This appendix contains information which is contained in the Natural Resource Inventory (NRI) report, but is not directly relevant to the NRI. The appendix is intended to provide additional detail into water management issues, especially water quality.

Watershed Management Plans must outline information regarding the following.

- ***Water Quality***
- ***Recreation and Fish and Wildlife***
- ***Erosion***
- **Assessment of Problems**
  1. specific lakes and streams with water quality problems
  2. impacts of water quality and quantity management practices on recreation opportunities
  3. impacts of stormwater discharges on water quality and water quantity
  4. impact of soil erosion on water quality and water quantity
  5. General impact of land use practices and, in particular, land development and wetland alteration on water quality and water quantity
- **Implementation Program**
  1. ***Regulatory Controls***
  2. ***Stormwater and Drainage Design Performance Standards***
  3. ***Management Programs***

Key Water Quality Concepts

These water quality concepts provide an understanding of how and why water quality changes occur. This in turn provides insight to management approaches which prevent or minimize water quality degradation from occurring, and management approaches to improve existing water quality. An understanding of these topics provides a foundation for the establishment of water quality goals and policies. Presented in the following sections are brief discussions of water quality concepts.

Eutrophication

The water quality problems caused by sediment and nutrients from a lake's watershed are described by the word eutrophication. Eutrophication, or lake degradation, is the process whereby lakes accumulate sediments and nutrients from their watersheds. The result is that a lake naturally becomes more fertile over time. It is converted from oligotrophic (nutrient-poor) to eutrophic (nutrient-rich) status as it is progressively enriched by nutrients and sediment. Nutrients serve as a catalyst for algae and weed growth in a lake. Biological production and sediment inflow from the

lake's watershed eventually fill the lake's basin. Over a period of many years, the lake successively becomes a pond, a marsh and, ultimately, a terrestrial ("upland") site.

The process of eutrophication is natural and results from the normal environmental forces that influence a lake. Cultural eutrophication, however, is an acceleration of the natural process caused by human activities. This acceleration may result from point-source nutrient loadings, such as effluent from wastewater treatment plants and septic tanks. Failing on-site septic systems have notable potential to add nutrients to lakes and other water bodies throughout VBWD, especially since the majority of VBWD is located outside the Metropolitan Urban Service Area (MUSA) boundary. It may also be caused by diffuse (i.e., non-point) sources of nutrients and sediments, such as stormwater runoff. Nutrients and sediments may be added to the lake via runoff from agricultural and/or urban watersheds. This accelerates the rate of water quality degradation. Unpleasant consequences of degradation include profuse and unsightly growths of algae (algal blooms) and/or the proliferation of rooted aquatic weeds (macrophytes).

Trophic States

Because the water quality of lakes can vary greatly from watershed to watershed, criteria have been established to evaluate lakes, such as those within VBWD, to denote their water quality. Four "trophic" descriptions are frequently used to describe the effects of nutrients on a lake's general water quality and to denote its trophic status. They are:

1. **Oligotrophic**
2. **Mesotrophic**
3. **Eutrophic**
4. **Hypereutrophic**

Oligotrophic (Greek for "food-poor") describes a clear, low productivity lake. **Mesotrophic** describes a lake of intermediate productivity. **Eutrophic** (Greek for "food-rich") describes a lake rich in nutrients and having a high productivity. **Hypereutrophic** lakes are extremely rich in nutrients and are extremely productive.

The Limiting Nutrient

The determination of a lake's trophic state (i.e., its stage of degradation) is an important aspect of the assessment of its problem. Determining a tropic state for a lake indicates the severity of its algal problems and the degree of change needed to meet its recreational goals. However, it does not indicate the cause of algal growth, or a means of reducing such growth.

The quantity or biomass of algae in a lake or pond is usually limited by the concentration of an essential element or nutrient in the water - the "limiting nutrient". (Rooted aquatic plants, in contrast, derive most of their nutrients from lake or pond sediments.) The limiting nutrient concept is a widely applied principle in the study of eutrophication. It is based on the idea that, in considering all of the substances needed for biological growth, only one will be present in limited quantity. The availability of this limiting nutrient will, therefore, control the rate of algal growth. It follows then, that the identification of a lake's limiting nutrient will point the way toward a solution to its algal problems.

Nitrogen (N) and phosphorus (P) are generally the two growth-limiting nutrients for algae in most natural waters. Analysis of the nutrient content of lake water and algae provides ratios of N:P that can indicate whether one or the other of these elements is growth-limiting. By comparing the tissue

concentrations of important nutrients in algae to the concentrations of the same nutrients in the ambient waters, one can estimate whether a particular nutrient may be limiting.

Algal growth is generally phosphorus-limited in waters with N:P ratios greater than 12. It has been amply demonstrated in experiments ranging from laboratory bioassays to fertilization of in-situ enclosures to whole-lake experiments, that phosphorus is generally the nutrient that limits algal growth. Algal abundance is nearly always phosphorus-dependent. A reduction in the phosphorus concentration in a lake is therefore necessary in order to reduce algal abundance and improve water transparency. Failure to reduce phosphorus concentrations will allow the process of eutrophication to continue at an accelerated rate.

Structure of Lakes and Ponds

The realization that the solution to eutrophication problems must focus on phosphorus reduction is the first step in the problem-solving process. Phosphorus enters lakes and ponds from internal and/or external sources. An understanding of the chemical/physical/biological "structure" of a lake helps one determine whether the solution should focus on internal and/or external (i.e., the tributary watershed) sources.

In any water body, certain physical phenomena occur that can profoundly influence its chemistry and biology. Probably the most important of these phenomena is "thermal stratification". When the ice melts in the spring, the water temperature in a lake is usually around 4°C (~39°F) from top to bottom. At this temperature, water is most dense (heaviest). During the spring and summer months, the sun warms the surface layer of the lake causing it to become warmer and less dense (lighter). The warm surface layer of the lake is called the **epilimnion**. In shallow portions of a lake, the sun's rays are often able to reach the lake's bottom in most places. During the summer, the water temperature in these portions (which are usually near the shore, or in the "littoral zone") may be warm throughout. Shallow lakes and ponds may also be warm throughout, exhibiting little or no thermal stratification.

The deeper portions of lakes typically have a thermal/density structure that differs from the shallow regions. Because sunlight does not reach the bottom of the deeper portions of the lake, these waters remain cool and denser. Therefore, the cooler, heavier water stays at the bottom of the lake.

The cooler, deeper water layer of the lake is called the **hypolimnion**. Between the warm epilimnion and the cool hypolimnion is a transitional layer of water known as the **metalimnion**. This layer of the lake is characterized by a rapidly-declining temperature.

Nutrient Recycling

The significance of thermal stratification in lakes is that the metalimnion provides a physical barrier to mixing between the epilimnion and the hypolimnion. While water above the metalimnion may circulate as a result of wind action, hypolimnetic waters at the bottom generally remain isolated. Consequently, very little transfer of oxygen occurs from the atmosphere to the hypolimnion during the summer.

If the lake or pond sediments are rich in organic matter, microbial decomposition and respiration can deplete hypolimnetic waters of their dissolved oxygen. Phosphorus contained in the sediment may then be released into the water column as a result of changes in the oxidation-reduction (REDOX) potential of the system caused by oxygen depletion. Later, this phosphorus will contribute to the growth of algae in surface waters when the thermal stratification of the lake breaks down and the lake or pond mixes.

Lakes with strong stratification generally mix only twice each year, typically in the spring and fall. Shallow water bodies (generally less than 10 feet in depth and typically eutrophic) may circulate many times during the summer as a result of wind mixing. Recycling of nutrients from anoxic

(devoid of oxygen) sediments to the surface waters of a lake or pond is most often a problem in highly-fertile, and relatively shallow water bodies. These eutrophic lakes are subject to hypolimnetic oxygen depletion during periods of weak stratification, with consequent recycling of phosphorus from the lake's sediments during mixing.

With this background material on the study of lakes, one is better able to consider appropriate criteria, goals and policies for VBWD lakes.

Water Quality Goals

Historically, the need to establish lake water quality criteria or goals has been recognized at the local, state, and federal levels of government. A variety of approaches have been taken to develop goals to protect and manage lake water quality. One or more of the following factors are generally considered in the development of lake water quality goals:

- type of lake
- natural background phosphorus concentrations
- use of the lake (i.e., recreational uses, water supply, etc.)
- expectations and tolerances of lake users
- economic factors

In the past, many water management regulatory authorities declared a "non-degradation" water quality philosophy, in the absence of specific water quality goals. However, numerous studies indicate that watershed development generally results in water quality degradation of lakes, streams and wetlands. The degradation process has occurred in areas despite the use of BMPs for the control of both erosion on construction sites and pollutant export from fully developed watersheds. This fact points out the need to establish water quality goals that are realistic relative to ultimate watershed land use considerations. Even if protection efforts are undertaken, water quality degradation will occur within VBWD as the watershed develops. Establishment of realistic goals will, however, define attainable levels of protection for VBWD water bodies.

During the plan revision process, VBWD established preliminary water quality goals for all major water bodies within VBWD. The VBWD goal setting process included the following steps:

1. Determination of desired uses and target water quality goals for VBWD water bodies, by category.
2. Evaluation of existing water quality uses of selected VBWD water bodies.
3. Identification of conflicts between current water quality and existing or future desired uses of selected VBWD water bodies.
4. Establishment of preliminary goals.

Final goal setting of VBWD water bodies will occur following the evaluation of predicted water quality under ultimate watershed land-use conditions. The final goal setting process will include the following steps:

5. Completion of annualized hydrologic and phosphorus budgets for VBWD lakes under existing and ultimate watershed land-use conditions.
6. Evaluation of goal attainment problems.
7. Description of possible solutions to these problems and finalization of lake and stream water quality goals.

Determination of Desired uses and Target Water Quality Goals for VBWD Water Bodies, by Category

Usage and water quality of water bodies are linked and must be considered jointly, rather than separately. Water bodies within VBWD are used for a variety of purposes including recreational activities, wildlife viewing, stormwater treatment, and waterfowl habitat. To some extent, the use of each water body is determined by its accessibility to people. That is, a water body located in an undeveloped watershed and lacking a public access is less likely to be used for recreational activities than a water body surrounded by residential development and/or containing a public access. Accessibility, however, only determines the public desires for usage. The degree to which a water body can support a particular use is primarily determined by its water quality. Water clarity is often the factor determining the suitability of a water body for a particular recreational use. This is particularly true for body contact activities. Algal abundance in a water body generally determines its water clarity, and nutrients (primarily phosphorus) determine algal levels. The first step in the goal setting process, therefore, is to define the relationship between usage and water quality of VBWD water bodies.

A methodology for linking usage and water quality was developed by Barr Engineering Co. in the early 1970s (Barr, 1973). The methodology was developed to enable watershed districts to establish appropriate management goals for district water bodies. Although some minor changes have been made due to more recent information and experience, the methodology is largely unchanged. Water bodies were categorized according to desired uses and water quality goals were established for each use. A discussion of the goal setting process follows:

Water quality limits were defined to establish boundaries between eutrophication levels which do not appreciably interfere, either physically or aesthetically, with various recreational activities. The levels were defined by identifying the physical and aesthetic impacts of algae abundance and water transparency on recreational uses and associating the occurrence of undesirable impacts with various levels of chlorophyll, transparency, and total phosphorus. The potential for algal growth was estimated by measuring chlorophyll concentrations and total phosphorus concentrations while water transparency was measured by the Secchi disc reading.

It must be well understood that the threshold water quality limits are not intended to serve as rigid standards, but rather to serve as guidelines to evaluate constraints placed on recreational use by water quality. The threshold limits define "ball park" levels of water quality which can be applied to a lake to obtain an idea if certain recreational activities have the potential of being affected. The threshold water quality limits are an attempt to give meaning to numerical water quality data which has been gathered. Tolerable water quality levels will obviously vary from lake to lake and from area to area, but on the average, the limits set forth in this section will serve as general guidelines for evaluating the suitability of a lake for various recreational activities.

In establishing threshold water quality limits, the recreational activities under consideration were combined into the following three levels on the basis of generally similar water quality requirements.

Level I Activities

Scuba Diving and Snorkeling

Swimming

Level II Activities

Sailboating

Waterskiing

Motorboating

Canoeing

Hiking and Picnicking

Wind Surfing

Jet Skiing

Level III Activities

Fishing

Aesthetic Viewing

Observing Wildlife

Desirable Water Quality for Level I Activities. Snorkeling, scuba diving and swimming are activities that are first affected as eutrophication progresses. Lake water begins to appear green to the casual observer when chlorophyll concentrations exceed approximately 10 μg/L. Since water color and the resulting loss of clarity affect Level I activities, the ideal lakes for Level I activities have an average chlorophyll concentration of 10 μg/L or less. Generally, a chlorophyll concentration of 10 μg/L corresponds to a Secchi disc transparency of about 7 feet (about 2 meters) during the swimming season.

Through observing the attitudes and through discussions with people active in Level I activities, threshold limits for Level I activities have been established at a chlorophyll concentration of approximately 10 μg/L and a Secchi disc transparency of about 7 feet (2.0 meters) during the swimming season. The relationship between chlorophyll concentration and Secchi disc reading will vary due to the size of the algae cells, turbidity from suspended silt and other factors. The threshold chlorophyll and Secchi disc values define an approximate level of water quality which, if exceeded, have the potential to interfere with Level I activities.

Desirable Water Quality for Level II Activities. Level II activities, which do not involve body contact, can be pursued under less stringent water quality conditions than Level I activities. Rooted vegetation reaching the surface and algae blooms are aesthetically and physically detrimental to the enjoyment of Level II recreational activities. Level II threshold limits for chlorophyll and Secchi disc were estimated to be 20 μg/L and 3.3 feet (1 meter), respectively. These limits were determined by studying the water quality data from lakes with nuisance algae problems. There have been no precise chlorophyll concentrations identified in the literature as necessary for odor problems to appear. Odor is not only a function of algae concentration, but also is dependent upon algae composition, wind direction and velocity, water temperature and lake morphometry. It is generally the blue-green algae which reach nuisance levels. Chlorophyll concentrations exceeding 20 μg/L appear to have a significantly greater potential for developing noxious odors under suitable wind and temperature conditions than concentrations less than 20 μg/L.

Aquatic vegetation reaching within 1 or 2 feet of the water surface can foul sailboat centerboards and motor propellers resulting in the diminished enjoyment of these activities. Weed growth is related to water clarity, availability of nutrients and water depth. The lakes with clearest water often have the most serious rooted aquatic vegetation problems. In these lakes, nutrients have been utilized in the production of rooted aquatic plants rather than in the production of algae. Nutrients, therefore, have

been "tied up" by the rooted aquatic plants and are not available for use by the algae. Water depths of approximately 8 feet (2.5 meters) or less contribute to the problem since it is usually possible for bottom rooted plants to reach the water surface at these depths. Secchi disc, chlorophyll and phosphorus data do not directly measure the weed growth potential for a lake, but a visual assessment of the situation during the summer is usually sufficient to determine if growth is extensive enough to interfere with Level II activities.

There are many recreational activities which do not require the use of the water surface but are nevertheless affected by the lake's eutrophic level. Examples are hiking and picnicking activities adjacent to the lake which can be affected by unsightly algae blooms, overabundant aquatic vegetation, and by odors from decaying algae and fish. Hiking and picnicking activities were, therefore, placed into Level II where aesthetic interferences should be kept at a minimum.

Desirable Water Quality for Level III Activities. Fishing is certainly more enjoyable in an aesthetically pleasant surrounding, however, fishing for certain fish species is often very good in lakes which are not appealing for the Level I activities of swimming and scuba diving. The optimum lake conditions for warm water fish production may not correspond to conditions preferred for Level I or even Level II activities. Studies have shown that fish production increased predictably with increasing phosphorus levels. Fish production increases only up to an optimum point, however, and then begins to decrease due to a change in fish food supply, oxygen depletion and other effects of advanced eutrophication. Due to these conditions, the species composition will gradually change from game fish to a dominance of the so-called "rough fish" species such as carp. For a lake in which rough fish are not present the increased food supply due to advancing eutrophication can be utilized even further by the game fish, but an optimum level of production will still be reached as the detrimental effects of eutrophication act on the life cycles of the fish and fish food organisms.

Most lakes in the metropolitan area are eutrophic and do not support trout. Fish management programs in this area are, therefore, primarily concerned with warm water species. Studies on fish production in ponds have indicated that total phosphorus concentrations in the range of 60 µg/L to 70 µg/L and chlorophyll concentrations in the range of 38 mg/m^3 to 55 mg/m^3 were condusive for the production of bluegill sunfish (Hall, et al., 1970). Total phosphorus concentrations near 130 µg/L were well over the optimum level for warm water game fish production and ponds with these levels of total phosphorus favored the production of rough fish over game fish (Haines, 1973). Moyle (1954) indicated that total phosphorus concentrations near 50 µg/L were optimum for the production of largemouth bass and sunfish in Minnesota lakes.

Data collected for a number of lakes in the Twin Cities Metropolitan Area indicates that lakes with significant game fish populations had average total phosphorus concentrations ranging from 65 to 88 µg/L in the surface waters during the ice-free period. Average chlorophyll concentrations in these lakes ranged from 20 to 30 µg/L with Secchi disc readings ranging from 4 feet (1.1 meters) to 5.5 feet (1.7 meters). Based on the above data, the recommended Level III limits are 40 µg/L summer average chlorophyll and about 75 µg/L summer average total phosphorus. The corresponding summer average Secchi disc reading would be about 2.0 feet (0.6 meters).

Fish production is also dependent upon other factors such as lake morphometry, predator-prey relationships, habitat, and species composition which can interact to modify the optimum range of production levels in either direction for a particular lake and a particular fish species. Fish production is additionally affected by a lake's dissolved oxygen condition under the ice during the winter months. Lake depth is critical in predicting the tendency of a lake toward winterkill conditions when large numbers of fish perish due to low dissolved oxygen conditions during late winter. The low oxygen levels are due to organic material decomposing on the lake bottom and completely using the dissolved oxygen in the overlying water. Lakes with greater mean depths have

a greater volume of water in relation to their sediment surface area, hence a longer time is needed to deplete the overlying water of dissolved oxygen. A study of several lakes in the Metropolitan Area which have game fish populations indicate that winterkill conditions are likely to occur periodically in eutrophic lakes having a mean depth of 13.3 feet (4 meters) or less. Lakes having a significant volume of winter inflow and outflow are normally less susceptible to winterkill than lakes with no continuous inflow and outflow.

Level IV Category. Not all water bodies are suitable for or are used for recreational activities. Level IV designates a level of water quality which is past the point of optimum warm water game fish production and severely limits most recreational uses. Level IV water bodies have a primary (not exclusive) function as stormwater detention basins, used for runoff management. Level IV includes nonwetland water bodies having a summer average phosphorus concentration greater than 75 μg/L and a summer average chlorophyll concentration greater than 40 μg/L. This corresponds to an average summer Secchi disc reading less than or equal to about 1.5 feet (0.5 meters).

Level V Category. Wetlands are generally not used for recreational activities, but may be enjoyed by the public. Uses include aesthetic viewing activities, observing waterfowl and wildlife, and other appropriate public uses. Because water quality in wetlands varies greatly, specific water quality criteria for wetlands have not been established. Table 3-3 lists ten examples of Category V wetlands. This is not a complete list of all the wetlands in VBWD. All wetlands are considered to be in the Level V Category.

The water quality categories established for evaluation of VBWD water bodies and target water quality goals for each category are shown in Table 3-1.

Establishment of Preliminary Goals

presents preliminary goals for VBWD water bodies. Goal establishment involved assigning one of the five water quality categories listed in Table 3-1 to each water body to designate its target water quality goal. Factors considered in the goal setting process included:

- Current and historical water quality;
- The existing and desired uses of water bodies;
- Usage/water quality conflicts and feasibility of their resolution;
- Classification by regulatory agencies (i.e., MPCA, Metropolitan Council, and MDNR).

The following paragraphs describe the water bodies assigned to each of the five goal categories:

- Seven water bodies within VBWD have been designated Category I (i.e., recreation, all activities). These water bodies include: Lake DeMontreville, Lake Elmo, Lake Edith, Lake Jane, Lake Olson, Silver Lake, and Valley Branch Creek.
- Two water bodies within VBWD have been designated Category II (i.e., recreation, except full body contact) water bodies. These include: Horseshoe Lake and Long Lake.
- Eight water bodies within VBWD have been designated Category III (aesthetic viewing) water bodies. These include: Cloverdale Lake, Downs Lake, Echo Lake, Goose Lake, McDonald Lake, Rose Lake, Sunfish Lake, and Sunnybrook Lake.
- Three water bodies have been designated Category III (aesthetic viewing)/Category V (wetlands). These water bodies, although wetlands, are used by the public for aesthetic viewing purposes. They include: Clear Lake, Bay Lake, and Mergens Pond.
- Two water bodies within VBWD have been designated Category IV (runoff management) water bodies. These include: West Lakeland Storage Site and Rest Area Pond.

- Ten water bodies have been designated Category V (wetland) water bodies. These include: Capaul's Pond, Eagle Point Lake, Fahlstrom Pond, Friedrich's Pond, Goetschel Ponds, Klawitter Pond, Kraemer Pond, Mud Lake, Legion Pond, and Weber Pond.

Also presented in Table 3-3 are management actions required to maintain or achieve the preliminary goals for VBWD water bodies. Protection is necessary for water bodies whose current water quality data do not conflict with preliminary goals. Possible restoration may be necessary where historical data suggests conflicts between preliminary goals and water quality may occur, depending upon climatic conditions. Restoration may be necessary for water bodies with conflicts between preliminary goals and current water quality.

A priority is assigned to each water body in Table 3-3 with respect to implementation of the listed management action. For those water bodies with a "Not Determined" (ND) designation, the listed priority pertains to the priority for removing the ND status and establishing a final management action goal and priority.

To achieve preliminary goals, additional stormwater runoff discharged to VBWD water bodies will require a certain amount of "treatment" to remove nutrients, sediment and trash. The recommended amounts of treatment that storm runoff should receive prior to its discharge into VBWD water bodies is shown in Table 3-4.

Table 3-1. Desired Uses and Target Water Quality Goals for VBWD Water Bodies, by Category

Water Quality Category	Desired Uses	Desired Total Phosphorus Concentration (µg/L)	Desired Chlorophyll a Concentration (µg/L)	Desired Secchi Disc Depth (meters)
Level I	Level I water bodies fully support all water-based recreational activities including swimming, scuba diving and snorkeling.	[TP] ≤30	[Chla] ≤10	2.0≤ SD
Level II	Level II water bodies are appropriate for all recreational uses except full body contact activities. Recreational activities for these water bodies include: sailboating, water skiing, motorboating, canoeing, wind surfing and jet skiing.	30< [TP] ≤45	10< [Chla] ≤20	1.0≤ SD <2.0
Level III	Level III water bodies will support fishing (in lakes capable of supporting a fishery), aesthetic viewing activities and observing wildlife.	45< [TP] ≤75	20< [Chla] ≤40	0.6≤ SD <1.0
Level IV	Level IV water bodies are water resources generally intended for runoff management (i.e., stormwater detention) and have no significant recreational use values.	75< [TP]	40< [Chla]	SD ≤0.5
Level V	Level V waterbodies are wetlands and may be suitable for aesthetic viewing activities, observing wildlife, and other appropriate public uses.	-	-	-

Table 3-2. Existing Recreational Uses Summary, VBWD Selected Water Bodies (From Discussions with Lake Residents and Local Water Resources Managers)

Water Body	Full Body Contact Activities			Non-full Body Contact Activities				Aesthetic Viewing			Stormwater Detention	Wetlands
	Level I	Level II			Level III						Level IV	Level V
	Swimming, Scuba, Snorkeling	Water Skiing	Jet Skiing	Sailing, Wind Surfing	Non-Motorized Boating, Canoeing[1]	Motorized Boating[2]	Fishing	Observing Wildlife	appre-ciating the View	Enjoying Peace and Tran-quility	Stormwater Treatment	Wildlife Habitat
Lake Edith	X				X		X	X	X	X		
Valley Branch Creek[3]							X	X	X	X		
Rest Area Pond											X	
Fahlstrom Pond								X	X			X

1 Includes electric motors.

2 Gasoline motors.

3 DNR-designated trout stream.

Table 3-3. **Water quality, recreational use and ecological classifications of, and management philosophies for VBWD lakes, referencing Carlson's Trophic State Index (TSI) values (Secchi disc transparency basis).**

Lake	Water Body Classification, by Regulatory Agency (TSI_{SD})[1]				Current Water Quality Condition/VBWD Category[6]	Recreational Use Survey Results (VBWD Category)[6]		VBWD Preliminary Water Quality Goal[6]	VBWD Management Action Required and Priority for Action
	MPCA Swimmable Use Class[2]	Applicable MPCA Water Quality Std.[3]	Metro Council Priority Waters Class[4]	MDNR Ecological Class[5]		Existing	Desired Future		
Edith	Fully supporting ***$TSI_{SD} \leq 53$***	2B, 3B, 4A, 4B, 5, 6	3 Single-use recreational	30 Primary Fish Species: NP, BLB, BG ***$TSI_{SD} \geq 53$***	1992 Data: [TP] = 23 µg/L: Cat. I [Chla] = 12.4 µg/L: Cat. I S.D. = 2.1 m: Cat. I ***TSI_{SD} = 49***: Cat. I	I Whole body-contact recreational	I Whole body-contact recreational	I Whole body-contact recreational [TP]≤30 µg/L [Chla]≤10 µg/L S.D.≤2.0 m ***$TSI_{SD} \leq 50$***	Protection/Possible Restoration High Priority
Valley Branch Creek	Fully supporting ***$TSI_{SD} \leq 53$***	1B, 2A, 3B, 4A, 4B, 5, 6	3 Single-use recreational	DNR Designated Trout Stream Primary Fish Species: BKT, BNT, RT	1993 Data: [TP] = 0.018 µg/L [Chla] = ND S.D. = ND ***TSI_{SD} = ND***	I Whole body-contact recreational	I Whole body-contact recreational	I Whole body-contact recreational [TP]≤30 µg/L [Chla]≤10 µg/L S.D.≤2.0 m ***$TSI_{SD} \leq 50$***	Protection High Priority
Rest Area		2C, 3D, 4C, 5, 6	4			IV	IV	IV	Protection

Lake	Water Body Classification, by Regulatory Agency (TSI_{SD})[1]				Current Water Quality Condition/VBWD Category[6]	Recreational Use Survey Results (VBWD Category)[6]		VBWD Preliminary Water Quality Goal[6]	VBWD Management Action Required and Priority for Action
	MPCA Swimmable Use Class[2]	Applicable MPCA Water Quality Std.[3]	Metro Council Priority Waters Class[4]	MDNR Ecological Class[5]		Existing	Desired Future		
Pond	(Unspecified)	?	Waters with aesthetic appeal	(Unspecified)	1986 Data: [TP] = 136 µg/L: Cat. IV [Chla] = 20.2 µg/L: Cat. II S.D. = 0.5 m: Cat. IV ***TSI_{SD}*** = 70: Cat. IV	Stormwater Detention	Stormwater Detention	Stormwater Detention [TP]>75 µg/L [Chla]>40 µg/L S.D.≤0.5 m ***TSI_{SD}≥70***	Low
West Lakeland Storage Site	(Unspecified)	2C, 3D, 4C, 5, 6 ?	3 Single-use recreational	(Unspecified)	L M U Year= 1986 [TP]= 84 88 83: Cat. IV [Chla]= 33.2 28.5 21.3: Cat.III SD= 1.1 : Cat. II ***TSI_{SD}= 59*** : Cat. II	IV Stormwater Detention	IV Stormwater Detention	IV Stormwater Detention [TP]>75 µg/L [Chla]>40 µg/L S.D.≤0.5 m ***TSI_{SD}≥70***	Restoration Low
Fahlstrom	(Unspecified)	2C, 3D, 4C, 5, 6	4 Waters with aesthetic appeal		No Data	V Wetlands	V Wetlands	V Wetlands [TP]=Unspecified [Chla]=Unspecified S.D.=Unspecified ***TSISD=Unspecified***	Low

Table 3-3. (Continued)

1 TSI_{SD} Carlson's Trophic State Index score. This index was developed from the interrelationships between summer Secchi disc transparencies and epilimnetic concentrations of chlorophyll a and total phosphorus The index results in scoring generally in the range between zero and one hundred. [VBWD values calculated by Barr Engineering Company (from field data). MPCA values taken from the 1993 Clean Water Act Report to the U.S. Congress; and MDNR values taken from Schupp (1992) Minnesota Department of Natural Resources Investigational Report No. 417. An ecological classification of Minnesota lakes with associated fish communities.]

2 MPCA

Fully Supporting = Fully supports swimmable and aesthetics uses; exhibits "impaired swimming" conditions and high algal levels less than 10 percent of the time.

Fully Supporting-Threatened = Lakes exhibit "impaired swimming" conditions and high algal levels 11 to 25 percent of the time.

Partially Supporting = Lakes exhibit "impaired swimming" conditions and high algal levels 26 to 50 percent of the time.

Not Supporting = Lakes exhibit "no swimming" conditions greater than 25 percent of the time and "no recreation possible" on occasion. These lakes exhibit "high algal" levels greater than 50 percent of the time.

3 MPCA Water Quality Standards are described in detail in MN Rule 7050.0220.

4 Metro Council

Multi-use recreational lakes have a public access and/or located in or adjacent to regional parks and recreation areas.

Single-use recreational lakes are used for recreational activities, but do not have a public access and/or are not located in or adjacent to regional parks and recreation areas.

Waters with aesthetic appeal are lakes primarily used for aesthetic viewing (i.e., human use and contact are limited or nonexistent).

5 MDNR

Lake Classes 24 and 30 are good, permanent fish lakes. Class 34 is a permanent fish lake which may winterkill on a rare occasion. Classes 36 and 37 may be subject to occasional winterkill. Class 42 is a marginal fish lake, and may winterkill frequently without the aid of winter aeration. With the aid of winter aeration, however, the lake may function as a good, permanent fish lake.

NP = Northern Pike

CA = Carp

BC = Black Crappie

BG = Bluegill

BKT = Brook Trout

BLB = Blue Bullhead

BNT = Brown Trout

RT = Rainbow Trout

Table 3-3. (Continued)

WS = White Sucker

VBWD Categories

I = Fully supports all water-based recreational activities including swimming, scuba diving and snorkeling.

II = Appropriate for all recreational uses except full body contact activities: sailboating, water skiing, canoeing, wind surfing, jet skiing.

III = Supports fishing, aesthetic viewing activities and wildlife observation.

IV = Generally intended for runoff management and have no significant recreational use values.

V = Wetlands suitable for aesthetic viewing activities, wildlife observation and other public uses.

Table 3-3. (Continued)

Table 3-4. Recommended Runoff Treatment for Discharges to VBWD Lakes, Streams and Wetlands

Classification	Runoff Treatment		
	Sedimentation	Skimming	Nutrient Removal
Levels I and II (Recreation)	Yes	Yes	Yes
Level III (Aesthetic Viewing)	Yes	Yes	Yes/No*
Level IV (Runoff Management)	No	No	No
Level V (Wetlands)	Yes	Yes	No

* As required to maintain intended use(s).