4.2.1 Advantages and disadvantages

Field strips slow runoff and allow for infiltration. With lesser runoff and runoff velocity, filtering occurs. Estimated reductions in phosphorus and nitrogen will depend upon many factors including the layout of the filter strips. These strips have an estimated lifespan of 15 years.

4.2.2 Estimated cost

Costs would be similar to that of buffer strips. NRCS specification 386 for field borders (USDA≤ NRCS, 1991) gives an estimated cost of $160.11 for 1/2 mile of border 16 feet wide. Annual maintenance costs are estimated at 5%. Adjusting for inflation (3%) results in a 1997 cost of $190 per 1/2 mile.

4.3 Grassed Waterways

Grassed waterways are vegetated channels used to convey runoff. When planted on cropland, they prevent erosion caused by concentrated flow. The pollutant removal efficiency of grassed waterways can be improved by adding check dams where slopes are greater than 4% (Center for Watershed Protection, 1994). Grassed waterways can become silted in if excessive erosion is occurring in the fields draining to them.

4.3.1 Advantages and disadvantages

Grassed waterways have been shown to reduce ephemeral and gully erosion by 60 to 80% (USDA-NRCS, 1989). By reducing erosion and sedimentation, grassed waterways also reduce nutrient loss. Sediment-attached nutrients will be reduced proportionally to the amount of sediment controlled. Sediment and nutrient removal will be greater when used in conjunction with filter strips. This practice is not effective in removing dissolved nutrients.

4.3.2 Estimated cost

The cost to install and maintain grassed waterways was estimated as $1.60 per cubic yard ($1.90 in 1997 dollars) for shaping plus annual costs of $0.25 per cubic yard for maintenance (USDA-NRCS, 1991). Seeding with native species is $128 per acre($150 per acre in 1997) + $15.21/year ($18 in 1997) maintenance.

4.4 Livestock Exclusion

Livestock allowed free access to lakes and streams are a nutrient source to the water body. Livestock trample the shoreline, remove vegetation and cause erosion of soils into the lake. These soils carry nutrients into the lake. Livestock also directly add nutrients to the lake through manure and urine deposited into the water or carried from the shore through runoff. In order to remove this source of nutrients to the water, livestock should be fenced off from the water. When fencing is installed, a water supply for the livestock may no longer be available. Therefore an alternate water supply may be needed.

Financial incentives provided to farmers to fence their cattle away from the lake and provide an alternate water supply would help reduce these obvious pollutant sources.

4.4.1 Advantages and disadvantages

Excluding the cattle out of the water through fencing can result in 50 - 90% reduction of suspended solids and total phosphorus (Brach, 1991). There will also be a reduction in bacteria.

Disadvantages of livestock exclusion is the initial cost for fencing, the potential need to install an alternate water supply, and periodic maintenance.

4.4.2 Estimated cost

Fencing: $3-4/foot (approximately 35% of the cost is labor)

Alternate Water Supply: dependent upon type, well drilling costs are approximately $16 per foot plus $2.17 per year in operation cost (USDA-NRCS, 1993)

Conservation Specialist: 80 hours @ $30

Cost estimates were obtained for materials to install 850' of fencing on a site on Lake Sarah. The cost is $525 for materials only. This does not include delivery or any labor or design.

4.5 Soil Testing

Testing the soil for nutrient content and availability is a method of reducing nutrient application and runoff from soils. Results of the soil test will help farmers determine appropriate application rates and optimum soil pH needed to maximize the phosphorus availability to plants.

Most fertilizer recommendations are based upon nitrogen. Nitrogen is a pollutant to surface and ground waters. However, for Lake Sarah, phosphorus is the major cause of eutrophication. Although the phosphorus content of soils may be high, much of the phosphorus is tied up in chemical forms that are unavailable to plants. Only about 1 % of the total phosphorus in soils is available to plants at a given time (Rehm, 1986b). Phosphorus is immobile once it's bound in clays and organic soils. Phosphorus is much more mobile in sandy or peaty soils because it does not readily bind to the soil particles. In manure, the organic forms of phosphorus are incorporated in soil microorganisms during the decomposition process and become more mobile. The optimum pH where phosphorus is most available for plant uptake is 6.5 to 7.3.

Phosphorus that enters lakes from land is most often carried with sediments. Both soluble and particulate forms can be carried to surface waters via runoff, especially during large rain events. Erosion control and tillage methods that reduce the movement of soil can help keep phosphorus out of the lake from this source.

Multiple soil tests should be collected for a field. Each soil sample should represent no more than 20 acres. Separate samples should be collected for sites that differ in major soil type, soil color and texture; cropping history, and fertilizer lime and manure treatments. Ten to twenty locations in each sample area should be sampled and combined for one soil test (Rehm, 1986a).

4.5.1 Advantages and disadvantages

Soil testing will result in more appropriate application of fertilizers to the soil. This will reduce the amount of phosphorus that could potentially be carried in runoff. A soil test may show the less fertilizer is needed. Also, the soil test results will show whether lime is needed to bring the soil pH to the optimum level for plant uptake of phosphorus. This would be beneficial to farmers by reducing their fertilizer needs, and therefore costs, without reducing yield. The disadvantages of soil testing include additional work for the landowner. The costs of the soil testing may be offset by the savings of lowering fertilizer use.

4.5.2 Estimated cost

Soil should be tested once every 3 years

One soil sample every 5 - 20 acres

$10 per sample (University of Minnesota)

Average Hennepin County Farm is 100 acres (U.S. Census Bureau, 1987)

5-10 tests per farm

$35 - $100/farm

Mileage: 80 miles @ 30¢/mile = $24

TOTAL: $55 - $120 every three years (assumes do-it-yourself soil test)

or $20 - $40 annual cost per farm

4.6 Animal Waste Management

Agricultural operations produce nutrient rich waste from manure, feedlot runoff and milk house waste. If these wastes are not properly managed, they are pollutants to the lake. An agricultural waste management system is used to temporarily store these wastes until they can be land applied in an environmentally safe manner. A storage structure such as an earthen or concrete pond, concrete pad, or pit is constructed to store the solid and/or liquid manure. Land spreading of manure is appropriate in that if done properly is an environmentally sound disposal method, but it also has nutrient value. Soil testing is needed to determine nutrient needs and calculate the amount of manure that can be spread on the site.

4.6.1 Advantages and disadvantages

Proper animal waste management can result in pollutant reduction of 60 - 75 percent and theoretically 100 percent from systems that totally control runoff (Brach, 1991). Waste management systems remove nutrients, bacteria, suspended solids and oxygen-demanding substances.

The major disadvantage of waste management systems is the cost.

4.6.2 Estimated cost

The initial investment for agricultural waste management systems is high. Construction costs can be in the 10's of thousands. Equipment used to handle the manure may be needed, if not already available. If new equipment is needed, the costs are substantial. Landowners in the Lake Sarah watershed are unlikely to install such a system because of development pressure. Many expect to sell off the land for development in the future.

4.7 Horse Stables And Backyard Livestock Management

Several of the sites included in the feedlot inventory are hobby farms with several horses. Many homeowners have difficulty disposing of livestock waste. Stockpiling of the waste may result in runoff into a creek or ditch which eventually reaches Lake Sarah. It is also a potential source of groundwater contamination. The management of runoff and manure on these hobby farms may be improved through education efforts. A project could also be initiated to work toward creating a network of landowners and business operators to connect landowners who need a way to dispose of manure and those who could make use of the waste. Best management practices for these sites will be implemented based on the Environmental Protection Agency publication entitled "Pollution Control for Horse Stables and Backyard Livestock."

4.7.1 Advantages and disadvantages

This project would be advantageous to both the hobby farm owners and the lake. If we can offer a solution to waste disposal and also work with landowners to implement improved pasture and runoff management, the project will be beneficial to all. One disadvantage is that it may be difficult to find others interested in taking the waste.

4.7.2 Estimated cost

Some of the costs would fall under the education effort listed under homeowner BMPs. The estimated cost to create the network is $2000 -$3000.

4.8 Feedlot Runoff Management

Runoff management may consist of several methods (Brach, 1991)

1. Diversions
2. Roof water collection and disposal
3. Sediment basins
4. Waste storage ponds
5. Vegetative filter strips

4.8.1 Advantages and disadvantages

Reduction in phosphorus loading is the primary benefit of animal waste management. Phosphorus reduction on the order of 80-90% is possible (Olem and Flock, 1990). Loading of other pollutants, including nitrogen, bacteria, sediments and BOD are also reduced. The disadvantages are additional costs and maintenance for the landowner. A waste storage or sediment basin pond is a big up-front cost. Landowners in the Lake Sarah watershed are unlikely to install such a system because of development pressure. Many expect to sell off the land for development in the future.

4.8.2 Estimated cost

Varies greatly dependent upon type of practice.

4.9 Manure Management/Utilization

Properly managing manure as a resource rather than a waste will result in both economic benefit to the farmer as well as reduced pollutant loading. In order to accomplish proper manure management, training of farmers is needed. A clinic to train farmers on how to determine the nutrient value of manure and how to calibrate their spreaders will help change the way manure is managed in the watershed. This is expected to result in changes in proper manure management practices and resulting reduced runoff and nutrient leaching (Chan-Meuhlbauer, 1993).

4.9.1 Advantages and disadvantages

Reduced input costs can result in substantial savings. When the true nutrient value of manure is determined, reduced fertilizer use is possible. In one example, for a farm producing 1,000,000 gallons of manure annually fertilizer purchase was reduced by 19,000 lbs. of N, 20,650 lbs. of

P_2O_5 and 22,550 lbs. of K_2O in 1992 (Chan-Meuhlbauer, 1993). The water quality benefits of manure management are reduced runoff of nutrients from cropland where manure is applied. The disadvantages of manure management are additional work required to determine appropriate application rates and to calibrate the manure spreader.

4.9.2 Estimated cost

No new or additional equipment is required

Video tape of manure calibration $25

Manure Calibration Clinic:

Staff: 50 hours @ $30/hour = $1500
Mileage: 200 miles @ 30¢/mile = $60
Brochures: 100= $50
Postage & Supplies: 100 @ 29¢+ $10 = $39

TOTAL: $764

4.10 Conservation Tillage

Conservation tillage is a method where crop residue (minimum 30%) is left in the field to hold the soil in place.

4.10.1 Advantages and disadvantages

Conventional tillage methods result in the loss of soil through wind and water erosion. Conservation tillage is used to reduce soil erosion. Erosion results in the loss of 6.4 billion tons of valuable topsoil each year (Successful Farming, 1983). Each year wind erosion claims about 5.3 tons of soil per cropland acre (Successful Farming, 1983). Estimates indicate that over 10 billion dollars worth of fertilizer is lost through soil erosion each year in the United States (Myers, undated). This results in about $6 - $7 per acre worth of fertilizer that must be replaced in order to maintain yield. The water quality benefits of tillage methods increase as the amount of residue increases. No-till provides the greatest protection against erosion. Estimated reductions in soil loss with different tillage methods are listed below (Brach, 1991).

Table 2. Conservation Tillage Soil Loss Reductions

Conservation Tillage Method	Reductions in soil loss
Full Width (chisel plowing)	40 - 90%
Wide Strip (Ridge Till, Inter-till, till-plant and rotary tillage)	40 - 60%
Narrow Strip (No-till, slot plant)	50 - 95%

Reduced tillage methods lower fixed costs. Planting is often delayed on farms by waiting for the conditions needed for tillage. Reduced tillage or no-till planting avoids the losses due to these delays.

The benefits of reduced tillage include, erosion control, fuel savings due to fewer trips across the field and lower consumption of reduced tillage equipment, yields comparable to those of conventional tillage, reduced loss of farm chemicals and less water pollution, time savings due to fewer trips across the field, less soil compaction due to fewer trips across the field and lighter equipment, and soil moisture preservation.

Time per acre of corn tilled:

Conventional	1.6 hours
Mulch-till (e.g. Chisel plowing)	1.2 hours
No-till	0.6 hours

Reduced tillage can be profitable (Myers, undated).

1. Less tillage = less machinery = lower fixed costs = less debt for equipment or less cash that must be set aside for future machinery replacement
2. Less tillage = fewer weather delays = more timely completion of planting and other production practices = higher short-term and long-term average yields = bigger income = more ability to service debt = more financial staying power.

Post emergence weed control costs are slightly higher for no-till soybean production. However, these costs can be offset by increased yields due to the ability to plant in narrower rows.

Equipment costs (average 1976 - 1980) to handle a 600 acre operation, are listed below (Successful Farming, 1983). Equipment costs for reduced tillage are less than for conventional tillage.

Table 3. Comparison of Tillage Costs

Tillage Method	Total annual ownership cost	Ownership cost per rotated acre
Conventional	$31,170	$51.95
Full Width	$27,720	$46.20
Strip Tillage	$23.110	$38.52
No-till	$23,220	$38.70

According to the Conservation Technology Information Center, conservation tillage offers the following economic and environmental benefits (CTIC 1996):

Reduced labor requirements- As little as one trip for planting compared to two or more tillage operations plus planting for conventional tillage.

Time savings - On a 500-acre farm, the time savings can be as great as 225 hours or almost four 60-hour work weeks.

Reduced machinery wear - Fewer trips save an estimated $5 an acre on machinery wear and maintenance costs- a $2500 savings on a 500-acre farm.

Fuel savings - Save an average 3.5 gallons per acre or 1,750 gallons on a 500-acre farm.

Reduce soil erosion- Soil erosion can be reduced up to 90%.

Improved surface water quality- Crop residues help hold soil particles and associated nutrients and pesticides on the field. Herbicide runoff can be cut in half on some sites.

Improved long-term productivity- Carbon accounts for about half of the organic matter in the soil. The latest research shows the less you till, the more carbon you keep in the soil to build organic matter and promote future productivity.

The Hennepin Conservation owns a no-till drill which is leased to farmers for use on their land. The drill will be loaned to farmers to try no-till. The Hennepin Conservation District Conservation Specialist will provide assistance to the farmers to help deliver, set up and calibrate the drill.

4.10.2 Estimated cost

No -till drill: @ $10/acre
Technician : 10 hours per farm @ $20 = $200
Estimate 20 acres per farm
Estimate 10 farms
Total 200 acres at $10/acre = $2000 + $2000 Conservation Specialist
TOTAL: $4000 or $400 per farm average per year

4.11 Wetland Restoration and Evaluation

Staff of the Hennepin Conservation District has identified several wetlands for restoration and has cooperated with the U.S. Fish and Wildlife Service to restore some wetlands through their programs. Additional evaluation of wetlands in the watershed is needed to determine if restoration is feasible and beneficial.

4.11.1 Wetland restoration

One large wetland that could be restored is a drained type 2/3 wetland of approximately 25 acres. A ditch (Dance Hall or Rush Creek) is channelized through the wetland. No treatment occurs because the water is limited to flowing within the ditch most of the year. Restoring the wetland by installing a dike in the creek would provide treatment of the water by slowing down and spreading the water out over a larger area. The wetland would provide treatment by settling and plant uptake before it reaches the lake. The water level across the main wetland basin would rise about two feet. The wetland has been used as pasture and therefore has received a significant load of nutrients from animal waste over the years. Phosphorus inactivation such as an alum treatment may be beneficial prior to restoring the wetland.

4.11.2 Estimated cost

Because there presently are several programs for restoring wetlands available, these programs can be used to accomplish wetland restorations in the watershed. These programs provide restoration at no cost to the landowner. Several programs offer payment for a permanent easement on the land. The programs available for wetland restoration in the Lake Sarah Watershed are: