS

Norma Silt Loam: A deep basin soil of glacial origin that has a dark colored silt loam surface high in organic matter over stratified layers of porous gravels and sands, silt lenses and compacted clay and sand layers. This moderately high fertile soil has a high water table and needs drainage for maximum crop production. Norma Silt Loam is a Class D soil.

Alderwood Gravelly Sandy Loam: A glacial till upland soil having a brown surface over a cemented gray hardpan that begins at about 24 inches. This gravelly, droughty, infertile soil is best adapted to tree growing. Alderwood Gravelly Sandy Loam is Class C soil. The upper 2 to 4 feet is typically free draining in its undisturbed state and readily absorbs rain water.

Sinclair Shotty Loam: A glacial till upland soil having a shotty, grayish-brown acid surface over a cemented gray hardpan that begins at about 28 inches. This low fertility soil needs drainage for the best crop production and is excellent for growing trees. Sinclair Shotty Loam is a Class C soil.

Everett Gravelly Sandy Loam: These are excessively drained pale-brown gravelly soils developed upon loose, porous glacial drift and outwash gravels at about 18 inches in depth. These shallow, gravelly droughty, low fertility soils are best adapted to Christmas tree growing. Everett Gravelly Sandy Loam is a Class A soil. It is free draining and can infiltrate over 20 inches of water an hour.

Everett Gravelly Loamy Sand: These are excessively drained, coarse textured, gravelly terrace and upland soils with loose gray gravels and sands beginning at about 12 inches in depth. These shallow, gravelly, very drought, low fertility soils are best adapted for Christmas tree growing. Everett Gravelly Loamy Sand is a Class A or B soil.

Orcas Peat, shallow: An organic soil composed mostly of sphagnum moss. This low fertility peat is unfit for agricultural use. Orcas Peat, shallow is class D soil.

Mukilteo Peat: An organic soil composed largely of remains of sedges and coarse water-tolerated grasses. It occupies very poorly drained basins which remain very wet throughout most of the year unless artificial drainage is furnished. Depth to mineral substratum is over 24 inches. Mukilteo Peat is a class D soil.

Semiahmoo Muck: A black colored muck soil developed from well decomposed sedge and water plant remains. Depth to gravelly substrata is over 36 inches. Artificial drainage is needed for best crop production. Semiahmoo Muck is a class D soil.

The Orcas Peat, Semiahmoo Muck, and Mukilteo Peat soils are typically classified as hydric soils. They are shown in Figures 3 and 4 and predominate under and around Anderson Lake, the golf course ponds and near Lake Deveraux.

In 1991 through 2005 over 180 soil test pits have been dug in LakeLand Village for the purpose of classifying the surface soils for septic systems. These soil log tests have verified the SCS soil survey results.

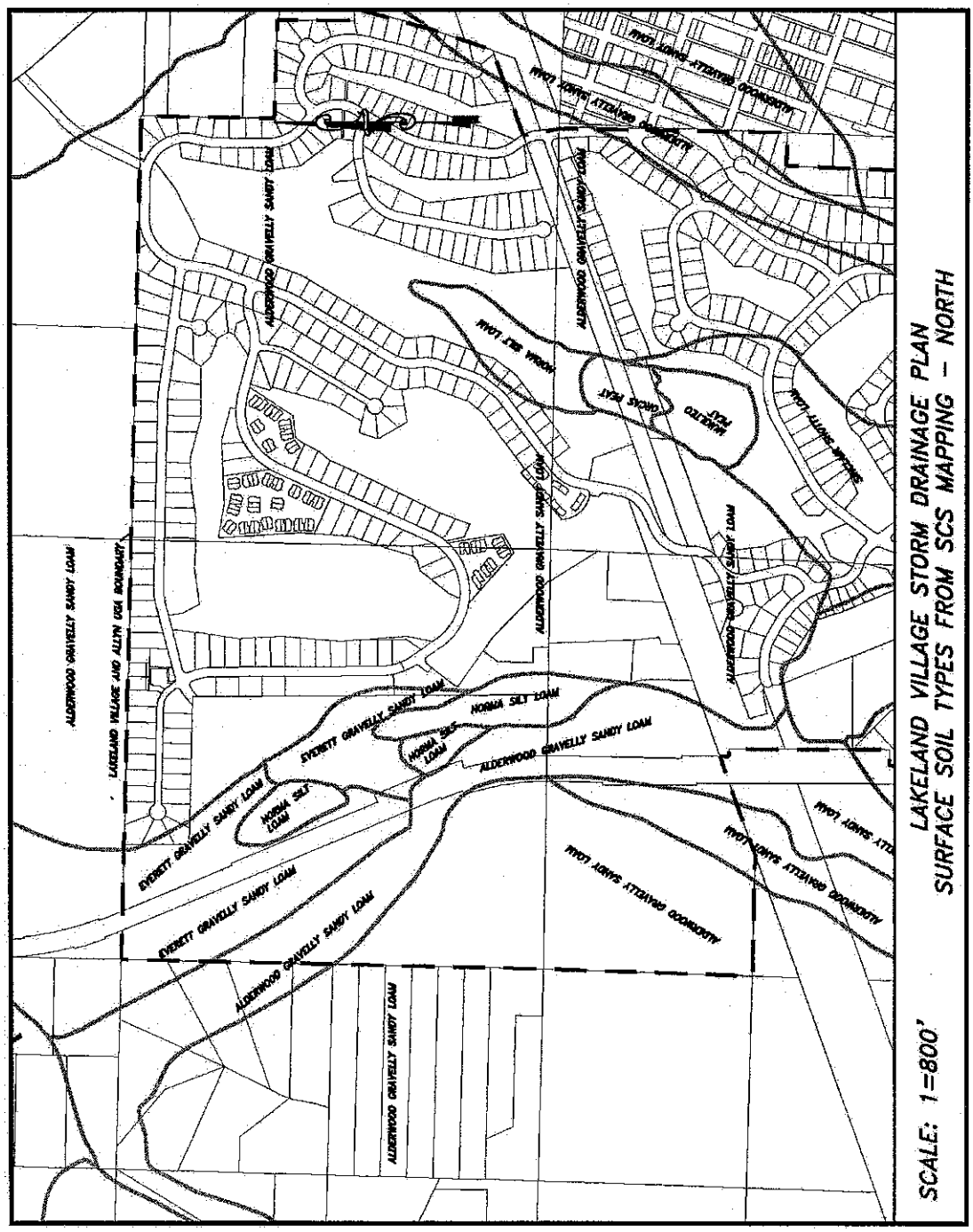
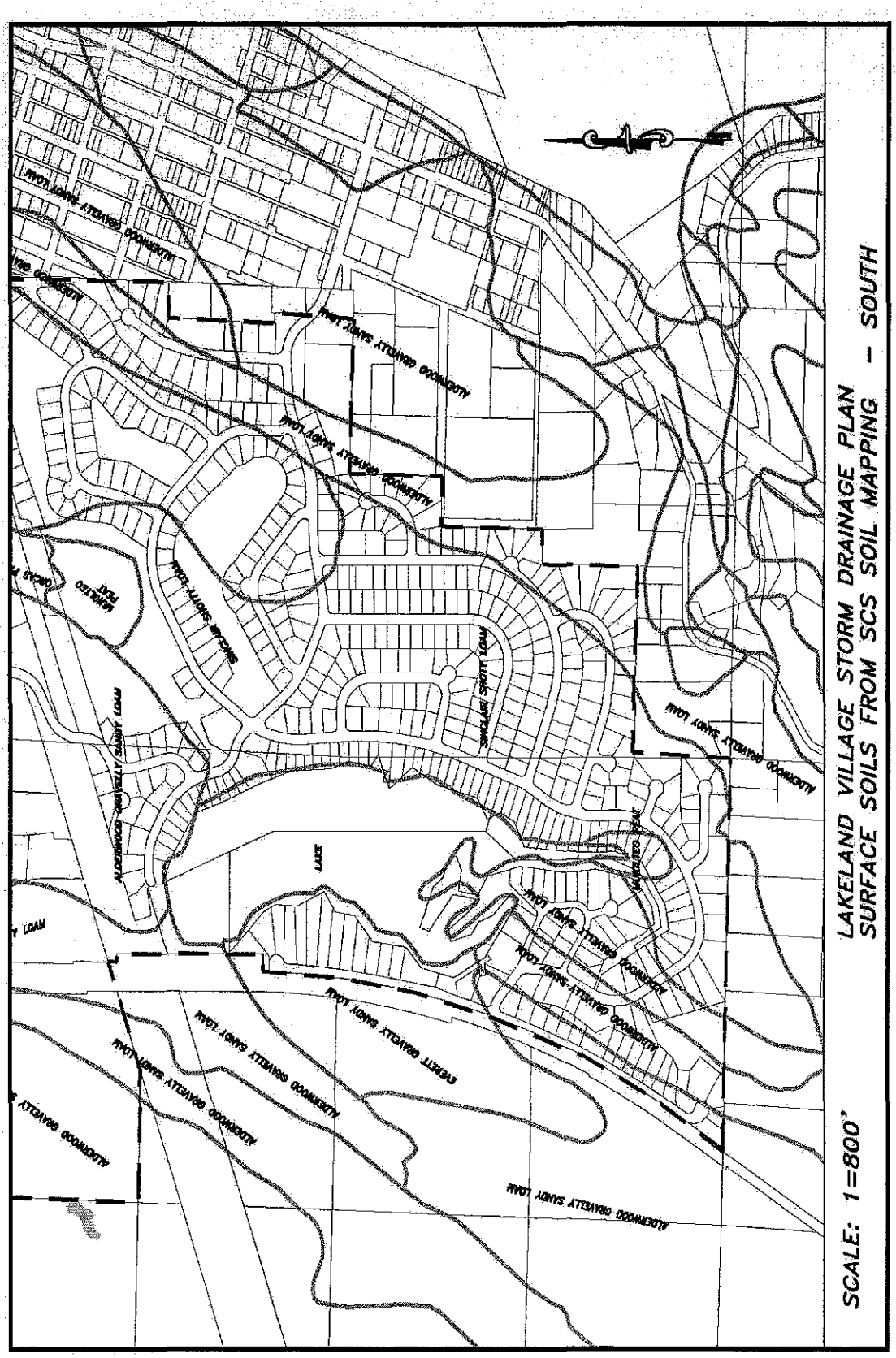


FIGURE 3: SURFACE SOILS IN THE NORTH END OF THE LAKLAND VILLAGE DRAINAGE BASIN


LAKELAND VILLAGE STORM DRAINAGE PLAN
SURFACE SOILS FROM SCS SOIL MAPPING - SOUTH
SCALE: 1=800'
ALDERWOOD GRAVELLY SANDY LOAM
SHOALWATER SILTY LOAM
ALDERWOOD GRAVELLY SANDY LOAM
LAKE
ALDERWOOD GRAVELLY SANDY LOAM
ALDERWOOD GRAVELLY SANDY LOAM
ALDERWOOD GRAVELLY SANDY LOAM

LakeLand Village Drainage Basin Hydrology: The LakeLand Village development drains to three drainages. 525.5 acres of the development drains south to Anderson Lake which drains into Anderson Creek. 64.5 acres of the development drains directly into Anderson Creek. 121.6 acres drains north to Lake Deveraux. 63.4 acres drains to the east to the town of Allyn. The easterly and southerly flowing drainages flow to Case Inlet in Puget Sound. The northerly flowing drainages drain to Lake Deveraux and down Deveraux Creek to Hood Canal.

Figure 5 further illustrates the LakeLand Village Drainage Basins. Figure 5 also includes the area of each drainage basin. Deveraux Drainages 1 through 4 north to Lake Deveraux, The Farm Basin, Rock Creek, Golf Course, Early Lakeland Village, Railroad Drainage, and Lake Basins flow to Anderson Lake. The Anderson Creek No. 1 and No. 2 drainages flow directly into Anderson Creek and Allyn No. 1 through No. 4 drainages flow east down the hill to the down of Allyn. Several of the drainage basins were further divided into sub drainage basins to facilitate hydraulic modeling of the watersheds.

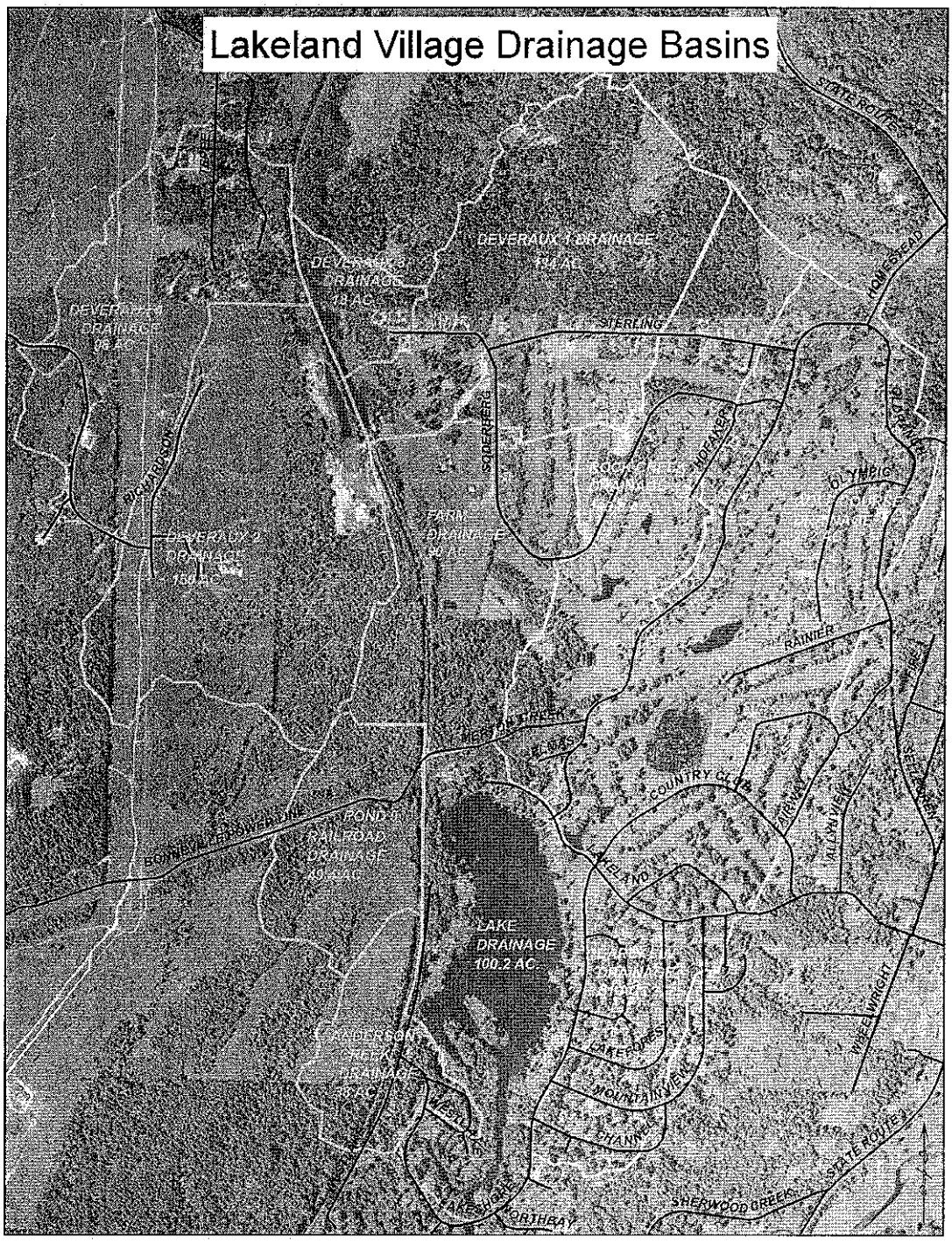


FIGURE 5: LAKELAND VILLAGE WATERSHEDS AND DETENTION POND LOCATIONS

Existing Drainage Facilities: The drainage facilities in Lakeland Village have been constructed over the last 40 years by Anderson and Sons, the Lakeland Village owner and developer. Until 1992 there were no drainage regulations in Mason County other then those needed to protect the roadways. The first designed storm water detention ponds were installed as part of Division 12 in 1995 through 2002. However, the developer should be applauded for developing a storm water treatment, storage, and

treatment system that exceeds all the current standards set forth in the 2005 Western Washington Hydraulics Manual.

They began in 1960 by constructing Anderson Lake is a very effective at reducing the rate of storm flow in the unnamed outlet stream and; subsequently in Sherwood Creek. The lake will store 230 acre feet of water before it overflows the crest of the dam. Later revisions to the outlet weir in the auxiliary spillway increased the storage capacity of the lake by 45 acre feet and substantially reduced down stream flow.

Anderson Lake was formed by the construction of a 21 foot high earthen dam at the outlet of a natural wetland bog that was fed by springs which flow continuously at the rate of 160 gallons per minute. The dam was designed by the United States Soil Conservation Service (SCS) in 1964. A pictorial representation of the Anderson Lake dam is shown in Figure 6.

Bob and Don Anderson built the dam with the assistance of the SCS and the close inspection of professional civil and soils engineers. They report that the key under the upper embankment of the dam extends18 feet down into a hard clay material.

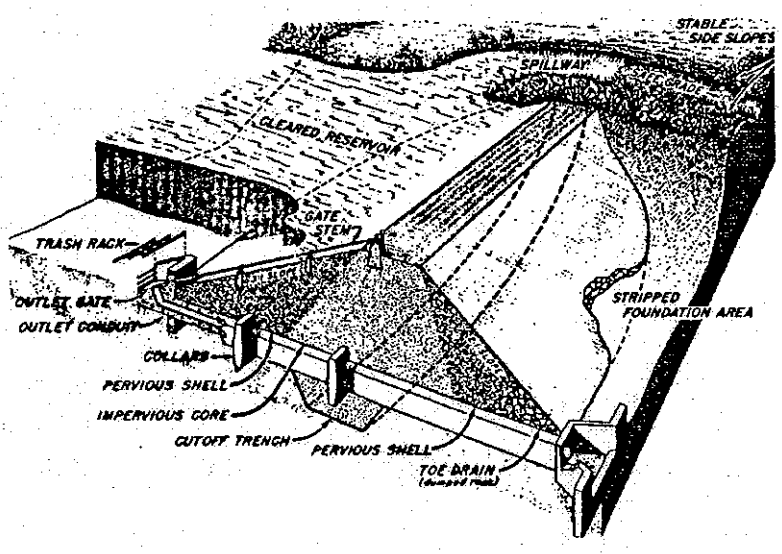


FIGURE 6: TYPICAL SMALL DAM

The Anderson Lake dam is regularly inspected by the Dam Safety Division of the Department of Ecology. A detailed inspection report was published on August 10, 1990 which completely updated the structural analysis of the dam and the hydraulic analysis of the watershed.

The outlet of the lake is controlled by a box-like weir structure with a one foot notch in the front. (See Figure 6) As the water in the lake rises, it reaches the top of the notch and flows over the three sides of the weir box. When the level of the lake reaches one foot over the weir box, the dual 36 inch culverts in Westlake Drive begin to control how much water can flow out of the lake. As the Lake level reaches 2.4 feet over the weir box, the storm water will begin to flow down the road side ditches in Westlake Drive. At a lake level of 2.75 feet over the top of the weir box the storm water begins to overflow Westlake Drive. The November 24, 1990 storm dumped 6.1 inches of rain on

the watershed during a 24 hour period. The flows into the lake reached 266 (120,000 gallons per minute) cubic feet per second during the peak period of storm. The flow out of the lake reached approximately 123 cubic feet per second and the level of the water at the twin 36 inch culverts on Westlake Drive was just below the top of the headwall. (Elev. 104.0 on the assumed datum) A graphical representation of proceeding discussion is shown in Figure 8 which is the Anderson Lake Auxiliary Spillway stage discharge curve developed by the Dam Safety and amended to show the 100 year flood flow computed by the author.

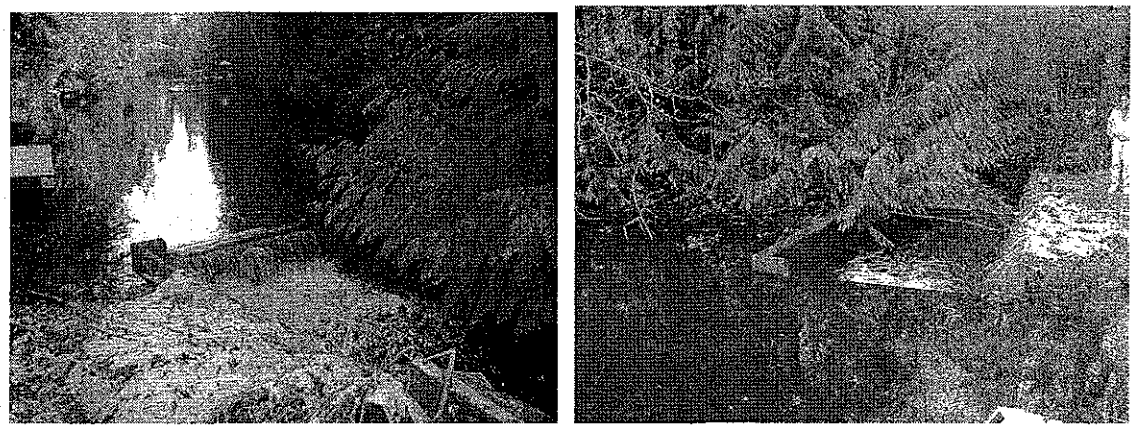


FIGURE 7: ANDERSON LAKE OUTLET WEIR BOX

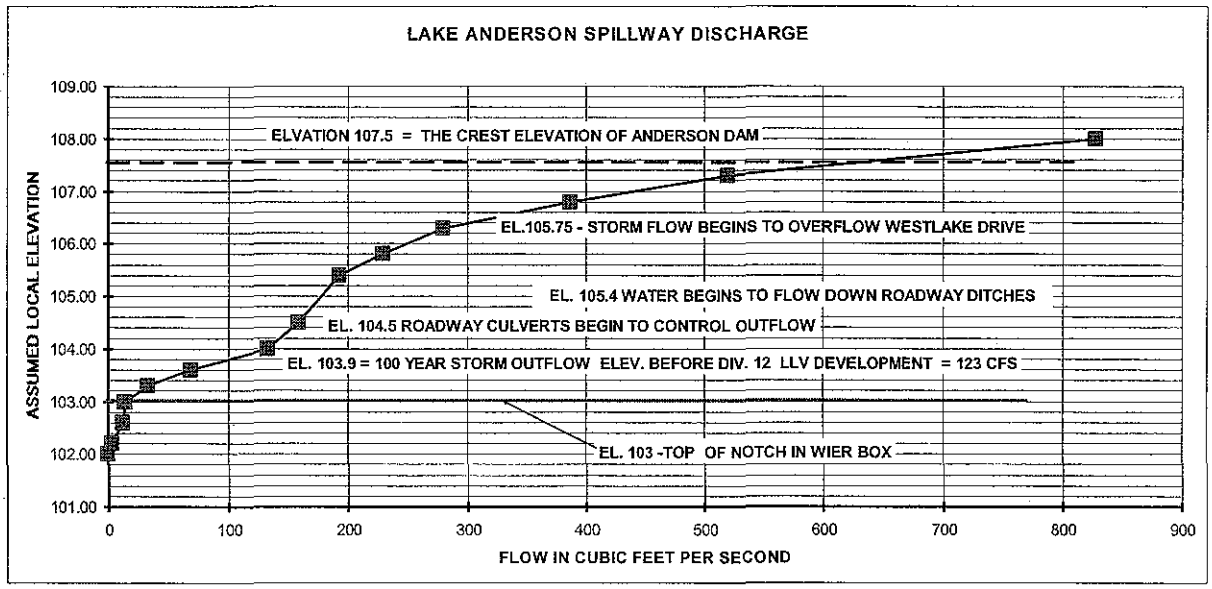


FIGURE 8: ANDERSON LAKE SPILLWAY STAGE DISCHARGE CURVE

The majority of the storm drainage in Lakeland Village is conveyed using open ditches. Most of the open ditches over 4% to 5% grade have rock check dams or are lined with quarry spalls to prevent erosion. This open ditch system provides a filtering and runoff infiltration function.

Figures 15 and 16 represent the inventory of drainage fixtures that the author made in December 2006. There are a total of 10 detention ponds and 12 water quality ponds in the LakeLand Village storm water conveyance, treatment and storage system. All the detention ponds are a combination detention pond and wet pond. The outlet structures for Ponds 4, 7 and 9 are culverts behind railroad or road fills. All the other outlet structures are risers with or without orifices and overflow weirs. (See Figures 9 through 14) The total area of water quality ponds is 5.3 acres not counting the 45 acre Anderson Lake. If Anderson Lake is included the area of water quality treatment increases to 50.3 acres or 9.6% of the Anderson Lake Watershed. There are 14.62 acres of Detention/Wetpond Ponds that create approximately 30 acre feet of detention storage not counting Anderson Lake (230 acre feet).

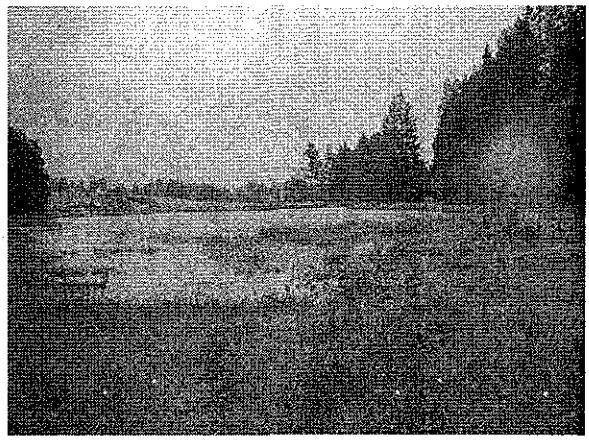


FIGURE 9: DEVERAUX –POND 8

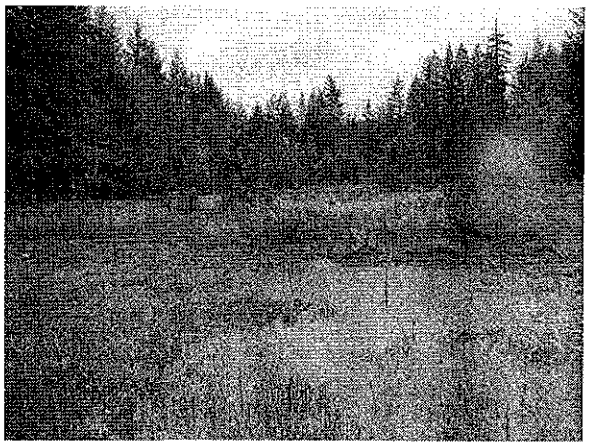


FIGURE 10: POND 8 OVERFLOW DIKE

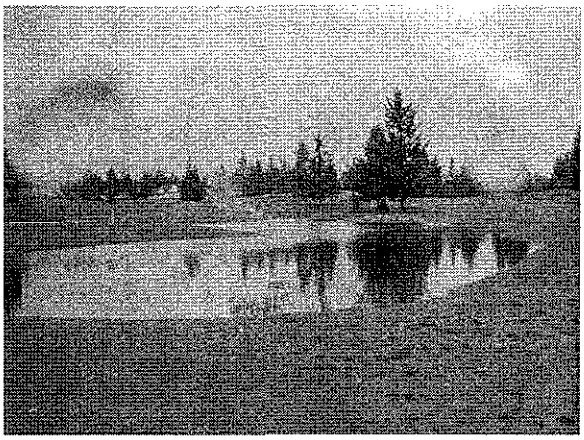


FIGURE 11: ROCKY CREEK POND 2

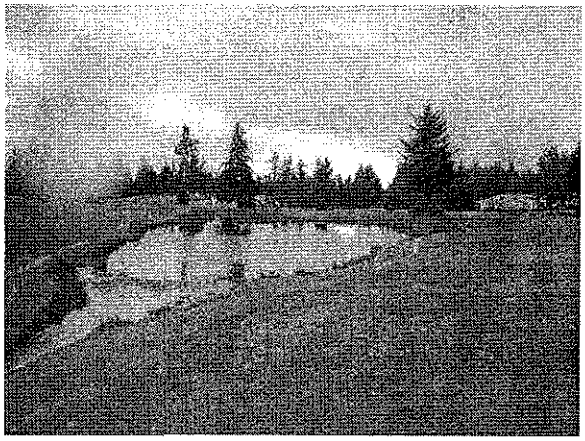


FIGURE 12: ROCKY CREEK POND 10

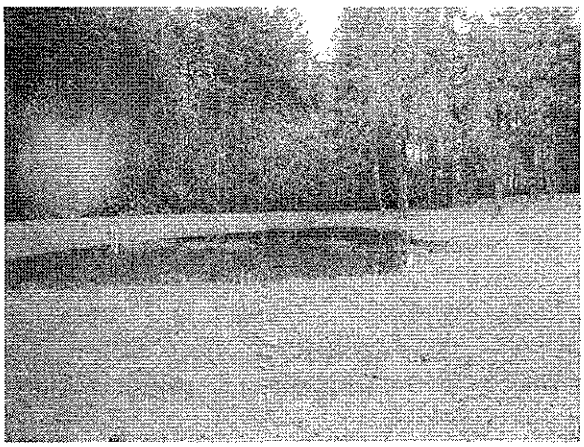


FIGURE 13: ROCKY CREEK POND 6

FIGURE 14: ROCKY CREEK

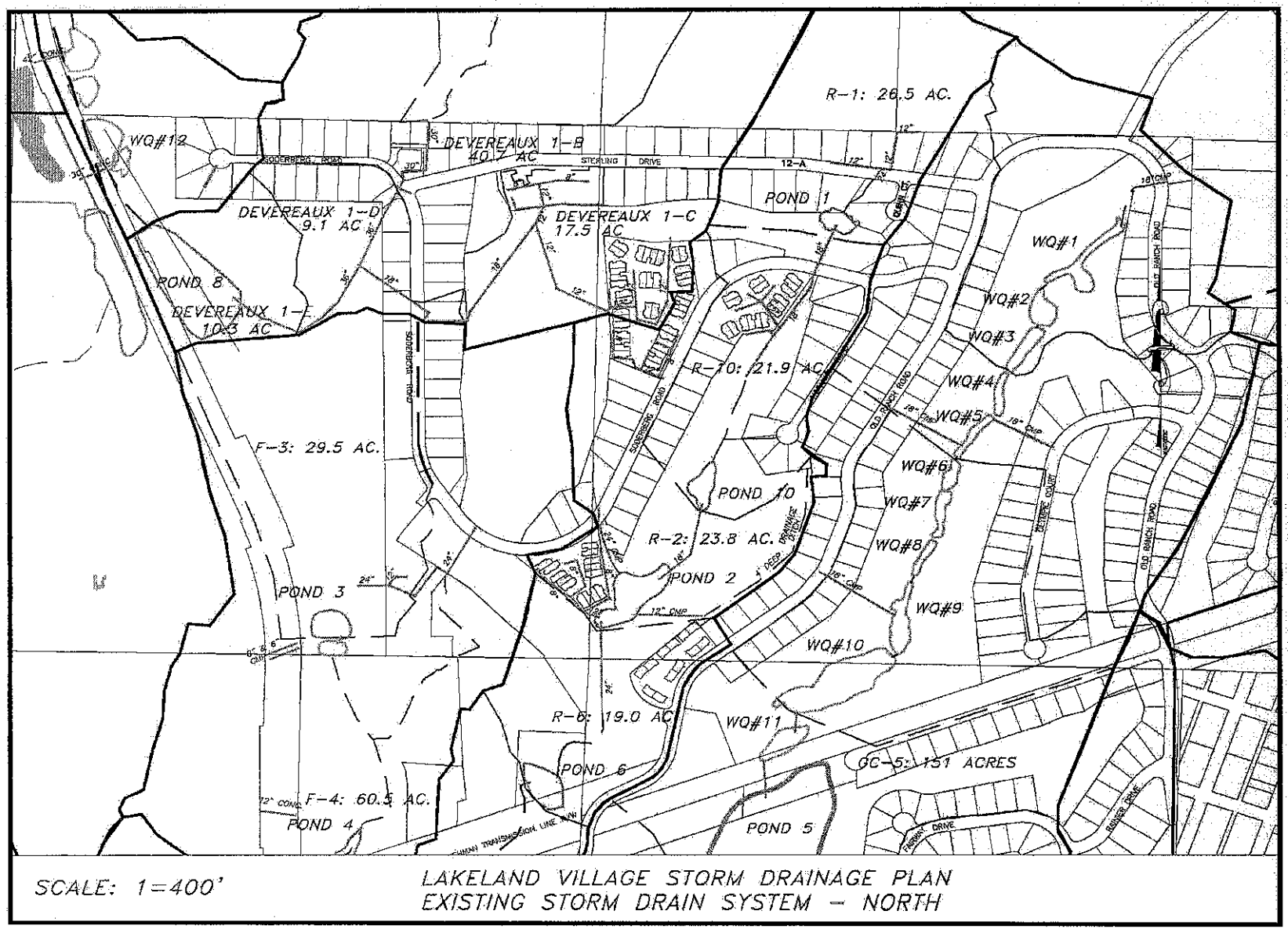


FIGURE 15: NORTH DRAINAGE FACILITIES INVENTOR WITH DRAINAGE SUBBASINS.

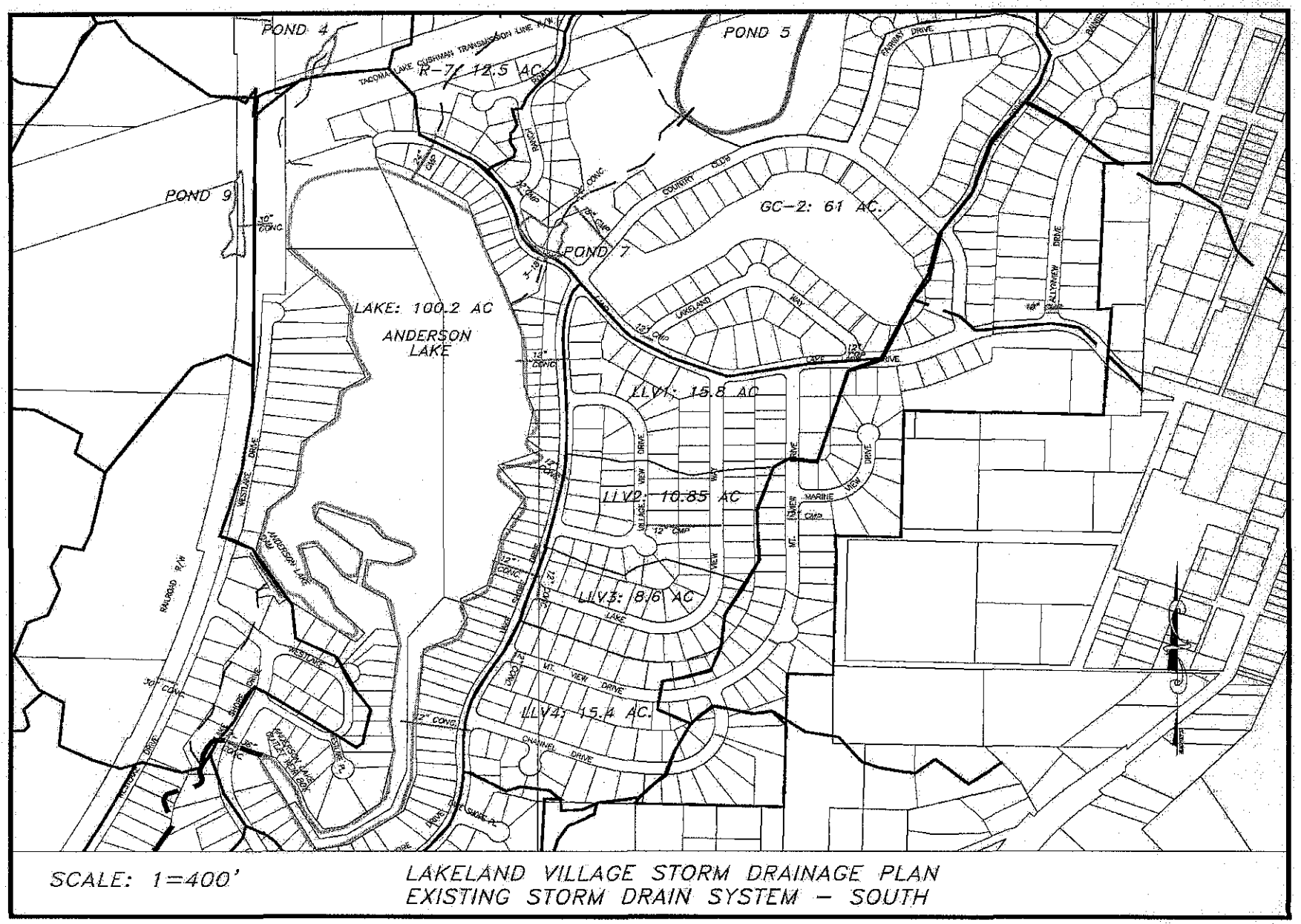


FIGURE 16: SOUTH DRAINAGE FACILITIES INVENTOR WITH DRAINAGE SUBBASINS.

A major goal of the water quality treatment design criteria for the Anderson Lake and Lake Deveraux storm drainage systems was to maintain a very low concentration of phosphorus in the storm water entering the lakes. In the LakeLand Village EIS a goal of 19 micro grams per liter of phosphorus was established as a goal for maintaining the pristine character of the lakes. Anderson Lake is tested twice a year for the following parameters:

Anderson Lake: Mid Lake Station

Total Nitrogen
Total Phosphorus
Chlorophyll A
Temperature and Dissolved Oxygen
Fecal Coliform

Over the last 3 years Phosphate levels have averaged 15 micro grams per liter. This level of phosphorus concentration puts Anderson Lake in the Oligotrophic category. See Table 3 Below.

The storm water that flows to Lake Deveraux flows to and through Pond 8 which is located in the northwest corner of the LakeLand Village development. Pond 8 has been monitored for the same parameters as Anderson Lake for the last 10 years. The phosphorus levels in the outlet of Pond 8 have been about the same or lower then those in Anderson Lake.

Table 2 summarizes the condition of Anderson Lake and Deveraux Lake.

TABLE 2

CURRENT CONDITIONS OF ANDERSON LAKE AND LAKE DEVEREAUX

	ANDERSON LAKE	LAKE DEVEREAUX
PHYSICAL DATA		
Lake Area	44 Acres	94 Acres
Lake Volume	370 Acre Feet	1800 Acre Feet
Mean Depth	8.4 Feet	19 Ft.
Maximum Depth	16 Feet (Near Dam)	55 Ft.
Shoreline Length	12,244 Feet	13,200 Ft.
Bottom Slope	2% to Flat on Bottom	2.4%
Bottom Geology	Sedimentary/Muck	Sedimentary/Meta.
Inflow		
Groundwater	338 Acre Feet	High Flow/Unknown
Runoff	475 Acres Feet (Ave)	933 Acre Ft.
Direct Rainfall	201 Acre Feet (Ave)	431 Acre Ft.
Outflow		
Evaporation	110 Acre Feet	235 Acre Ft.
Seepage	Negligible	High/Unknown
Sherwood Creek	904 Acre Feet	Unnamed Creek
CHEMICAL DATA	Sample Time/Site = Summer at Surface	
Secchi Disk (Visibility)	12 to 16 Feet	21 Ft
Dissolved Oxygen	Saturation/Unstratified	Saturated/Stratified
Total Nitrite	0.001 mg/l	0.00 mg/l
Total Nitrate	0.011 mg/l	0.00 mg/l
Total Amonia	0.020 mg/l	0.05 mg/l
Total Phosphorus	0.017 mg/l	.004 mg/l
Ortho Phosphate	0.006 mg/l	0.002 mg/l
Chlorophyll A	1 mg/Cubic M	Unknown
Water Temperature	33-75 Deg. Far	33-75 Deg. Far
Fecal Coliform	5 -10 col/100 ml	3 col/100 ml

TABLE 3

LAKE CLASSIFICATION BASED ON ANNUAL MEAN VALUES OF TOTAL PHOSPHORUS AND WATER CLARITY (Secchi Disk)
Units are Micrograms/Liter and Feet
Based on a Study of 200 Lakes by Vollenweider

Trophic Status	OLIGOTROPHIC	MESOTROPHIC	EUTROPHIC	HYPEREUTROPHIC
Parameter				
Total Phosphorus				
Mean	8	27	84	-
Range	3 - 18	11 - 96	16 - 386	750-1200
Shecchi Disk (Ft.				
Mean	30	13	8	-
Range	17 - 56	5 - 27	3 - 24	1.5 - 1.8

HYDRAULIC COMPUTER ANALAYSIS

In the last week of November and the first week of December 2006 the author visually surveyed all the drainage facilities in the LakeLand Village watershed in order to develop an As-Built computer model of the existing storm drainage system. (Note the November 2006 was the wettest month in recorded history for this area.) My first observation was that the entire LakeLand Village storm drainage system preformed extremely well during November. There were no flooding or erosion issues in the watersheds in the month of November, 2006 or during two previous storm events that approached the 100 year storm event magnitude in the last 10 years. Several changes to the system design and previously existing facilities were noted:

1. The Lake Deveraux-1 Drainage Sub Basin has increased from 71 acres to 134 acres because of piping installed in the Generation 3 Golf Course.
2. 18.4 acres of golf course and residential drainage that was designed to be directed to Farm Pond 3 (See Figures 5 and 9) flows into the drainage below Farm Pond 3. The developer is about to construct Division 14 in this drainage. The storm drainage conveyance system to the Farm Pond 3 in the Farm Pond Drainage will be expanded to include the undeveloped lands in the drainage basin. The storm water conveyance system in the proposed Division 14 will direct this storm runoff to the Farm Pond as originally planned.
3. The outflow piping from Pond 7 which is the last detention pond in the Rock Creek Drainage was changed from 2 – 18" CMP Culverts to 3 – 18" ADS Culverts. This change was made by Mason County to eliminate the roadway overflow from Pond 7.
4. Mason County has replaced two 12" CMP culverts in Old Ranch Road in the Golf Course drainage basin with 18" CMP culverts. This change resolved a local flooding problem for downstream property owners.

The existing storm drainage system for LakeLand Village was computer modeled using StormShed 2G developed by Engenious Systems of Seattle, Washington and the Western Washington Hydraulic Model 3 (WWHM – Version 3). An earlier version of the StormShed 2G model was used to design the storm drainage system for Division 12 in 1991 - 1993. The StormShed 2G model is an "event" model that applies

a 24 hour storm of various recurrence intervals to the landscape and then calculates the flows and volume of storm water runoff. The results of the StormShed 2G modeling is shown below in Table 4.

TABLE 4

AS-BUILT FLOW RATES FOR THE LAKELAND VILLAGE DRAINAGE BASINS AND PONDS AS OF 12-06-06 IN Cubic Feet per Second (CFS)

Basin or Detention Wet-Pond	WQ	2 yr	10 yr	25 yr	100 yr As Built	100 yr Design Completed in 1991	BASIN
Pond1	1.8279	4.6635	9.2338	11.547	15.5656	29.23	Rock Creek
Pond2	5.795	11.1553	23.4551	29.2865	39.8378	39.8	Rock Creek
Pond3	1.2512	3.1848	5.8093	6.8447	8.196	23.85	Farm Drainage
Pond4	16.9204	27.9856	39.5828	44.0002	61.493	26.1	Farm Drainage
Pond5	10.0778	18.5481	29.7927	30.6658	32.1086	55.26	Golf Course Drainage
Pond6	1.9863	4.7	9.4	11.9	16.4	26	Rock Creek Drainage Outfall
Pond7	11.2576	20.7073	50.6572	67.6842	86	69	Golf Course Drainage Outfall
Pond 8	16.7	26.4	42.7	51.6	67.4	40.15	Deveraux Lake
Pond10	5.0574	11.4277	25.5079	31.2779	40.6616	New Pond	Mid Rock Creek = Above Pond 2
ELLV-1	5.8747	9.4951	14.7298	17.2495	21.497	No Change	Early LLV
ELLV-2	4.0333	6.5194	10.1141	11.8444	14.7613	No Change	Early LLV
ELLV-3	3.1976	5.1682	8.0175	9.389	11.7009	No Change	Early LLV
ELLV-4	5.7259	9.2547	14.3569	16.8128	20.9528	No Change	Early LLV
RailRoadPond	5.9825	9.9989	14.8124	16.978	20.3991	25.25	Existing Pond
LakeAnderson	7.9562	13.5563	61.0576	81.5075	102.1243	124.4	Outfall to Anderson Creek

A review of the As-Built flows shown in Table 4 verses the 100 year design flows reveals the following:

1. The increased area in the Deveraux 1 drainage basin resulted in an increase of the 100 year outflow from Pond 8 of 27.3 cfs. Pond 8 has ample capacity to store the additional runoff. The outflow structure needs to be modified to restore the release rate from Pond 8 to 40 cfs.
2. The change in the outlet structure in Pond 7 of the Rock Creek Drainage resulted in 15 cfs more flow into Anderson Lake from this drainage. No change is recommended because the outflow from Anderson Lake 22.3 cfs less the planned for the 100 year storm.
3. All the 12" culverts in the four Early LakeLand Village drainage basins (ELLV- 1 through 4) that cross Lake Shore Drive need to be replaced with new 24" ADS culverts from the ditch to Anderson Lake.
4. The Farm Creek drainage needs to be modified to comply with the proposed design.

The culverts on Lake Shore Drive should be improved by Mason County Department of Public Works. The revisions to the Lake Deveraux-1 basin and the Farm basin should be made by the developer.

FUTURE DEVELOPMENT:

Approximately 126 acres remains to be developed in LakeLand Village. 46 acres of the undeveloped property lies east of the railroad tracks in the Farm Creek Basin (primarily) and 80 acres lies west of the railroad tracks. 60 acres of the property east of the railroad tracks flows to Lake Deveraux and 20 acres flows to Anderson Lake. Mason County is proposing to allow 6 units per acre development densities for the LakeLand Village. The developer has requested that an additional 40 acres be included in the LakeLand Village development and in the Allyn Urban Growth Area. The planning for the future development of LakeLand Village has been underway for several months but is not yet complete.

It is important that the future development of LakeLand Village continue to incorporate water quality treatment and storm water detention in the design of storm water facilities. Table 5 and Figure 17 presents both the water quality and detention volumes required for the development of the Deveraux-2 drainage sub basin. Two alternatives were considered. The 60 acre alternative includes the property currently in the Allyn UGA. The 81 acres alternative includes 21 acres of the property currently outside the Allyn UGA but within the Deveraux – 2 drainage basin.

TABLE 5

Density vs Water Qualtu and Detention Volumes for Future Development of Drainage Basin Deveraux - 2

	60 Ac Alt		81 Ac Alt	
Density	**WQ Vol (acft)**	**Detention Vol (acft)**	**WQ Vol (acft)**	**Detention Vol (acft)**
2	7.5	7.722	10	10.257
3	7.9	8.242	10.5	10.972
4	8.3	8.736	11	11.635
6	8.8	9.36	11.7	12.48

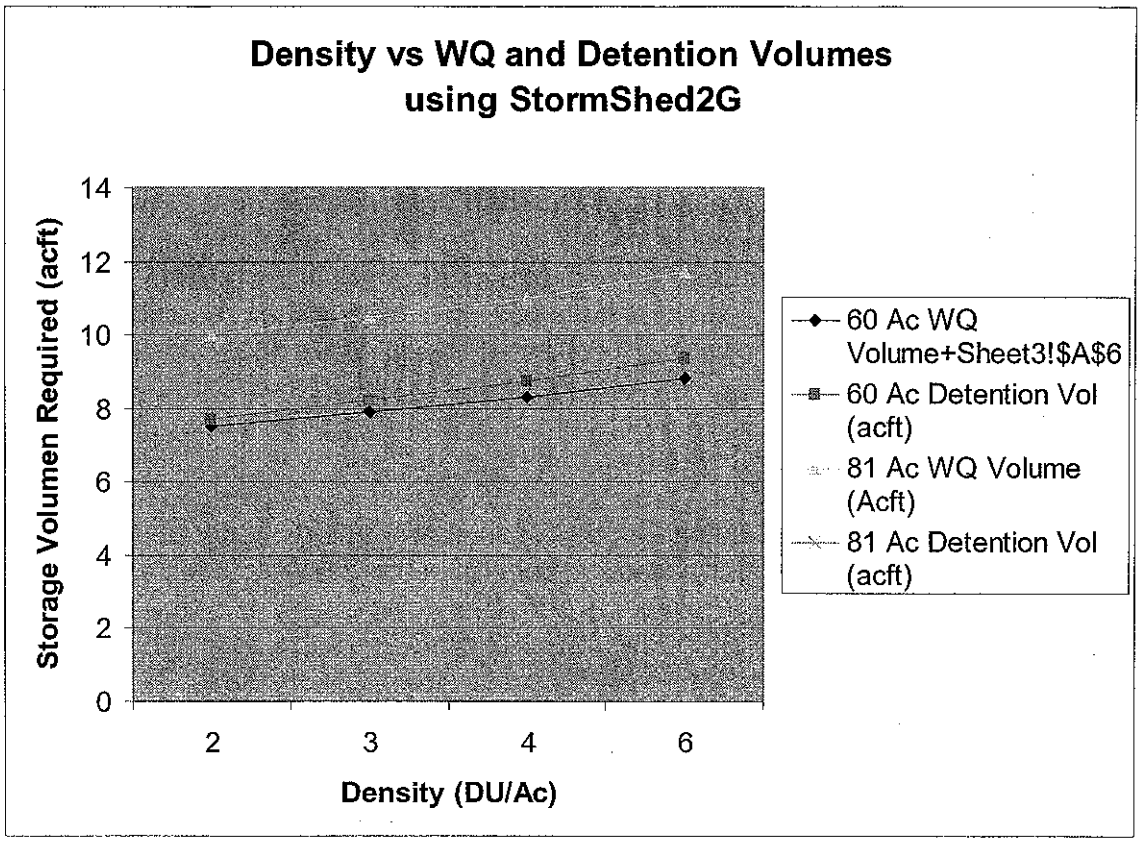


FIGURE 17

Various Low Impact Development (LID) alternatives were evaluated. It was determined that the if the roof and driveway drainage for a 4 unit per acre development in the Deveraux Lake – 2 basin were infiltrated into the ground on site the regional detention pond volume could be reduced by more then 50%. The water quality volume remains about the same. LID should be incorporated into the project at every opportunity, particularly for the residential lot development.

The proposed drainage facilities for the future development of LakeLand Village should continue to focus on preservation of the water quality of Anderson Lake and Lake Deveraux.