IV. Watershed Characteristics and Resources

A. Physical Environment

This section describes the physical environment in the SWWD, including climate and precipitation, topography, geology, soils, and groundwater.

1. Climate and Precipitation

The climate in the South Washington Watershed is similar to that over all the Seven County Metropolitan Area. Winters include extended periods of below freezing temperatures with an average temperature of 17EF. Summer is fairly short with warm temperatures and high humidity and an average temperature of 70EF. The annual normal temperature is 44EF. In most years there are at least 120 days with a daily minimum temperature above freezing.

As described in the Soil Conservation Service (SCS) Hydrology Guide for Minnesota, total annual precipitation in the watershed is approximately 28 inches, including 46 inches of snowfall. Table IV-1 presents 24-hour rainfall amounts for various recurrence intervals. The recurrence interval is a measure of the probability of occurrence of the storm event. For example, a 5-year storm has a 1-in- 5, or 20%, chance of occurring or being exceeded in any given year, while a 100-year storm has only a 1-in-100, or 1%, chance. Also shown in Table IV-1 is the 100-year, 10-day runoff event. This is normally associated with a springtime rainfall/snowmelt event.

Table IV-1. Storm Events

Recurrence Interval, Years	24-Hour Rainfall Amount, Inches
2	2.8
5	3.6
10	4.2
25	4.8
50	5.3
100	6.0
100	7.2 *

*10 -day Runoff Amount

2. Topography

The northern half of the South Washington Watershed District has a general drainage direction that runs north to south through the middle of the watershed. This drainage system has a series of elongated, sometimes isolated, depressional areas which contain the lowest elevations in this part of the watershed. Elevations above sea level range from 1070 in Oakdale to 880 at the Woodbury/Cottage Grove boundary. The major drainageway in the northern part conveys the stormwater from the cities of Oakdale and Lake Elmo, through Wilmes Lake and Colby Lake, to Bailey Lake in Woodbury. The terrain of this portion of the watershed is characterized by long continuous slopes, large spacing between ridges and knolls, and flat and wide valleys and draws.

The southern half of the South Washington Watershed has two distinctive types of topography. In the west, the topography varies from nearly flat to fairly steep slopes and the landscape is fairly well dissected by a series of draws that ultimately discharge to the Mississippi River. The southwest

corner of the watershed contains a very flat terrace area. Land surface elevations range from 1000 in the north to a low of 687, which is the normal pool elevation of the Mississippi River. In the east, the ground surface has elongated depressions that could be classified as intermittent streams, except very near the Mississippi River where the drop in elevation is rapid and the topography is somewhat bluff-like. There is one dominant ravine in the east with landlocked depressions in it. Topography in this area varies from elevation 980 in the north to the normal pool elevation of the Mississippi River of 687 in the south. Ravine areas in this southern half of the watershed are generally wooded with areas above the ravines flat and open for farming. Figure IV-1 shows the topographic and legal boundaries of the watershed.

3. Geology

Bedrock Geology

The bedrock geology of the SWWD reflects a complex mixture of depositional and erosional environments. During the early Paleozoic age, shallow seas covered the area. Carbonate was deposited in the deeper marine environments, silt-sized particles in the transitional areas, and sand in the near-shore and beach areas of the ancient sea. Over time, these sediments were compressed and solidified into sedimentary rocks.

Erosion of these sedimentary rocks occurred when the sea retreated, and deposition occurred when the sea advanced. Depending on the depositional environment, the bedrock formations exhibit the characteristics of aquifers or aquitard. Refer to the Washington County Geologic Atlas Plate 2 for more information and schematics of the bedrock sedimentary stratigraphic column.

Figure IV-1 South Washington Watershed Boundaries

In the SWWD, the Mount Simon sandstone formation comprises the Mount Simon aquifer, which is a regionally significant water source. It is composed of fine-to-coarse-grained sandstone and ranges in thickness from 160 to 225 feet. The aquifer is generally not used in the SWWD, due to the depth of the formation and the availability of other sources. The Mount Simon sandstone grades into the Eau Claire formation, which consists of approximately 100 feet of shale interbedded with siltstone and fine-grained sandstone. The Eau Claire is considered an aquitard (does not pass water freely).

The Eau Claire grades into the Ironton-Galesville formation, which consists of siltstone interbedded with fine to coarse-grained sandstone. The Ironton-Galesville is considered an aquifer, although it is not used widely in the SWWD. Overlying the Ironton-Galesville are the Franconia and St. Lawrence formations. The Franconia is composed of very fine-grained sandstone, while the St. Lawrence is a sequence of thinly bedded dolomitic shale and siltstone. These formations are both considered aquitards, although they exhibit permeabilities that are suitable for domestic water supply development.

The Jordan formation overlies the St. Lawrence. It is composed of fine-to-coarse-grained sandstone, approximately 100 feet thick. The Jordan forms the lower portion of the regionally significant Prairie du Chien-Jordan aquifer. The Prairie du Chien group is a series of thinly bedded dolostone and sandstone approximately 200 feet thick. The Prairie du Chien formation represents a past erosional surface; consequently, the fracturing caused by exposure provides secondary permeability and makes the formation a very productive aquifer. Taken together, the Prairie du Chien - Jordan aquifer provides water for the cities of Oakdale, Cottage Grove, and Woodbury, along with numerous high capacity irrigation, commercial, industrial, and public supply wells in the watershed.

Overlying the Prairie du Chien group is the St. Peter Sandstone. This formation is present in the central portion of the watershed. It has been eroded away in other parts of the watershed. Where it exists, the St. Peter is roughly 150 feet thick and consists of fine-to medium-grained well-sorted

sandstone. The basal portion of the formation is considered an aquitard, while the upper two-thirds is considered an aquifer. The Platteville-Glenwood formation and remnants of the Decorah shale overlie the St. Peter, primarily in the northwestern portion of the watershed. Both of these units are considered aquitards.

The bedrock surface in the watershed was altered by glacial processes during the Pleistocene epoch, approximately 1.5 million years ago. The most prominent feature is a north-south trending bedrock valley cutting through the center of the watershed. The valley was formed by a glacial tributary to the Mississippi River. The valley was excised into the Jordan sandstone, creating a hydraulic connection between overlying glacial sediments and deeper aquifers.

Surficial Geology

The topography of the SWWD is dominated by sediments dating from the late Wisconsinan glaciation, roughly 10,000 to 35,000 years ago. Meltwater from the Superior lobe of the Labradorean ice sheet created wide outwash plains throughout much of the watershed, creating regionally valuable sand and gravel deposits. As the glacier retreated, ice blocks were left behind in topographic lows on the bedrock surface. Melting of these ice blocks created many of the land-locked depressions and small lakes in Woodbury and Cottage Grove, including Bailey and Gables Lakes.

Superior lobe outwash sands and gravels mantle the bedrock surface in the watershed. The thickness of these glacially derived sediments ranges from less than ten feet in portions of Cottage Grove, to greater than 300 feet in the central buried bedrock valley cutting through Woodbury and Cottage Grove. The marked lack of outwash in southern Cottage Grove is due to variation in water level in the Mississippi River over time. Two separate terraces are apparent along the river in southern Cottage Grove. These terraces correspond to various periods of river downcutting in response to water level changes. The lack of glacial sediments in these terrace areas is cause for concern because of the proximity of the Jordan sandstone to the surface, and the potential for contamination of the aquifer.

Hydrogeology

There are four major aquifers available for use in the watershed. The water table aquifer is generally unconfined and recharged through direct infiltration from precipitation and leakage from surface water bodies. The surface aquifer discharges to the St. Croix and Mississippi Rivers, with a potentiometric high occurring in the northern portion of Washington County. The gradient of the water table system is relatively flat in the central portion of the watershed, but steepens near the Mississippi River in Cottage Grove. The water table aquifer has not been a major source for groundwater development, although the capability of the unit to produce water is high, particularly in the major and minor buried bedrock valleys. Water quality is generally very good, with the exception of locally contaminated areas. Currently, Cottage Grove is exploring the water supply potential of buried valleys in the city.

The Prairie du Chien - Jordan aquifer is the source for all high capacity wells in the watershed. It is confined by the St. Peter throughout the north central portion of the watershed; elsewhere, it is generally unconfined and overlain by glacial drift. Where the St. Peter exists, the Prairie du Chien - Jordan is recharged through leakage from the basal St. Peter. Where it is overlain by glacial sediments, the aquifer is generally unconfined and recharged by outwash deposits. The aquifer discharges to the Mississippi and St. Croix Rivers; a potentiometric high exists in the northern half of Washington County. The gradient is flat in the central portion of the watershed, but steepens near the Mississippi River. The potentiometric surface of the Prairie du Chien - Jordan aquifer is roughly 10-50 feet below that of the water table aquifer. Water quality in the aquifer is generally good, although tritium analysis of supply wells in Cottage Grove and Woodbury show a portion of the water contributing to the wells is less than 50 years old, indicating a vulnerability to contamination.

The Franconia-Ironton-Galesville aquifer is confined by the St. Lawrence formation in Washington County, which is the local source of recharge to the aquifer. The flow system in the aquifer closely resembles that of the Prairie du Chien - Jordan aquifer, but the water level is approximately 25'-50'

lower than that of the Prairie du Chien Jordan aquifer. The Franconia-Ironton-Galesville aquifer is not used in the SWWD, primarily because of the availability of the Prairie du Chien - Jordan aquifer.

The last major aquifer in the watershed is the Mount Simon sandstone. This aquifer is recharged through leakage from the Eau Claire confining unit within the county and subcrops to the north and northwest of the county. Information on groundwater movement within the aquifer is based on very limited data, but it appears that the St. Croix River is the primary discharge boundary for the aquifer. Because of the lack of data, a gradient is not obvious. The water level in the aquifer ranges from 0 - 150 feet below that of the Franconia-Ironton-Galesville aquifer. Currently, the Mount Simon aquifer is not an important water source for the watershed, although it could be in the future if contamination or excessive head loss become a problem with the Prairie du Chien - Jordan aquifer. The availability of the Mount Simon aquifer is not a given and the DNR would be issuing appropriation permits assuming it meets the DNR=s criteria. Water quality in the Mount Simon is good, but iron, manganese and excessive hardness can occur.

Groundwater Sensitivity

The Minnesota Geological Survey (MGS) and DNR rated the sensitivity of the water table aquifer and Prairie du Chien - Jordan aquifer in the watershed based on the relative travel time for water-soluble, geologically inert contaminants released at the surface to reach the water surface of each aquifer. The travel time was evaluated according to: 1) depth to water, and 2) vertical conductivity of geologic materials.

For the water table aquifer, the entire watershed was rated as high or very high. This indicates that the residence time of groundwater in this system is on the order of weeks to years. This means that water infiltrating in the watershed will reach the water table system in a very short period of time, leaving little opportunity for attenuation of contaminants through degradation.

For the Prairie du Chien - Jordan aquifer, groundwater sensitivity ranged from high in the Cottage Grove area, to moderate and moderately high in the eastern portion of the watershed, to very low in the western portion near Woodbury. See the Washington County Geologic Atlas Plate 6 for more detailed information.

4. Soils

Covering the glacial deposits are soils. Soils are small particles deposited by water and wind and enriched by decaying plant material. The SCS Soil Survey is the reference document for soils information. The soils map from the SCS shows broad areas that have a distinctive pattern of soils. Each map unit consists of several soil types. The unit is named according to the predominant soil type; therefore, the soils making up one unit can occur in other units, but in a different pattern. The SWWD is comprised of a variety of soils. The most common soils, such as those in the Antigo-Chetek-Mahtomedi map unit and the Sparta-Dickman-Hubbard map unit, are formed dominantly in outwash under deciduous hardwood forest or prairie. The Antigo-Chetek-Mahtomedi soils are well drained to excessively drained, medium textured to coarse textured soils, typical on low convex side slopes or knolls, crests and side slopes. The Sparta-Dickman-Hubbard soils are somewhat excessively drained and are coarser textured soils than the Antigo type. These soils occupy broad flats and knolls. The surface layer is dark brown-black loamy sand, while the subsoil is dark brown sandy loam in the upper part and dark brown sand underneath. Typical seasonal high water tables for these soils are below a depth of 6 feet. Other soils in the SWWD are also well drained and sandy loamy types.

Crops and pastures produced in the farming soils of the watershed include corn, soybeans, oats, legume hay, bromegrass, alfalfa, and Kentucky bluegrass. Common native trees include a variety of pines (such as the red pine, eastern white pine, and jack pine), American elm, maples, and oaks (red, white and bur). Soil erosion is a common problem on disturbed sites. However, the erosion problem can be much worse when there are steep slopes present.

B. Hydrologic System

1. System Overview

The South Washington Watershed District hydrologic boundary is illustrated on Figure IV-1 and Map 1. The hydrologic boundary is defined by high topographical points or ridges that delineate drainage basins and the direction that runoff will follow. The hydrologic boundaries or ridges for the watershed are defined typically by elevation 1050 in the north areas, 1000 in the central areas, and 950 in the southern portion. The Mississippi River is the southern boundary of the watershed and has a normal pool elevation of 687. The difference in elevation from the topographic highs to the Mississippi River demonstrates the steep topography that exists in the draws of the watershed in the southern areas.

The Mississippi River is the southern boundary of the South Washington Watershed District. This river is the natural waterway that receives and transports the runoff from the watershed down to the Gulf of Mexico. According to records of the hydrometer station at the Wabasha Bridge in St. Paul, Minnesota, the river at this point has an average discharge rate of 10,530 cubic feet per second (cfs), and a maximum discharge of 171,000 cfs. The Wabasha Bridge station is located approximately 10 miles upstream of the South Washington Watershed District.

~~In the southern portion of the South Washington Watershed District, there are two major natural drainageways that drain to the Mississippi River. These drainageways run north to south and are located in the southeastern portion of Cottage Grove.~~

The 34,000-acre SWWD watershed has numerous natural elongated depressions that run through the middle of the northern areas and exist as various ravines in the southern areas. In the north, the depressions typically do not have natural outlets except for very large storms. Geologic history indicates that glacial drainage created several ravines to the Mississippi River. The easterly ravine extends from Cottage Grove Ravine Park north through Bailey, Colby Wilmes, Powers and Markgrafs Lakes. The drainage area would have collected all the area in this subwatershed including CD-P85 and CD-P86 North. The westerly half of the watershed would drain through the west ravine

area of Cottage Grove. The runoff from this area would terminate in the glacial river terrace along the Mississippi River. Drainage from the central ravine area of Cottage Grove is also include in this subwatershed. The drainage pattern of the SWWD is a glacial remnant and would require similar volumes of water to recreate this pattern.

~~In the north, a central~~ The easterly drainage~~way~~ begins at Armstrong Lake ~~in the north~~ in Oakdale flows south through ~~and~~ Lake Elmo, into Woodbury and travels approximately 7 miles to Bailey Lake at Dale Road. The outlet for Bailey Lake is a pump station , constructed in 1994, that discharges into a large infiltration basin in Woodbury, known as CD-P85. ~~A permanent outlet to the Mississippi River has been proposed, but has not yet been built. This outlet is identified as a SWWD project and is discussed in greater detail later in the report.~~ The natural overflow point for Bailey Lake is over County Road #19 and to the southeast towards Gables Lake. The construction of the Bailey Lake lift station has directed the overflow to the southwest. Overflow from CD-P85 will flow south into CD-P86 north, the elevation of County Road #19 will force the water into CD-P86 south and eventually to 70th street in the City of Cottage Grove.

~~Major basin and lake elevations tend to decrease from north to south in the watershed usually following the buried bedrock valley. Powers Lake, which has a history of fluctuating water levels, is located along the path of the bedrock valley and has a water level typically lower than the adjacent Wilmes Lake, but similar to downstream Colby Lake.~~

~~South of Gables Lake and DNR Protected Water #84W, the topography changes from a series of depressions to steeply sloped, channels with little evidence of significant flows. The easterly drainageway runs south through the Cottage Grove Ravine Regional Park. A box culvert exists beneath T.H. 61 which drains to the Mississippi River, but some obstructions between the culvert and the Regional Park waterbody in the past have caused flooding of the park entrance road. The recent high water levels in the Regional Park waterbody appear to be caused by higher than normal groundwater elevations in the area.~~

The westerly drainage~~way~~ area includes approximately 9300 acres and runs northwest to southeast. Serveral ~~with a series of~~ small ~~drainages~~ tributaries feed~~ing~~ into the main ravine which enters the ~~it and outlets into the~~ Mississippi River ~~just west of the 3M industrial complex~~ at the existing wastewater treatment plant. ~~Approximately 9,300 acres of land naturally drains to this drainageway~~. The topography in this subwatershed is similar to the topography in the rest of the watershed but with moderately steep slopes. ~~The extreme northern portion contains several low depressions that act as landlocked ponding areas. The northwest portion of this subwatershed drains into a landlocked basin located just north of the boundary of the cities of Woodbury and Cottage Grove. The City of Woodbury has installed a lift station to be able to pump from this basin to another landlocked basin on the Woodbury-Cottage Grove border. The northeastern portion flows through an intermittent stream channel which eventually dead ends into a landlocked area just south of 70th Street in Cottage Grove.~~

The southwestern portion of this subwatershed includes a wide flat river terrace area. The flat terrace areas in the southwest portion of the SWWD drain directly to the Mississippi River through many small drainageways. The terrace areas are very sandy and in their natural state do not appear to produce significant runoff.

2. ~~Existing~~ Major Drainage Areas ~~System~~

The SWWD can be divided into four major sub-watersheds ~~drainage districts., The~~ North~~ern~~, ~~Central~~, South East and South West ~~Drainage Districts~~. ~~The term "Drainage District" is used to describe the hydrologic land features that correspond to land that drains to common areas. The term Drainage District is used here in order not to confuse it with "subwatersheds" which can be used in project financing.~~ These sub-watersheds define the major drainage areas of the SWWD. The SWWD has delineated minor sub-watershed as a result of surface water modeling efforts.

Combinations of minor sub-watersheds form sub-watersheds used for projects, management standards, or major drainage areas (Figure XX).

Northern Sub-watershed Drainage Area ~~District~~

The Northern Sub-watershed Drainage Area ~~District is located in the northern portion of the South Washington Watershed District. This drainage district is the smallest of the four drainage districts in the SWWD with an area of 1,600 acres. It is shown as Project Subwatershed 1 on Map 1 at the back of the report.~~ The general drainage system in the Northern sub-watershed ~~Drainage District~~ is characterized by numerous small drainage~~s~~ areas and a larger network of ~~partially~~ landlocked basins ~~wetlands and Armstrong Lake~~. ~~There are three major wetland basins present, which are DNR Protected Wetlands: #420W, #422W, and #431W. These all drain to Armstrong Lake, which is DNR Protected Water #116W.~~ The headwaters of the Northern sub-watershed is Armstrong Lake in the City of Oakdale. From Armstrong Lake water drains to the south through the City of Lake Elmo, into the City of Woodbury, through Wilmes Lake to Colby Lake and eventually to Bailey Lake. From Bailey Lake surface water is pumped via the Bailey Lake lift station to a depressional area due west of the lift station. This depressional area known as CD-P85 has provide the primary outlet for the northern watershed since the lift station was constructed in 1994. If excess water from CD-P85 were to overflow, the water would naturally flow into the next downstream basin known as CD-P86Excess stormwater has been pumped into CD-P85 and allowed to infiltrate into the ground water table. The lift stations has operated since 1994 on an annual basis for the purpose of a pump maintenance program and a fall draw down program to increase storage for spring runoff events. Since the construction of the lift station operation has been require approximately two times to handle excess runoff in 1997 and 1998.~~The southern portion of the drainage district is characterized by a central draw which becomes fairly steep as it nears I-94. There is a steep, 72" culvert under I-94 to carry flows from this drainage area to the south. The intermittent stream from Armstrong Lake to I-94 and beyond to Wilmes Lake is designated a DNR Protected natural waterway.~~

The Central Drainage District receives the flow from under I-94 from the North Drainage District. The Central Drainage District occupies the north-central portion of the South Washington Watershed District and has an area of approximately 17,600 acres. It is shown on Map 1 as Project Subwatersheds 2 and 3.

The Central Drainage District contains 17 DNR protected wetlands along with six lakes, which are also DNR protected waterbodies: Markgrafs, Wilmes, Powers, Colby, Bailey, and Gables lakes. Many of the wetlands and lakes in the drainage district have been connected and incorporated into the main drainage system. The main drainage system runs north to south from I-94 to Bailey Lake, CD-P85, and CD-P86. Gables Lake and East Cottage Grove wetlands, while not currently connected to the main drainage system, are considered part of this drainage district. Several sub-drainage areas flow into the main drainage system. The intermittent stream between I-94 and Wilmes Lake is a DNR protected natural waterway.

There are approximately 500 acres in the Drainage District in the City of Afton. This area, which is mainly farmland, drains into two ponding areas in Woodbury.

Powers Lake is located in a low topographical depression, which requires the use of a pumping facility in order to discharge the outflow to the main drainage system at Wilmes Lake. The pumped outflow rate for Powers Lake will be fairly small, on the order of 5 ~~to 10~~ cfs.

The southeastern portion of the Drainage District consists of a series of land-locked basins that lie along the alignment of the buried bedrock valley. The two major depressions are Gables Lake (DNR #82W) which is in a large depression and is separated by a high point at an elevation of about 900 from a large wetland basin known as the East Cottage Grove Wetland (DNR #84W).

Cottage Grove Central Ravine Sub-watershed Drainage Area ~~District~~

The Cottage Grove Central Ravine Sub-watershed drains the central area of the City of Cottage Grove. The Central Ravine Sub-watershed has an area of approximately XX acres.

~~The Central Drainage District receives the flow from under I-94 from the North Drainage District. The Central Drainage District occupies the north-central portion of the South Washington Watershed District and has an area of approximately 17,600 acres. It is shown on Map 1 as Project Subwatersheds 2 and 3.~~

~~The Central Drainage District contains 17 DNR protected wetlands along with six lakes, which are also DNR protected waterbodies: Markgrafs, Wilmes, Powers, Colby, Bailey, and Gables lakes. Many of the wetlands and lakes in the drainage district have been connected and incorporated into the main drainage system. The main drainage system runs north to south from I-94 to Bailey Lake, CD-P85, and CD-P86. Gables Lake and East Cottage Grove wetlands, while not currently connected to the main drainage system, are considered part of this drainage district. Several sub-drainage areas flow into the main drainage system. The intermittent stream between I-94 and Wilmes Lake is a DNR protected natural waterway.~~

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Southeast Drainage District

The Southeast Drainage District is located in the southeastern portion of the SWWD. This area contains approximately 3,200 acres of land (Figure XX). ~~It is shown on Map 1 as Project Subwatershed 4~~. This area is largely undeveloped and the topography typically has flat plains with steep slopes and a series of elongated depressions. The natural topography forms a ~~dry~~ ravine which runs north to south ~~with some minor landlocked basins within the ravine~~.

The Cottage Grove Ravine Regional Park (Regional Park) is a major feature of this Drainage ~~District~~ area and contains a large waterbody (DNR #87W) within the ravine about midway down the drainage pattern. The water levels in this waterbody have risen in recent years, changing the system from a wetland-like system to more like a lake system. For this report the waterbody will be discussed in the lake section even though it possesses both lake and wetland characteristics. The Regional Park has an outlet under T.H. 10 and 61. Recently, the County has responded to rising water levels in the park's lake that has flooded the entrance roadway by excavating a channel connecting the park's lake to the culvert under T.H. 10 and 61. From T.H. 10 and 61, the ravine travels to the Mississippi River, although there is no evidence that significant flows have traveled through the ravine in recent history.

The Southeast Drainage District contains one protected DNR wetland: #87W. The ravine from 80th Street through the Regional Park and to the Mississippi River has been designated a protected natural waterway under the DNR's Protected Waters Program although much of the ravine does not show evidence of flowing water. The lack of flowing water is presumably due to the excessively well drained sandy soils in the tributary drainage area and in the ravine bottom itself.

Southwest Sub-watershed Drainage Area ~~District~~

The Southwest Drainage District is located in the southwestern portion of the SWWD and has an area of 11,400 acres. It is shown as Project Subwatersheds 5, 6, and 7 on Map 1. The main drainage system runs northwest to southeast, starting in the southwestern corner of Woodbury and would eventually discharge to the Mississippi River in the south in Section 34. Several storm drainage facilities connect into this main system along T.H. 10 and 61. The Southwest Drainage District topography has natural ponding areas in the very upper reaches with ravines in the central portions and flatter river terraces in the southern areas.

This Drainage District begins in Woodbury just east of La Lake which is outside the SWWD. The northwestern portion of the Drainage District is landlocked and has a tributary area of 852 acres. The elevation of the topographic high point separating the last depression at the Woodbury-Cottage Grove border and the intermittent stream is approximately 880.

The central portion of this drainage district has a western branch and an eastern branch. The western branch includes what is known locally as the West Draw and passes under T.H. 10 and 61 near 80th Street. The eastern branch crosses T.H. 10 and 61, east of Jamaica Avenue. The two branches join just south of T.H. 10 and 61 at DNR protected wetland #86W.

The southern portion of the Southwest Drainage District is typically flat with sandy soils and in some places shallow bedrock. The amount of direct runoff that can potentially drain into this ravine makes it an important waterway. This waterway must pass through three ponding/wetland areas before reaching the Mississippi River. The channel and the wetland in the ravine are protected by the DNR. A small portion of the Southwest Drainage District drains directly into the Mississippi River through small local drainageways.

3. Existing Flood Level Information

Federal Flood Insurance Studies (FISs) are available at the DNR's Division of Waters and the City of Cottage Grove. The only FISs addressing areas in the SWWD are those areas directly adjacent to the Mississippi River. For further information on the extent of the floodplain along the river, the FIS for Cottage Grove is available from the City of Cottage Grove.

All the cities with waterbodies in the watershed have some form of local stormwater plans that give some information on flood levels of the waterbodies in the watershed. The information in the plans continues to change and be updated as changes occur in the communities. This data is generally more accurate than the level of detail used in a watershed management plan and therefore was used by reference in developing the WMP. The detailed local information on flood levels can be obtained through the public works departments of each city.

4. History of Stormwater Management in the Watershed

Stormwater management became a significant issue in the 1970's when the watershed encountered steady suburban-type urbanization. Until the early 1980's, the principal institutions responsible for local stormwater management planning and implementation were the cities. Early stormwater management planning in the watershed included the 1979 Woodbury Storm Drainage Plan and the 1984 Cottage Grove Comprehensive Storm Drainage Plan. Both plans included the entire city, which covered most of the area in the SWWD.

The drainage systems presented in the plans accounted for full development of the cities. The general approach used in the Woodbury and Cottage Grove plans is to provide outlets for landlocked basins once urbanization occurs to control water levels in the basins. The connection of numerous landlocked areas within the northern portion of the watershed necessitated planning for a central drainage system. The 1979 Woodbury plan shows the central drainage system as carrying runoff water from the northern portion of the watershed to its southern border. It would then need to be

transported downstream to the Mississippi River. The central drainage system shown consists of a gravity system connecting the lakes that lie in the center of the watershed.

The 1984 Cottage Grove plan shows the upstream central drainage flow from Woodbury being carried through the eastern portion of the city to the Mississippi River. The planned stormwater system consisted of gravity connections between landlocked basins and a natural drainage channel to the Mississippi River. The other areas in Cottage Grove in the western and central portions of the city were shown to be conveyed to the Mississippi River through pipes, man-made channels, and natural channels and includes outlets for landlocked areas in the city.

The cities of Oakdale and Lake Elmo prepared or had prepared for them basic stormwater plans that documented existing hydrologic conditions and flows. The City of Afton did not prepare stormwater plans for the portion in the SWWD. The portion of Lake Elmo in the SWWD (which includes areas that are now in Oakdale) was covered by a 1986 Lake Elmo-Cottage Grove Ravine WMO Local Water Management Plan prepared for the City by the Washington County Soil and Water Conservation District. The 1986 Lake Elmo plan does not propose any significant modifications to the existing drainage system except to repair and maintain the drainage way and further study of the 100-year flood plane at the time of any major development in the area.

Pursuant to Minnesota's 1982 Surface Water Management Act, a joint powers Watershed Management Organization (WMO) called the Cottage Grove Ravine WMO was formed in 1984 to manage the water resources of the area that is now the SWWD. The joint powers agreement included the same five cities that are currently included in the SWWD. The boundaries of the two organizations are virtually the same except that the WMO included the eastern half of Grey Cloud Island which is not included in the current SWWD boundaries.

The Cottage Grove Ravine WMO prepared a draft Watershed Management Plan (WMP) in 1988. The WMO draft WMP includes a drainage system generally consistent with the city plans. The

central drainage system shown is a series of landlocked basins interconnected and an outlet system to the Mississippi River. The Cottage Grove Ravine WMO draft WMP shows additional ponding north of I-94 not shown in the 1986 Lake Elmo Plan.

The Cottage Grove Ravine WMO draft WMP stresses cooperative efforts by the member cities. The WMO outlined a process where implementation and enforcement of controls would be carried out by the cities once they adopted their Local Municipal Management Plans. The WMO draft WMP was never adopted since the WMO could not obtain a four-fifths majority to adopt the WMP as was required in the joint powers agreement.

With the WMO unable to adopt and implement its WMP, the WMO was dissolved which led to the formation of a Watershed District (WD) in 1993 known as the Cottage Grove Ravine WD. The Cottage Grove Ravine WD decided in 1995 to change its name to the South Washington Watershed District (SWWD) to prevent confusion with the City of Cottage Grove. The SWWD is the entity that has prepared this WMP.

The SWWD is faced with the past issues of addressing intercommunity water resource issues such as preventing flooding due to urbanization as the drainage system continues to be expanded to include new areas. In addition, the SWWD is also responsible to address new concerns over water quality, lakes, wetlands, and loss of natural areas. The SWWD shares the approach used by the WMO to keep as much of the implementation and enforcement as possible at the local level in order to reduce administrative costs. Like the WMO, the SWWD will still maintain oversight to ensure compliance with the standards presented in the WMP.

The majority of the drainage issues and improvements that were needed in the watershed up until now have been implemented by the individual cities. The nature of the improvements up until now have been fairly easy to implement at a local level, even though some improvements have included some portion of intercommunity drainage. The major drainage or flood control issues facing the

SWWD at this time are intercommunity drainge improvements that are not easily dealt with at a city level.

The largest drainage improvement facing the watershed currently is the potential for flooding in the central draw in Woodbury until an outlet of some type is provided. The potential for flooding in the central draw is due to the rapid urbanization of the watershed. The urbanization has led to the connection of many landlocked areas as shown in the Cities= previous stormwater plans. However, the outlet that was assumed in the stormwater plans does not yet exist.

In 1993, the City of Woodbury began looking at what intermediate steps and options would be possible at Bailey Lake, which was the end of the central draw drainage system at that time. The summer of 1993 was an unusually wet period and Bailey Lake water levels increased significantly, covered Dale Road, and flooded and killed many older trees around the basin.

In 1994, the City of Woodbury took several measures to formalize Bailey Lake as part of the City=s stormwater drainage system and to provide additional capacity to the system to help prevent flooding. The improvements at Bailey lake included:

- ∃ Acquire the land encompassing the Bailey Lake basin through fee title and easements.
- ∃ Raise Dale Road to prevent it from being flooded based on the 1979 Stormwater Plan HWL established for Bailey Lake.
- ∃ Relocate one home at the south end of Bailey Lake that was inadvertently built too low.
- ∃ Raise several driveways for homes at the south end of Bailey Lake.
- ∃ Install an outlet structure with removable stop logs at Dale Road to allow control of the Bailey Lake NWL.

The City of Woodbury also incorporated several improvements to provide additional capacity to the system and lower, but not eliminate, the flooding risk until an outlet was provided. The extra capacity was generally in the form of additional storage and infiltration areas and included:

- Open a channel from Bailey Lake at Dale Road to a depression (South Bailey Stormwater Basin) that appears to be good for infiltration along County Road 19.
- Purchase land for a ponding and infiltration basin at the cent of Section 34 known as CD-P85.
- Build a lift station with an ultimate capacity of 180 cfs and install half of the pump and force main capacity at South Bailey Stormwater Basin to pump water approximately 30 feet higher to CD-P85.

C. Biological Environment

The lakes, watercourses, and wetlands in the South Washington Watershed are valuable for recreation, flood storage, groundwater recharge, sediment collection and nutrient entrapment. Their aesthetic value, as well as their support of fish and wildlife, can be priceless benefits.

1. Lakes

A total of eight lakes within the watershed were inventoried for general characteristics (size, depth, watershed area) and water quality. These lakes are Armstrong, Markgrafs, Wilmes, Powers, Colby, Bailey, Gables, and Regional Park (unnamed).

Armstrong Lake is approximately 39 acres in size and has a contributing watershed of 487 acres. It is divided into two parts by County Road 10. A culvert under the road connects the two parts. The northern portion of the lake has a maximum depth of 3 feet while the southern portion has a maximum depth of 5 feet. The northern portion of the lake has a large area of cattail and is more characteristic of a deep marsh system than a lake due to its shallow depths. The southern portion of

the lake is a deeper water system with macrophytes. The southern portion was assessed as a lake system and the northern part will be considered a lacustrine wetland. Figure IV-2 shows the lake depth in several locations.

Markgrafs Lake is approximately 46 acres in surface area and has a contributing watershed of 413 acres. The lake has a storm sewer outlet that was installed in 1990. Access is available via Brookview Road at the south end of the lake. A bathymetric map is presented in Figure IV-3. The lake has a maximum depth of 8 feet.

Markgrafs is occasionally used by the DNR Fisheries as a rearing pond for walleyes. This is possible due to the low dissolved oxygen preventing the survival of game fish during ice over conditions in the winter. Without the predation of game fish such as northern pike, walleye fingerlings are allowed to grow throughout the summer months and are removed prior to ice cover. The DNR will likely continue to use this as a rearing pond for walleyes.

Wilmes Lake is divided into two parts by a berm. A culvert under the berm connects the two parts. The northern portion is 15 acres in size and the southern portion is 13 acres. The total future drainage area to Wilmes Lake will be approximately 5,030 acres with a direct drainage area of 670 acres. The ultimate watershed to the northern portion of the lake was completed during the time of this WMP in 1996. A 48" RCP outlet is located at the southern tip of the lake. There is a public access planned for the northern tip of the lake.

A bathymetric map of Wilmes Lake is presented in Figure IV-4. The southern portion of the lake has a maximum depth of 7 feet while the northern portion has a maximum depth of 18 feet.

FIGURE IV-2

FIGURE IV-3

Powers Lake is 56 acres in size with a total planned drainage area of 1,238 acres. The lake has two main inlets: a small stream on the east side and a concrete culvert under Woodbury Drive.

A lift station was installed in 1995 and currently serves as the outlet for this previously land-locked lake. A public access and fishing pier are proposed to be constructed just east of County Road 19. The DNR has done fishery surveys in 1977, 1984, and 1992, but has not conducted fish stocking due to the lack of a public access. Fisheries management could begin following the construction of the public access. Based on the limited fisheries and water quality data, and on conversations with anglers, it appears that the lake can and does possess a fairly good self- propagating game fish population.

A bathymetric map, furnished by the DNR, is presented in Figure IV-5. Powers Lake has a maximum depth of 41 feet and a littoral zone (fringe area from 0 to 15 feet in depth where macrophytes grow) covering about 48 percent of its surface.

Colby Lake is 70 acres in size with a total planned drainage area of 8,088 acres. The DNR successfully used this lake as a rearing pond in 1989 and potentially will use it again in the future. Water quality information for the summer of 1994 is available from the Metropolitan Council as part of its Citizen Assisted Monitoring Program. A bathymetric map recently completed by the DNR is shown in Figure IV-6.

Bailey Lake historically has had fluctuating water levels, but during most years it has been a series of isolated wetlands. Due to landlocked conditions and development occurring upstream, runoff has increased to the basin and caused it to become one large open body of water. In 1994, an outlet and a control structure in combination with a pump station were constructed to manage the water level of the lake. Bailey Lake, North and South, currently is approximately 80 acres in size at a NWL of 870 feet, with a total future contributing watershed of 12,600 acres. The maximum depth of the lake, as of August 1994, was 17 feet. This depth should be conducive to creating a game fishery;

figure iv-4

Figure iv-5

Figure iv-6

however, water quality will dictate which type of fishery becomes established. There currently is no public boat access on the lake. A bathymetric map of Bailey Lake is shown in Figure IV-7.

Gables Lake is 5 acres in size with an existing direct drainage area of 450 acres. No bathymetric map for Gables Lake was developed or is available. It is estimated that the maximum depth is about 5 feet and fluctuates somewhat depending on yearly rainfall. This waterbody may actually be closer to a wetland in characteristics.

Regional Park Lake is referred to as such in this report due to its location in the Cottage Grove Ravine Regional Park; however, this is not an official name. This waterbody is approximately 16 acres in size and currently has a drainage area of approximately 600 acres. This waterbody formerly existed as a Type 4 wetland, but due to higher water levels in recent years, it more closely resembles a lake now. It is not clear whether this waterbody will continue to exist as a lake or revert back to a wetland-type system in the future due to its apparent reliance on groundwater and higher than normal groundwater levels in recent years. The maximum depth of the lake, as of August, 1994, was 19 feet. This depth should be conducive to creating a game fishery; however, water quality will dictate which type of fishery becomes established. Currently there is no formal public boat access to the lake. A simple bathymetric map of the lake is shown in Figure IV-8.

Lake Water Quality

Powers, Colby, Wilmes, and Markgrafs Lakes were each sampled 9-13 times from May to September of 1994 through a citizen monitoring program coordinated through the Metropolitan Council. The SWWD and member cities will be sampling Armstrong, Bailey, Gables, and Regional Park Lakes at a frequency similar to the Metropolitan Council monitoring program. A spot check of total phosphorus, chlorophyll-a, water clarity and depth measurements was completed for Armstrong, Bailey and Regional Park Lakes by the SWWD in 1994. These measurements were taken to get an idea of the water quality of these lakes due to the lack of historic data. A more

figure iv-7

Figure iv-8

intensive monitoring plan will be implemented by the watershed if these lakes are not included in the citizen monitoring program in 1995. The following data represents a preliminary assessment of the lakes; this will be adjusted as more data on these systems becomes available in the future.

Ecoregion values were used to evaluate the lakes within the watershed. This allows an evaluation of lakes that should be similar in water quality based on location, land use, soils, land form and potential natural vegetation. The MPCA, in cooperation with the Environmental Protection Agency (EPA), has developed a means to geographically group Minnesota lakes based on the above characteristics. These areas are called aquatic ecoregions. There are seven of these ecoregions in the state, as shown in Figure IV-9 (from Wilson and Walker, 1989). The Twin Cities Metropolitan area is within the ecoregion known as the North Central Hardwood Forest.

Lakes within an ecoregion should be somewhat similar to each other. Ecoregions also provide a means for gathering useful information for setting water quality goals. The potential water quality of a lake may be estimated based on data for the lakes having the best water quality for the ecoregion. The MPCA refers to these lakes as minimally impacted lakes. These minimally impacted lake values were used as a comparison for the lakes within the SWWD.

Phosphorus is a chemical element that is essential for plant growth. Concentrations of total phosphorus indicate the maximum growth potential for algae and macrophytes in a lake. High phosphorus concentrations will generally result in either dense macrophyte or algal blooms. The frequency and severity of these algal blooms is dependent upon phosphorus concentrations. Total phosphorus values for minimally impacted lakes in this ecoregion are between 23 and 50 parts per billion (ppb)[1]. The 1994 summertime (May through September) mean concentrations for Colby, Markgrafs, Powers, and Wilmes Lakes are shown in Figure IV-10. In addition Armstrong, Bailey, and Regional Park Lakes were sampled once in August of 1994 by the SWWD. The results of the total phosphorus sampling for these lakes are included in Figure IV-10.

FIGURE IV-8

FIGURE IV-9

Of the eight lakes assessed, only Powers Lake currently has total phosphorus levels which are within the levels considered as minimally impacted. The 1994 mean summertime (May through September) total phosphorus concentration was 31 ppb. (Number of samples (n)=11).

Wilmes Lake has phosphorus levels which are near the required threshold for minimally impacted lakes. The 1994 mean summertime (May through September) total phosphorus concentration was 58 ppb (n=10).

The rest of the lakes sampled had total phosphorus values which exceed the levels of minimally impacted lakes in this ecoregion. The total phosphorus readings for Bailey, Regional Park, and Armstrong Lakes were 180, 120 and 150 ppb, respectively. The high total phosphorus readings have likely caused the abundant algal amounts which are discussed in the following paragraph.

Chlorophyll-a is a photosynthetic pigment found in all green plants. The concentration of chlorophyll-a is a measure of algal abundance. If the algal populations are dense, the water will become noticeably green or brown and will have low transparency. These conditions limit the recreational and fishery use of a lake. In certain circumstances high algal amounts, which die off under ice covered conditions, can contribute to winter fish kills. Chlorophyll-a values for minimally impacted lakes in this ecoregion are between 5 and 22 ppb.

All of the lakes assessed in 1994, except Powers and Wilmes lake, have chlorophyll-a values which exceed the levels of minimally impacted lakes in this ecoregion which is shown in Figure IV-11. The chlorophyll-a readings for Bailey, Colby, Markgrafs, Regional Park and Armstrong Lakes were 55, 56.7, 44.1, 36, and 55 ppb respectively. These high chlorophyll-a readings have likely caused the decrease in water transparency discussed in the following section.

FIGURE IV-11

Powers and Wilmes Lakes have chlorophyll-a values of 8.1 and 12.7 ppb, respectively. These chlorophyll-a readings are consistent with those found on minimally impacted lakes and have resulted in the greater water clarity of Powers and Wilmes Lakes.

Secchi disc transparency is a measure of water clarity. A Secchi disc is a circular disc with alternating white and black quadrants. It is lowered through the water column on the shaded side of a boat, and the depth at which it disappears is recorded. This is a visual estimate of the clarity of water and the depth of light penetration in a lake. A higher Secchi disc transparency indicates greater water clarity. The Secchi disc values for minimally impacted lakes in this ecoregion are between 4.9 and 10.5 feet.

Secchi disc transparencies for lakes within the SWWD are shown in Figure IV-12. Powers and Wilmes Lakes, with 1994 Secchi disc readings of 7.5 and 10.5 feet, respectively, are the only lakes in the watershed which fall within the minimally impacted lake values. Armstrong, Bailey, Colby, Markgrafs and Regional Park Lakes had Secchi disc values which did not meet the standards of minimally impacted lakes in this ecoregion. The Secchi disc readings for Armstrong, Bailey, Colby, Markgrafs, and Regional Park Lakes were 1, 2, 1.6, 3.3 and 1.5 feet, respectively. It may not be possible or realistic for some of these basins to meet minimally impacted standards, but this serves as a uniform standard for comparison purposes between lake basins.

Trophic state is a type of lake classification. It is based on Carlson's Trophic State Index (Carlson, 1977). This index indicates nutrient enrichment and is calculated based on measured values for total phosphorus, chlorophyll-a and Secchi disc transparency. This index is used to assess the quality of a lake. It provides a quantitative means of assessing lake changes after protection and restoration practices have been implemented. Trophic State Index (TSI) values for the lakes sampled along with the corresponding recreational suitability are shown in Figure IV-13.

FIGURE IV-12

FIGURE IV-13

The TSI for Powers Lake is 49, which is the lowest of the lakes studied in the watershed. This value indicates the lake is mesotrophic (moderate nutrients) and thus has relatively good water quality. Mesotrophic lakes are considered moderately clear and fully swimmable by the users of these lakes.

Wilmes Lake has a TSI of 56. This value indicates the lake is eutrophic and has relatively moderate water quality. Eutrophic lakes are often perceived as having poorer water clarity then a mesotrophic lake and often are swimmable, but may be considered nonswimmable by some users of these lakes.

The other lakes within the watershed are hypereutrophic. Hypereutrophic lakes are considered nonswimmable by the users of these lakes. The values for Armstrong, Bailey, Colby, Markgrafs and Regional Park were 69, 72, 71, 67 and 68, respectively. These values indicate the potential for heavy algal blooms throughout the summer and/or dense macrophyte beds. Hypereutrophic lakes are perceived as having very poor water clarity and normally are considered nonswimmable.

2. Wetlands

Wetlands are a valuable resource. Research results over the past 20 to 30 years have documented various ecological and socially beneficial functions that are performed by wetlands. Among these are water quality improvement, flood control, fish and wildlife habitat, cultural and recreational resource values, education and interpretation values, habitat for unique plant and animal species, groundwater recharge, nutrient removal, and perhaps others that have yet to be discovered.

Wetlands are widely divergent in their quality. Many have been marginally to substantially impacted by surrounding land uses. Wetlands will vary in quality depending on past and present land uses. This variation can be useful in evaluating what types of future land uses are appropriate as well. The key consideration in determining future uses is water quality, since water is the means by which sediment and nutrients enter and leave the wetland. Depth and persistence of water also can determine the types of vegetation that will dominate. Wetlands are highly dynamic hydraulically, but

a wetland without vegetation is a rare sight, even during the most severe drought. The plant species seed bank within a wetland is highly diverse in order to respond to the changing hydrologic conditions.

Wetlands, lakes and rivers are part of a dynamic system which has been in the making for hundreds, thousands and sometimes even millions of years. Water resources have been impacted more in the last 400 years than in the previous 4000 years. Wetland deterioration can be caused by the earth's natural erosion process. This erosion is mainly caused by the following:

- Wind
- Precipitation
- Freeze/Thaw Cycles

Human activity accelerates the erosion process and threatens the existence of many of our water resources. A waterbody's water quality is in large part a reflection of the human activities taking place in its watershed. Whatever reaches the storm sewer will reach the wetlands, streams, lakes and rivers.

Having an understanding of wetland hydrology and ecology along with the influences of past land uses is essential in developing a system of wetland evaluation that will permit the wise planning and long term use of wetlands within an urbanizing area. The first steps in creating a management plan for wetlands are to inventory, evaluate, and classify the resource.

National Wetlands Inventory

The National Wetlands Inventory (NWI) maps use high altitude (40,000 feet) aerial photography to determine wetland boundaries and classifications. While this may be appropriate for regional inventories, these photographs lack the accuracy required for use at a watershed level other than as a general guide for what wetlands can be expected in an area.

The SWWD wetland inventory methodology was developed within a Geographic Information System (GIS) framework. The data sources used were digital NWI data obtained from the state of Minnesota Land Management Information Center and hydric soil information derived from the SCS soil survey. The NWI boundaries were combined with the hydric soil boundaries using GIS. Including the hydric soils on the NWI map aids in locating potential wetland areas not shown on the NWI map.

The wetland acres presented in Table IV-2 were determined using the NWI data. These often have a margin of error on the low side, so it is likely the watershed has a larger acreage of wetlands than indicated in Table IV-2.

Table IV-2 . Wetland Areas

Wetland Type	Acres	% of Total Wetlands
Type 1 - Type 4	474	66
Type 5	220	31
Type 6	10	1
Type 7	14	2

The wetland types shown in the Table IV-2 are described in the appendices along with the other major wetland hydrologic classification scheme, the Cowardin Classification.

SWWD Wetland Classification System

The SWWD has classified wetlands within the watershed according to a functional value classification system called the Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire (1991), or simply the New Hampshire Method. Wetland function depends on the

specific biological and physical features of each wetland site. The method addresses 14 functional values of wetlands, which are listed in Table IV-3. A description of the New Hampshire Method and samples of its data sheets is given in Appendix F. Not all the functional values shown below were needed or deemed appropriate, so select functional values were used. The results of the limited inventory and evaluation of wetlands is presented in Appendix D.

Table IV-3 . Functional Values By The New Hampshire Method

1.	Ecological integrity	8.	Groundwater use potential
2.	Wetland wildlife habitat	9.	Sediment trapping
3.	Fish habitat	10.	Nutrient attenuation
4.	Educational potential	11.	Shoreline anchoring
5.	Visual/aesthetic quality	12.	Urban quality of life
6.	Water-based recreation	13.	Historical site potential
7.	Flood control potential	14.	Noteworthiness

A functional value classification will aid in the management of the wetland resources within the watershed. Management of the wetland resources is discussed later in the report.

DNR Wetlands

At the State level, lakes and Types 3, 4, and 5 wetlands (see Appendix B) above certain size thresholds are protected by the DNR. Wetlands generally characterized by open water and cattails throughout most of the year are the type most likely to be protected by the DNR. The DNR has jurisdiction only over those wetlands appearing on the State's Inventory of Protected Waters.

The minimum size criteria used to establish the wetlands under DNR jurisdiction and compile the State's inventory and maps was 10 acres in rural areas and 2.5 acres in incorporated areas. If an area meets the jurisdictional criteria, but is not on the State's inventory, it is not regulated. If it does not meet the statutory criteria, but is listed on the inventory, it is still subject to DNR regulations. There is presently no mechanism for adding or deleting waterbodies. The inventory was begun in the late 1970s and all DNR inventories were completed during the early 1980s. The boundary of DNR jurisdiction is defined by the Ordinary High Water Levels (OHWL) elevation. The DNR has OHWL elevations defined for many of its protected waters but not all.

The DNR protected waterbodies within the watershed are presented in Appendix C , along with their location and OHWL if available from the DNR. For those DNR wetlands that do not have a defined OHWL, one must request that the DNR make a determination on an as-needed basis for the elevation. The DNR protected waterbodies are shown on Map 1 at the back of the WMP.

DNR rules specify that permits for work in Protected Waters and Wetlands may not be issued for any project except those that provide for public health, safety and welfare.

Priority Wetlands

Based on Minnesota Statutes 103B.231 Subd. 6(a)(b), a watershed management plan must identify high priority areas for wetlands. High priority areas are to be areas where preservation, enhancement, restoration, and establishment of wetlands would have high public value by providing benefits for water quality, flood water retention, public recreation, commercial use, and other public uses. These wetland areas are subject to a property tax relief which is administered by the county.

The wetland inventory and evaluation performed by the SWWD looked at all the wetlands shown on the NWI map that were greater than three acres in size but were not already designated as DNR Protected Wetlands. The rationale for the size element is that the protection efforts initially have to be prioritized to focus on larger, regional resources. The SWWD wanted these resources identified

immediately due to the rapid development that is occurring within the watershed. Provisions for the future inventory of all the wetlands in the watershed are discussed later in the report.

3. Analysis of Biological Surveys and Reconnaissance Studies

A search of existing information was done by the DNR to determine if any rare plant or animal species or other significant natural features are known to occur within the boundaries of the watershed. The following paragraphs include a general location and the species or areas of concern within the watershed. Detailed information on the species is found in Appendix D. The natural heritage information is shown on Map 2 at the back of the report.

The DNR's Natural Heritage Program inventory of the natural resources within the watershed revealed three main areas of concern due to the existence of rare features occurring within the watershed. The three areas are the Cottage Grove Ravine Regional Park, areas along the Mississippi River across from Grey Cloud Island, and areas along the Mississippi River in the eastern part of the Watershed.

Cottage Grove Ravine Regional Park

The first area of concern is the Cottage Grove Ravine Regional Park and areas west of the park boundaries. The legal description for this area is T27N, R21W, Sections 22 and 23, the NW1/4 of Section 26 and the NE1/4 of Section 27. The park itself includes three unique natural features: a Dry Prairie, a Mixed Emergent Marsh, and a state endangered plant, kitten-tails (*Besseya bullii)* . West of the park is a unique Dry Prairie community. The prairie in the East 1/2 of the NW 1/4 of Section 22 supported a rare but unlisted plant, long-bearded hawkweed (*Hieracium longipilum*), but this area appears to have been lost due to recent development activities.

Mississippi River across from Grey Cloud Island

The second significant area of concern is located along the Mississippi River within the boundaries of the Mississippi National River and Recreation Area. The legal description is T27N, R21W, Sections 29, 30, and 32. Three Dry Prairie natural communities exist here which support eight rare plants including the following species listed as special concern in Minnesota: Hill's thistle (*Cirsium hillii),* Louisiana Broom-rape (*Orobanche ludoviciana),* sea-beach needlegrass (*Aristida tuberculosa*), and purple sand-grass (*Triplasis purpurea).* Illinois tick-trefoil (*Desmodium illinoense*), a state threatened species, occurs on the prairie in the SW 1/4 of Section 29 and the NE1/4 of the NW1/4 of Section 32. A special concern snake species, blue racer *(Coluber constrictor),* has also been found in the area.

Mississippi River in the East

The third biologically significant area occurs along the Mississippi River in T27N, R21W,Sections 33, 34 and 35. A Dry Prairie community is located just west of the wastewater treatment plant. East of the treatment plant is a Dry Oak Savanna community. The location of the significant natural areas are shown in the Greenway and Natural Features map which is Map 2 at the back of the report.

State Management Plans for Wildlife Areas

There is no land in the watershed owned by the State, which eliminates the potential for state management. There is a Regional Park, which is managed by Washington County Parks, and the Mississippi National River and Recreation area, includes areas along the Mississippi River within the watershed.

The Mississippi National River and Recreation Area has guidelines set up to protect, preserve, and enhance nationally significant resources in the Mississippi River corridor through out the Twin Cities Metropolitan area. The area designated as the Mississippi National River and Recreational area within the watershed boundaries is not owned by the Federal or State governments. If an area is designated as a Mississippi National River and Recreation area, there are management guidelines

that have been written in a Comprehensive Management Plan provided by the National Park Service. These were written to provide a management framework to assist the State of Minnesota and its units of local governments in the development and implementation of integrated resource management programs for the Mississippi River corridor in order to ensure orderly public and private development in the area. The SWWD supports these efforts and encourages the cities to use land use planning as a means of protecting the natural character of the Mississippi River.

D. Human Environment

1. Land Use

Existing and anticipated future land uses of the cities are presented on the land use maps shown in Figures IV-14 and IV-15. The figures indicate that the existing urban centers of Woodbury, Cottage Grove, and Oakdale will continue to develop, while the area to the east and southeast will remain rural for the foreseeable future.

The density of development associated with each land use is an indication of the amount of runoff that can be expected from the different areas. Since future development increases the amount of runoff, all hydrologic modeling is based on anticipated development of the watershed. As the land use changes from that assumed here, the hydrologic data should be reviewed and revised as required. The SWWD requires the municipalities to monitor all the planning and land use revisions in their localities to ensure that peak runoff rates defined in Chapter 6 are not exceeded and are kept within the capacities of downstream conveyance facilities.

2. Public Utility Service

The Cities of Cottage Grove, Woodbury, and Oakdale have municipal sanitary sewer systems that transport their wastewater to facilities for treatment. The local elements of the system are sewer

services, laterals, trunks, manholes, lift stations, force mains and all correlated appurtenances associated with the collection and transportation of wastewater.

Treatment and disposal of wastewater generated by the cities of Woodbury and Oakdale is presently accomplished by the Metropolitan Council Environmental Services (MCES) at the Metro Treatment Plant in St. Paul. Three MCES interceptors serve the northern portion of the watershed. The WONE interceptor collects flow from Oakdale, portions of Lake Elmo, Landfall and northern Woodbury. The Lower Afton and Carver Lake Interceptors serve the remainder of Woodbury.

The wastewater generated by the city of Cottage Grove is treated at the Cottage Grove Treatment Plant, also operated by the MCES. Cottage Grove is currently the only city served at this plant. Future MCES studies will determine the fate of the Cottage Grove plant. Ultimately, the plant could be upgraded or a new plant constructed in the vicinity to provide regional treatment for the entire watershed.

Maps of the cities' wastewater collection systems are available at the respective cities and must be included in their Local Water Management Plans. The existing land use map shows the current Metropolitan Urban Service Area (MUSA) boundaries within the watershed. The MUSA represents the extent of existing or potential sanitary sewer service area. Accordingly, the MUSA areas basically define the current or near future extent of medium and high density housing and commercial/industrial land uses. The current boundaries are estimated to be adequate through the year 2000.

Figure IV-14

Figure iv-15

Public Water Supply

The cities of Cottage Grove, Woodbury, and Oakdale have municipal water supply systems in the SWWD area. Each city must include a map of its current water supply system in its Local Water Management Plan.

Cottage Grove, Woodbury, and Oakdale obtain their raw water from deep wells drilled into the Jordan Sandstone Aquifer. The water is pumped directly into the distribution system following chlorination and fluoridation at each well site. There are ten existing wells that currently serve the city of Cottage Grove with a combined capacity of 8400 GPM or 18.7 MGD. Existing storage tanks in Cottage Grove have a total storage capacity of 4.15 million gallons. Woodbury's water supply system contains 10 wells, and has a combined pumping capacity of 10,850 GPM or 24.2 cfs. Water quality samples taken at several wells in Cottage Grove in 1965, 1976, and 1984 show almost no variation.

3. Water-based Recreation Areas and Land Ownership

There are ten significant or potentially significant water-based recreation areas in the watershed. They include a diversity of types of waterbodies and a diversity of recreational opportunities. Table IV-4 outlines the basic role of each waterbody as well as its location and ownership. The waterbodies are shown in Map 1 at the back of the report. There are numerous smaller waterbodies in the watershed that also provide recreational benefits and opportunities, but they are usually smaller wetlands and ponds and their primary role is usually aesthetics and wildlife viewing. Several areas contain intermittent streams in the watershed. While the intermittent streams often provide desirable natural areas along the stream banks, they do not appear to provide consistent aquatic environments and therefore were not included in the inventory of water-based recreation areas.

Many of the water resources listed in Table IV-4 are in rapidly urbanizing areas of the watershed. These waterbodies will become more important recreational resources in their communities and presumably encounter more recreation-related pressures. The burden to manage the recreational

pressures will continue to rest with the cities and the county with coordination and support from the SWWD.

Table IV-4. Recreational Status of SWWD Waterbodies

Waterbody	Location	Role/Value	Ownership
Armstrong Lake	Sec. 28/33, Oakdale/Lk Elmo	Currently aesthetics and wildlife viewing. Non-motorized boating possible.	Private LDR farm), Oakdale, Co. Rd. ROW
Wilmes Lake	Sec. 3/10, Woodbury	Aesthetics, wildlife viewing, fishing, limited boating.	Woodbury, Private (MDR, Comm.)
Evergreen Bog - North	Sec. 4/5/8/9, Woodbury	Aesthetics, wildlife viewing.	Private (MDR, HDR Comm.), Woodbury
Markgrafs Lake	Sec. 2, Woodbury	Aesthetics, wildlife viewing, fishing, boating.	Woodbury, Private (farm) Co. Rd. ROW
Powers Lake	Sec. 11, Woodbury	Aesthetics, wildlife viewing, game fishing, boating, swimming.	Woodbury, Private (LDR)
Colby Lake	Sec. 15/22, Woodbury	Aesthetics, wildlife viewing, possible fishing, limited boating.	Woodbury, Private (LDR)
Bailey Lake	Sec.27/34, Woodbury	Aesthetics, wildlife viewing, possible fishing, limited boating	Private (farm, LDR), Woodbury, City Rd. ROW
Gables Lakes	Sec.2, Cottage Grove	Aesthetics, wildlife viewing	Private (farm)
C. Grove Ravine Park Lake	Sec. 22/23/26, Cottage Grove	Aesthetics, wildlife viewing, limited boating, possible fishing.	Washington County
Mississippi River	Sec. 30/32/33/ 34/35, Cottage Grove	Aesthetics, wildlife viewing, game fishing, boating.	Private (LDR, MDR, Indust.), Railroad ROW

Note: LDR=Low Density Residential, MDR=Medium Density Residential, HDR=High Density Residential, ROW = Right-Of-Way, Comm.=Commercial, Indust.=Industrial.

4. Pollution Point Sources

Point sources of pollution refer to locations where potentially large amounts of contaminants are discharged into the environment at a single location. As with any watershed, there are many documented and undocumented potential pollution sources. Solid waste disposal areas are important potential sources of pollution. Solid waste disposal areas are important potential sources of pollution, as are sites where improper hazardous waste disposal has occurred.

Water pollution point sources such as feedlots; unused, unsealed wells; storage tanks; and permitted wastewater discharges can also contribute to water pollution. These activities are generally regulated and must meet certain base-line standards. The feedlot impoundments and permitted wastewater discharges in the SWWD identified by the MPCA are shown on Figure IV-16. The feedlot impoundments are designed to provide treatment of farm feedlot runoff. The landfill and open dump areas include old sites that may no longer receive solid waste. Unused, unsealed wells can pose a potentially serious risk for contamination since these wells are a direct connection or conduit to aquifers that are commonly used for drinking water supplies.

The 3M dump site in Woodbury near its border with Cottage Grove is the only site with monitoring data available. The groundwater surrounding the site has been monitored for organic chemicals since 1966, when the site closed. The clean up of groundwater at the site is being monitored by the MPCA, and monitoring data is available through its office.

Disposal of household hazardous wastes can be a problem for many residents of the watershed. For lacking knowledge about disposal areas and impacts to downstream waterbodies, residents may dump household hazardous wastes such as used motor oil and lawn chemicals into storm sewers. Citizens should be aware that the Washington County Department of Health, Environment, and Land Management has a program for collection of household hazardous wastes. The county operates a year-round collection site in Oakdale and a summer collection site in Cottage Grove. Residents can contact the county at **430-6655** for more information.

Figure IV-16. Pollution sources.

There are no known previously existing permanent sampling stations in the watershed. The only known historical surface water sampling sites were two temporary sampling stations in Cottage Grove at Iverson Avenue and on 80th Street, which were part of a 1980 study. The study, "Quality of Runoff from Small Watersheds in the Twin Cities Metropolitan Area, Minnesota. Hydrologic Data for 1980" was prepared by the U.S. Geological Survey and the Metropolitan Council. The results support and document the widely accepted fact that stormwater from residential areas, especially those under construction, contribute significant amounts of pollution such as sediments, nutrients, and sometimes heavy metals.

The SWWD has installed two water quality monitoring stations in the upper half of the watershed in 1996. The stations are each equipped with flow monitoring devices, automatic samplers, and rain gauges. The monitoring program will establish annual loadings of nutrients and sediments and will periodically check heavy metal concentrations. The sampling sites both present and historic, are shown on Figure IV-16.

5. Status of Shoreland and Floodplain Ordinances

The DNR shoreland ordinance requirements, which restrict land uses and land clearing activities in areas adjacent to lakes, rivers, and streams, vary from community to community. The 1989 revised rule dealing with shoreland ordinances provides specific guidelines for what must be included in the local ordinances. In general terms, the DNR has ranked communities based on need for a shoreland ordinance into four categories. The first two categories were given higher priority and those communities= have been informed that they must update their existing ordinance or adopt a new ordinance that meets the state requirements. The third and fourth level communities are encouraged to adopt a shoreland ordinance but are not being forced to do so at this time.

Floodplain ordinances are also required based on the community's need for such an ordinance. In this case, the federal government has prioritized the need by eliminating some communities that do

not have floodprone areas identified on the FIS floodplain maps. Table IV-5 summarizes the status of the shoreland and floodplain ordinances in the cities in the watershed.

Table IV-5. Status of City Shoreland and Floodplain Ordinances

Community	Shoreland Ordinance			Floodplain Ordinance	
	Required	Adopted	DNR Approved	Required	Adopted
Lake Elmo	Yes	Yes	Yes	Yes	Yes
Oakdale	No	No	N/A	No	N/A
Woodbury	Yes	Yes	Pending	No	N/A
Afton	No	Yes	N/A	Yes	Yes
Cottage Grove	No	No*	N/A	Yes	Yes

*Have adopted a specific ordinance for the Mississippi River shoreland areas.