

**PLUM LAKES
MULTIDISCIPLINARY RESOURCE MANAGEMENT
TASK FORCE**

- FINAL REPORT -

December, 1997

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1.0 INTRODUCTION

1.1 BACKGROUND TO THE ISSUE OF WATER MANAGEMENT

The Oak-Plum Lakes complex (Figure 1) is one of the larger wetland areas in southwestern Manitoba. Wildlife interests have long recognized this complex as a valuable staging area and a marsh with great waterfowl and wetland wildlife production potential. Plum Lakes has been named a candidate Heritage Marsh by a committee of conservation agencies as a direct recognition of its wildlife and biodiversity values.

The area has had a long history of water related problems, particularly for those landowners who have farmed in the area. Some level of positive water management was achieved when much of Oak Lake was dyked in 1964 and Pipestone Creek, the major tributary from the west, was channelized. Oak Lake has high recreation use, both for water sports and fishing. Oak Lake is one of the few fishing lakes of any size in southwestern Manitoba, and as such is important regionally.

Landowners who own or rent land within or near the Plum Lakes complex have had differing opinions about the level at which this marsh should be managed. Because of the difficulty of trying to resolve or develop a water control/management scheme for the marsh area, considering agricultural and wildlife interests, this has not been successful to date.

The Manitoba Water Commission reviewed the entire issue in 1982 and subsequently arrived at several recommendations. A key recommendation was the establishment of the Oak and Plum Lakes Management Board, which was appointed by the Minister of the Department of Natural Resources in 1983. To date, the board has been unable to effect any program of water management. The Board has acted as a local advisory committee to the Plum Lakes Multidisciplinary Resource Management Task Force, established in 1986.

1.2 STRUCTURE AND MANDATE OF THE TASK FORCE

The Multidisciplinary Task Force is comprised of the following personnel, representing their respective agencies:

Larry Bidlake - Chairman, Operations Division, Department of Natural Resources
Barry Oswald - Secretary, Water Resources Branch, Department of Natural Resources
Don Sexton, Ducks Unlimited Canada
Bill Howard, Operations Division, Department of Natural Resources
Pat Rakowski, Canadian Wildlife Service

Jerry Gramiak, Department of Agriculture
Jack Robson, Chairman, Oak-Plum Lakes Management Board
Al Shier, Department of Rural Development
Edgar Hardy, Rural Municipality of Sifton

Numerous staff from all involved agencies have assisted or contributed to the development of this report. In the early years of the Task Force, Bruce Webb then John Arthur of Water Resources acted as secretary and Art Toews then Kendall Heise represented the Department of Agriculture. Herb Schellenberg of the Department of Agriculture/Manitoba Crop Insurance Corporation has provided constant advice to the group and agricultural section. As the sole economist, Herb provided the overall cost benefit analysis necessary for the project. Dwight Williamson of Manitoba Environment summarized all existing water quality data. Joyce Maynard of Water Resources had the onerous task of typing the several drafts and many changes to the report. To all of these people, the Task Force owes a great deal of gratitude.

The Task Force was established in 1986 at the request of the Wildlife Branch of Natural Resources to facilitate implementation of the Manitoba Water Commission recommendations in association with the Management Board.

The Task Force was charged with the task of:

- 1) Identifying and evaluating the most reasonable water management options for improving conditions in Plum Lakes.
- 2) Determining the agricultural, wildlife and other benefits and disbenefits, as well as costs of any works.
- 3) Undertaking a benefit cost and net benefit analysis of each of the water management options evaluated.
- 4) Receiving input from the Advisory Committee (Management Board) at all stages.

In order to adequately review any water management options as developed by the Task Force or requested by the Management Board, a great deal of data was collected and analyzed over the decade since the Task Force began. The Department of Natural Resources, being the proponent of the study, did not have the necessary budget to do this, so that all expenses for services both in and out of government had to be borne by various agencies. Some data and services were provided gratis while others had to be paid for and recovered from an outside agency or from the budget of a Branch of the D.N.R. With the inception of the Task Force, members realized there was a critical lack of precise topographic and soils information for the area. Thus, over time, the following data has been collected and/or produced.

1. Aerial photographic coverage of the project area in 1986.
2. A one-foot contour survey for the area.
3. Digitized map development of the contour survey information.
4. Detailed soil survey and report for the project area.
5. Flooded acreage tables.
6. Current land use maps from Landsat imagery.
7. Land ownership maps.

With the completion of detailed topographic maps of the project area in 1992, a detailed soil survey for the majority of the project area, aerial photography taken of the area in 1986 and flooded acreage tables, the Task Force and Management Board were finally able to begin looking at different options, and solicit public opinions. To this end, two "open houses", in October and December, 1992, were held at the Oak Lake Community Hall, for all landowners within the entire marsh area, as well as those adjacent to Plum Creek downstream to P.T.H. 21. As a result of these "open houses" and responses to questionnaires completed by landowners, the Management Board requested the Task Force to address four options for water management. After the Task Force reviewed each of these options, other options were proposed and considered.

There has been literally hundreds of hours of staff time from various agencies spent on developing the raw data, reviewing the data and the options, and discussing possibilities over the years. A conservative estimate of fixed costs incurred on behalf of the Task Force, excluding most staff time, would be \$280,000. Agencies providing the necessary funding to gather the data and complete the report are:

The Department of Natural Resources

- Water Resources Branch
- Wildlife Branch
- Surveys Branch

The Manitoba Habitat Heritage Corporation

The Canadian Wildlife Service

Canada-Manitoba Soil Survey

Ducks Unlimited Canada

In this report, the culmination of almost ten years of data collection, discussion with the Oak-Plum Lakes Management Board and subsequent analysis, the Task Force has attempted to present a balanced view of all of the proposed water level/land management options. Our conclusions and recommendations are based on the best information we had available to us. Anecdotal information from landowners was used or considered as necessary.

2.0 HISTORY OF PROJECT AREA

Although extensively explored prior to his account, Thompson (1891) provides a brief description of the pre-settlement condition of the area around Plum Lakes. He refers to the Souris Plains upon which the lake lies as a "remarkably level region entirely devoid of trees excepting in the river gorges and diversified by numerous lakes and alkaline flats". Reference is also made to the "sandhills" or dunes of the area and the covering of trees on these formations. He also refers to the bird life of the marshes adjacent to Oak Lake (ie. Plum Lakes).

Along with the development of agriculture in the area during the early 1900's came traditional recreation pursuits of the settlers. These included sport hunting. A review of Ducks Unlimited files show that in 1937, several letters from concerned sportsmen requested that the marshes of Oak and Plum Lakes be investigated for water level restoration. As early as that time concern over water levels was being voiced by residents. Many individuals favoured water level management, no doubt due to the extended drought of the 1930's.

As early as 1945, the Rural Municipality of Sifton met with Ducks Unlimited (DU) over possible regulation of Oak Lake water levels. Dissenting views quashed these early attempts by expressing fears of flooding more land. DU was approached by the rural municipality again in 1951 to survey and propose water control. This was brought about by concerns over high water levels in Plum Lakes that year. This plan was rejected by local residents, again fearing further and future flooding.

The municipality next approached the federal and provincial governments, with a request for assistance. In 1955-56, the Prairie Farm Rehabilitation Administration (PFRA) excavated a portion of the channel of Plum Creek, the Plum Lakes outlet, from a location just west of PR 254 to a location about 1.5 miles east of PR 254. At the same time, many local ranchers and the rural municipality requested some form of water level regulation to prevent complete drainage of the lakes. Fears of a lowered water table and loss of stock water were expressed if such a control was not put in place. In 1958 DU completed the Kansas City Oak and Plum Lakes Dam on Plum Creek to regulate water in the lakes. This construction was authorized by the Rural Municipality of Sifton and Water Resources Branch of the Manitoba Government. Due to DU's inability to obtain all signatures on landowners easements, however, the structure was operated for only a short period of time.

Through the 1960's, due to varied concerns over water levels considered to be too high or too low, suggestions and requests for surveys and operation of the DU dam were commonplace. During this period concern was being expressed by cottage owners over low water levels on Oak Lake. Similarly, landowners to the west of Oak Lake in the

vicinity of the Pipestone Creek expressed concern over periodic flooding near the inlet to Oak Lake when spring flows exceeded channel capacity. As a result of these concerns, Pipestone Creek was channelized for approximately two miles west of Oak Lake and a dyke was built from the Pipestone Creek channel around the lake. A fixed crest dam on Oak Lake at elevation 1410 ft. above sea level (ASL) was constructed with an outlet to the Plum Lakes in 1964.

Concern over water levels in Plum Lakes, however, continued through the 1960's and 1970's with advocates for lower water levels and others for water retention at higher levels and management. Residents of the area also expressed concern that drainage in the upstream portion of the watershed has contributed to more frequent and severe flooding around Plum Lakes. In 1971, the Plum Lakes Regulation Study (Somers, Bossenmaier and Ramsey, 1971) examined several flood control schemes. The report noted a desire by local residents of a level of 1407 ft. ASL in June, with acceptance of a spring level higher than this.

A group of government representatives from Wildlife, Agriculture and Water Resources, tasked to evaluate the 1407 ft. ASL level as the preferred water management option, was the first major study of the Plum Lakes marshes evaluating all resources. This report concluded that lowering levels to 1407 ft. ASL was not economically viable when the benefits to agriculture were compared to the losses to wildlife, (Grower & Kabaluk, 1973). A recommendation was made to regulate water levels at an elevation of 1409 ft. ASL, chosen as a level to provide high wildlife benefits, minimal agricultural losses and alleviate future flooding by improving the outlet channel. However, no contour survey data was gathered by this study to show landowners where this water level would lie relative to their own land. Included in the proposal was a recommendation to purchase all privately affected land. This proposal was rejected by local landowners.

The development concept was reworked and submitted by the Canadian Wildlife Service in 1975 to include cost-sharing of the land purchase and water control structures. The outcome was to be a cooperative Federal-Provincial Wildlife Management Area with land acquisition to 1411 ft. ASL. Water levels were to be controlled at 1409 ft. ASL. A management authority with federal and provincial representatives and a funding ratio of 75:25% respectively was proposed. Again, local residents opposed the idea of land purchase and the province withdrew its support of the proposal in 1977.

High water levels on Plum Lakes occurred again in 1976. In 1976 and 1977, the Rural Municipality of Sifton carried out some channel works on the Plum Creek starting two miles east of PR 254 and west of PTH 21. In 1981, the Rural Municipality of Sifton passed two resolutions concerning the area. Both requested Water Resources to upgrade Plum Creek channel on section 31-7-24W by cleaning and straightening, in order to pass flows comparable to the capability of downstream reaches. This work was not carried

out.

In 1981, the Rural Municipality also began constructing an access road to Crown hay leases along the east side of sections 30 and 31-7-24W and completed it in 1982. Water Resources had given tentative approval so long as the road did not impede natural flow. The road and spillway is periodically inundated under flood conditions and is locally known as the Hardy Dam.

The conflicting water-related issues expressed during 1979 to 1981 (and earlier) resulted in the Manitoba Water Commission holding hearings in 1982. Their objective "was not to solve all problems, but rather to reduce the effects of extreme fluctuations by providing more control of the flow of water over the whole year and thereby provide some stability to water levels" (Manitoba, 1983). The Commission's report noted that the landscape has evolved due to man's activities and that these changes cannot be undone. Further intrusion and impact into the marsh area was not recommended. The Commission recommended a moratorium on agricultural expansion in the marginal areas, and because the area is unique for wildlife, efforts should be directed toward its conservation and enhancement.

The eight Commission recommendations for action are listed below as taken from the 1983 report:

1. A management board, known as the Oak and Plum Lakes Management Board, be established to manage the water levels in the Oak and Plum Lakes area, and that it be representative of the various interest groups, namely:
 - a) A chairman - appointed by the Minister of Natural Resources
 - b) Agricultural community - 2 representatives
 - c) Recreational interests - Cottage Owners Association - 1 representative
 - d) Rural Municipality of Sifton - 1 representative
 - e) Wildlife interests - 2 representatives, 1 of whom shall be from Ducks Unlimited
 - f) Educational community - Brandon University - 1 representative
 - g) Water Resources Branch - 1 representative (ex-officio) who acts as Secretary to the Board
2. The Oak and Plum Lakes Management Board endeavor to maintain the level of the Plum Lakes within a range of 1407 - 1409 ft. ASL. Presently, the full supply level (FSL) of the Kansas City Oak and Plum Lakes Dam is 1407.86 ft. ASL and at levels above this the dam will act as a weir.
3. The Province of Manitoba should acquire control of the Kansas City Oak and Plum Lakes Dam. This dam should be refurbished and made operational in order to maintain water levels.

4. That the carrying capacity of Plum Creek be increased to permit greater control of the water levels in the wetland complex after the Kansas City Oak and Plum Lakes Dam is made operational.
5. The Board should establish a monitoring program to determine the suitability of the range 1407 to 1409 ft. ASL, a summer level of 1407 ft., and the date of drawdown.
6. The Board should consider the tentative selection of more than one level within the regulation range (1407 to 1409 ft. ASL) in order to explore the practicality of various levels with respect to costs of outlet works, channel excavation (Plum Creek) and downstream impact from the increased flood releases.
7. The Board review all records relative to water levels, flows and (a) developments since 1973 within the Oak and Plum Lakes wetland complex, and (b) determine the relationship between groundwater levels and the water levels in Oak and Plum Lakes.
8. The Board's activities under recommendations 5, 6 and 7 (above) extend over a five year period. The Board may make interim recommendations to the Minister with respect to water levels and any required physical works.

The Minister of Natural Resources appointed a seven person Management Board in 1983 as a result of the Manitoba Water Commission's first recommendation. The Board, however, was unable to act on recommendations 2 and 3 as there was no Water Rights licence in place, or landowners easements that would permit these regulating activities to legally occur. Further, it was known that recommendation 4 could not proceed unless items 2 and 3 were completed. These failings prevented recommendations 5 and 6 from being assessed.

In order to assist the Management Board with developing a strategy to meet the Water Commission's recommendations, the Plum Lakes Multidisciplinary Resource Management Task Force was organized in 1986.

3.0 PROJECT AREA SETTING

3.1 PHYSIOGRAPHY

Located in southwestern Manitoba (49° 37' N, 100° 45' W), Plum Lakes are located in the Rural Municipality of Sifton immediately southwest of the Town of Oak Lake and situated approximately 18 miles west of the Town of Souris. The Plum Lakes complex wetlands covers approximately 24,000 acres of shallow (<3 ft.) interconnected wetlands lying within a large depressional area situated in the extreme northeastern edge of the mixed-grass prairie biome (Shay, 1984). The flat topography in and along the basin proper, and adjacent wind-worked dunes of sand (now vegetated) originated within glacial Lake Souris (Scoggan, 1957). Plum Lakes have a bottom elevation of 1402.0 ft. ASL at the deepest point while adjacent dunes area reach 1421.3 ft. ASL. Aerial photography maps at a scale of 1:12,000 with contours are presented in Appendix A. This appendix is bound under a separate cover.

3.2 CLIMATE

The general climate in Manitoba is classified as Db (Langley, 1972). This indicates mean temperatures for the warmest month is above 50 degrees F and coldest below -26.6 degrees F. Brandon area (closest station) extremes show a recorded low of -52 degrees and high of 109.9 degrees F. The region is considered dry with mean annual precipitation at 18.9 inches and evapotranspiration of 22 inches. About half the annual precipitation falls in summer (June, July and August). Over the period of 1921 to 1950 the Oak Lake area had an average annual moisture deficit of 5.9 inches (Manitoba, 1983). Mean annual snowfall is about 50 inches. The area is characterized by having the last spring frosts before June 1 and the first fall frost by September 15 on average; earliest frosts have occurred as early as mid August (Langley, 1972).

3.3 SOILS AND VEGETATION

3.3.1 SOILS

The Canada-Manitoba Soil Survey Report, D81, "Soils of the Plum Lakes Project" (Michalyna and St. Jacques, 1989) provides much information on lands in the Plum Lakes area as to their capability for agricultural production. This detailed survey covered approximately 38,000 acres of land in the general area of Plum Lakes. These are the lands generally considered to be affected adversely for agricultural production by high water levels, salinity and droughtiness. Omitted in this survey, the land area northwest of Oak Lake is also adversely affected for agricultural production when water levels are high.

The system of mapping used with Report D81 was detailed, with the taxonomic category used to classify soils being the soil series. It is defined as a naturally occurring soil body such that any profile within the body has a similar number and arrangement of horizons, whose colour, texture, structure, consistence, thickness, reaction and composition are within a narrowly defined range. A soil series was further categorized into phases indicating degrees of erosion, slope, stoniness and salinity.

Table 1 provides the acreage associated with each soil series and phase, sorted according to agricultural capability. These soils are fully described within Report D81. Soil texture classification maps at a scale of 1:15,000 are presented in Appendix A.

A total of 8,096 acres of prime agricultural land was identified. "Prime agricultural land" means land defined as Classes 1, 2 and 3 soils under the agricultural land capability system of Canada Land Inventory and interpreted as such by Soil Survey, Manitoba Department of Agriculture.

Class 4 soils totalled 5,155 acres and can be used for annual crops. Class 5 soils totalled 1,705 acres and are suitable for perennial forage crops. Class 6 soils are suitable only for perennial forage crops and improvement practices are not feasible. Class 6 soils totalling 11,784 acres, cover a large portion of the study area.

The balance of the Plum Lakes area that was surveyed totalled 11,258 acres comprising 3,788 acres of marsh complex and 7,470 acres of open water.

The area has been classified as to its irrigation suitability, with 12,172 acres rated as Very Good, Good and Fair (Classes 1-3). As the text states: "Irrigation suitability of soils is a relative rating to indicate their limitation for sustained production, risk of damage or crop losses, and the ability to maintain favourable soil properties under long term irrigation use" (Michalyna and St. Jacques, 1989).

**TABLE 1.
AGRICULTURAL CAPABILITY CLASSES
PLUM LAKES AREA**

Series-Phase	Acres	Class	Series-Phase	Acres	Class
Cameron	153	1	Wawanesa-xxxxt	52	4N
			Total Class 4	5,155	
Cameron-1cxx	124	2T			
Cranmer	40	2W	Cromer	89	5W
Hartney	257	2W	Cromer-xxxxs	605	5W
Lyleton	116	2M	Grand-Clairiere-xcxx	897	5M
Lyleton-xcxx	576	2MT	Hartney-xcxu	32	5N
Lyleton-ocxx	94	2MT	Pipestone-xxxu	62	5N
Lyleton-1cxx	49	2MT	Wawanesa-xxxu	20	5N
Pipestone	655	2W	Total Class 5	1,705	
Switzer	217	2W			
Wawanesa	2,350	2W	Cromer-xxxxt	2,389	6W
Total Class 2	4,478		Cromer-xxxu	430	6NW
			Emblem	57	6W
Lyleton-xdxx	86	3T	Emblem-xxxxs	140	6W
Pipestone-xxxxs	1,099	3NW	Emblem-xxxu	32	6NW
Souris-1xxx	255	3ME	Grand-Clairiere-xdxx	1,077	6M
Souris-oxxx	32	3ME	Grand-Clairiere-xexx	10	6M
Souris-xxxxs	67	3NM	Grand-Clairiere-xfxx	568	6M
Souris-xcxx	1,253	3M	Martinville	2,132	6W
Souris-xcxs	210	3NM	Martinville-xxxxs	1,480	6W
Switzer-xxxxs	208	3NW	Martinville-xxxxt	363	6W
Wawanesa-xxxxs	255	3NW	Martinville-xxxu	232	6NW
Total Class 3	3,465		Oak Lake	435	6W
			Oak Lake-xxxxs	1,532	6W
Pipestone-xxxxt	168	4N	Oak Lake-xxxxt	677	6W
Ralston	227	4M	Oak Lake-xxxu	25	6NW
Scarth-xdxx	240	4TM	Plum Lake	205	6W
Souris	1,913	4M	Total Class 6	11,784	
Stanton	514	4M			
Stanton-1xxx	292	4M	Marsh Complex	3,788	7W
Stanton-oxxx	143	4M	Water	7,470	7W
Stanton-xcxx	1,391	4M	Total Class 7	11,258	
Stanton-1cxx	158	4ME			
Stanton-1dxx	57	4TM	Total All Classes	37,998	

3.3.1.1 SALINITY

Soil salinity refers to a condition of the soil in which water soluble salts are present in sufficient amounts to affect plant growth. Salinity occurs most commonly in landscapes where soil drainage is impeded and surface evaporation (and evapotranspiration) removes water and leaves the salts to accumulate. It is basically a function of high water table plus evapotranspiration exceeding infiltration.

The primary effect of salts in soils is to deprive plants of water. Plants need both the water and the nutrients dissolved in it for proper growth. The sap in plant roots contains salt which attracts water into the plant via osmotic pressure. Dissolved salts in the soil increase the osmotic pressure of the soil solution. This decreases the rate at which water from the soil will enter the roots. If the soil solution becomes too concentrated the plants slowly starve, though the supply of water and dissolved nutrients in the soil may be more than adequate.

Salinity has distinctive characteristics which affect management and productivity. These areas are characterized by slow germination, bluish-green tinge in the leaf colour, reduced plant growth, irregular growth patterns, and the presence of saline tolerant plant species. In addition, the soils are usually moist, have poor trafficability, and have poor structure.

Severe saline areas are recognized by white salt crusts on the soil surface or white flecks in the upper part of the soil profile. Generally, such weed species as goosefoot red samphire and salt meadow grass are found in areas of high salinity. Other weeds which may be found on the periphery are kochia, Russian thistle, wild barley, gumweed, smartweed, and cocklebur.

A saline soil is a soil containing soluble salts in such quantities that they interfere with the growth of most plants. The electrical conductivity of the saturated extract is greater than 4 millimhos per centimeter at 25 degrees Celsius. Approximate limits of salinity classes are:

Non-saline or minimal salinity	0-4 millimhos/cm
Slightly saline	4-8 millimhos/cm
Moderately saline	8-16 millimhos/cm
Strongly saline	> 16 millimhos/cm

Soil salinity classification maps at a scale of 1:15,000 are presented in Appendix A. Because salts are soluble, water movement causes salts to accumulate in some parts of the landscape. A prerequisite for soil salinization is a high water table close enough to the soil surface to allow capillary action to lift water from the free water table to the surface. However, the critical depth varies with soil texture. It is important to note that a high water table alone is not sufficient to cause soil salinization.

Salt accumulation occurs whenever the quantity of water leaving the soil surface by the evaporation process exceeds the quantity of water that enters the soil through

rainfall or runoff accumulations.

The high water table required for salinization to proceed can be a result of several groundwater movement patterns. Water enters the groundwater system in the recharge area, where infiltration exceeds evaporation, for at least part of the year. Groundwater flows in water bearing layers called aquifers to lower positions in the landscape. Salinity develops in the discharge area where the water table is near the soil surface (within two meters), and where evaporation exceeds infiltration.

3.3.2 VEGETATION

Plum Lakes are situated in the extreme northeast portion of the mixed-grass prairie (Shay, 1984). Bird (1961) considered it a portion of the Aspen Parkland whereas Rowe (1972) considered it the Aspen-Oak Association of the boreal forest - a transition between prairie and forest. Prior to settlement the area was prairie, undoubtedly maintained by periodic fires (Hind, 1860). The invasion of trees followed elimination of these fires.

Within this region much of the native vegetation has been altered by man's activities. Close to Plum Lakes the effects are less obvious and mature stands of vegetation remain today. Dominant plants by community are summarized from Carreiro (1972), Scoggan (1957) and Ducks Unlimited (1979, 1982 and 1986).

Wooded areas, particularly dune sites, are dominated by burr oak (*Quercus macrocarpa*), trembling aspen (*Populus tremuloides*) and creeping juniper (*Juniperus horizontalis*). On moister sites or adjacent to Oak Lake, Manitoba maple (*Acer negundo*), American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), cottonwood (*Populus deltoides*) and rarely, balsam poplar (*Populus balsamifera*) are present.

A variety of woody shrubs occurs in the understory of wooded tracts or along their margins. They include saskatoon serviceberry (*Amelanchier alnifolia*), western snowberry (*Symphoricarpos occidentalis*), pin cherry (*Prunus pennsylvanica*), chokecherry (*Prunus virginiana*), sandcherry (*Prunus pumila*), shrubby cinquefoil (*Potentilla fruticosa*), Canada buffaloberry (*Shepherdia canadensis*), wolfwillow (*Eleagnus commutata*), willows (*Salix* spp) and roses (*Rosa* spp). Some of these, particularly roses, saskatoon and snowberry, form low dense clumps on moister sites on the prairie grasslands.

Grasses which predominate on undisturbed prairie areas are blue grama (*Bouteloua gracilis*), blue grasses (*Poa pratensis*, *Poa* sp), June grass (*Koeleria cristata*), wheatgrasses (*Agropyron* spp), fescues (*Festuca* sp), awnless brome (*Bromus inermis*), bent grasses (*Agrostis* spp), big bluestem (*Andropogon gerardi*), little bluestem (*Andropogon scoparius*), and speargrass (*Stipa* spp). The variety of species present of

both tall and short grass types indicate the area is a mixed grass prairie association. In addition to grasses, a wide variety of herbaceous plants are evident. Species such as crocus (*Anemone patens*), prairie lily (*Lilium philadelephicum*) and lady's slipper (*Cypripedium* sp) provide attractive viewing in the grassland and along margins of wooded areas. A comprehensive prairie vegetation inventory of all lands within the project area has not been completed, but cursory checks on some parcels indicate that the Nature Conservancy of Canada property has remnants of good quality prairie. Numerous other locations in the area are rated fairly low in terms of quality of prairie largely due to the presence of non-native species including leafy spurge (*Euphorbia esula*) (Moore, 1996).

Wetland vegetation is represented by species common to wet meadows, temporary marshes and semi-permanent wetlands. Grasses common to moist sites include whitetop (*Scolochloa festucacea*), cordgrasses (*Spartina gracilis*, *Spartina pectinata*), sloughgrass (*Beckmania syzigachne*), northern reedgrass (*Calamagrostis inexpansa*), reed canary grass (*Phalaris arundinacea*) and sedges (*Carex* spp). Rushes (*Juncus* spp) and spikerush (*Eleocharis* sp) are common there also.

Where water is more permanent, a variety of emergent plants are found growing. Cattail (*Typha latifolia*), hardstem bullrush (*Scirpus acutus*), softstem bullrush (*Scirpus validus*), river bullrush (*Scirpus fluviatilis*) and giant reed grass (*Phragmites communis*) are the principle species. Deeper, more open waters harbour an abundance of submergent plants. The dominant species are watermilfoil (*Myriophyllum* spp), bladderwort (*Utricularia vulgaris*), several pondweeds (*Potamogeton* spp) and duckweeds (*Lemna* spp).

3.4 LAND USE

Carreiro (1972) classified the lands around Plum Lakes as 8% cultivated, 11% improved forage, 32% grazing and native hay, 5% woodland and 44% marsh or water. The extent of marshland and native hay varies annually depending on water levels and weather conditions during the July-August haying period. The subsequent detailed Canada-Manitoba Soil Survey Report D81 (Michalyna and St. Jacques, 1989) determined that 35% of the lands in the Plum Lakes area have the agricultural capability of producing annual field crops (soil capability for agriculture classes 1 to 4) while 31% were limited in agricultural capability to the production of native hay only (class 6).

Current land use reflects these capabilities in that most farmers realize the agricultural value of the wetter area is limited to hay production or grazing. The very severely limited (Class 6) area comprises the wetland edge. Some of the dune area is considered severely limited (Class 5). Ehrlich et al. (1956) noted the fragility of these sites, particularly the dune areas, and recommended they be left in native vegetation with minimal disturbance. Land cover/land use maps at a scale of 1:15,000 are presented in Appendix A.

3.5 WILDLIFE AND FISHERIES

3.5.1 WILDLIFE

Plum Lakes is one of the most important wetland complexes in southern Manitoba. It lies within the region of the highest waterfowl production in Manitoba. This wetland has been rated Class 2Si by the Canada Land Inventory (Adams and Hutchison, 1968). This indicates the area has potential for very high waterfowl production with water level fluctuations as the only limiting factor, and has special significance as an important staging area for migrant waterfowl. Breeding species of ducks observed in the lakes include a variety of divers and dabblers. In order of abundance these are mallard, lesser scaup, pintail, blue-winged teal, redhead, canvasback, shoveler and American wigeon (Ducks Unlimited, 1988). Carreiro (1972) suggested the marshes can produce 25,000 ducks per year under managed conditions.

Plum Lakes were formerly a nesting area for prairie Canada geese which disappeared from the area in the early 1900's. Beginning in 1965, DU initiated a Canada goose release program which continued until 1976. In 1966 a Special Canada Goose Refuge was created around Oak and Plum Lakes to protect this small breeding nucleus of geese from overharvest. Counts in 1982 indicated up to 51 nesting pairs.

According to Webb (1967), Oak and Plum Lakes are especially important to waterfowl during drought periods. The entire area serves as a nesting or resting area for displaced birds from the surrounding region during such times. As many as 20,000 molting ducks have been seen on Oak and Plum Lakes in late July with a large portion using the Plum Lakes (Ducks Unlimited, 1988). The availability of large bodies of water such as Plum Lakes undisturbed by human or other activity and possessing an abundance of food, are required by molting ducks, especially the diver species.

Autumn staging concentrations of waterfowl on Oak and Plum Lakes have been documented by both the Manitoba Department of Natural Resources and Ducks Unlimited (Robertson, 1967; Davies, 1968; Coulson, 1969; Bidlake, 1973; Manitoba Department of Natural Resources, 1996 and 1997; Ducks Unlimited, 1988). The principal species stopping in the marshes are mallards, blue-winged teal, lesser scaup, canvasback, Canada geese, snow geese, tundra swans and sandhill cranes. Between 1962 and 1980 aerial counts by the above agencies recorded duck numbers in excess of 40,000 birds at one time. Fall populations of staging geese were low (<400 birds) in the 1960's. By the early 1970's this had increased to as high as 10,000 birds and by 1990's over 50,000 birds as a result of large concentrations of snow geese in some years. Hatch (1968) reported about 27,000 white-fronted geese in the area. This represents a significant portion of the white-fronted population that migrated through southwest Manitoba in this period. Present observations indicate few white-fronts staging here or

on other major marsh areas in southwest Manitoba. Poston et al., (1990) ranked the area as regionally important to staging geese, and nationally important for staging ducks. These categories indicate over 20,000 ducks and upwards of 10,000 geese stage here annually.

In years when water levels become extremely low, avian botulism outbreaks can take place at Plum Lakes. The most recent well-documented outbreak was in 1980 when over 12,000 dead or dying ducks were picked up and buried by DU, Canada Wildlife Service and Manitoba Natural Resources staff during a major clean-up. Records of previous outbreaks are scanty, but some ducks were reported dead here in the late 1940's and in 1965. These deaths may have been botulism related.

In addition to waterfowl, a variety of other water/marsh birds make use of the Oak-Plum Lakes complex. Poston et al., (1990) ranked the area as a regionally important site for migrating birds with Plum Lakes being especially important as a concentration point for great blue heron. American coots are especially abundant and over 7,000 being counted here at one time (Robertson, 1967). De Smet (1996) indicated that he has observed a large Franklin's gull colony southeast of the Oak Lake control structure. Associated with the Franklin's gulls were Forster's terns and western and eared grebes, and a large black-crowned night heron colony.

Other water birds found in the marsh are pied-billed grebes, Virginia and sora rails, horned grebes and non-breeding American white pelicans. Cuthbert et al. (1990) indicate that the Oak Lake area is noted as a special area for observing the rare Clarke's grebe and western grebe, American avocet, marbled godwit, willet, sedge wren, Le Conte's and sharptailed sparrows. Uncommon wetland birds observed in this area include the snowy egret, little blue heron, cattle egret, cinnamon teal, surf and white-winged scoters, yellow rail, glaucous gull, and buff-breasted sandpiper.

In autumn, the lakes and marshes provide ideal sites for foraging migrant shorebirds (Robertson, 1967). Beginning in early August the pasture and hay lands adjacent to the marshes host migrant sandhill cranes and later in October, tundra swans are common on Oak Lake and the larger open marshes. The endangered piping plover was observed nesting on the extensive beach in front of the Oak Lake Resort in the spring of 1991 (Manitoba Department of Natural Resources, 1991).

The surrounding uplands, wet meadow and wooded sandhills or beach ridges provide ideal conditions for nesting by an extremely wide variety of avian species, apparent to even the earliest naturalists (Thompson, 1891). Robertson (1967) reports a local naturalist had produced a list of 234 species either breeding in or migrant through the area. Almost 90% of the breeding bird species common to southwestern Manitoba can be found in or around Plum Lakes. The richness and variety of bird life in the area is attributable to the diversity of habitats available over a relatively small area, coupled with

the abundant food supply. The availability of stands of native grassland, rare in Manitoba today, are especially significant as they provide tracts of land suitable for nesting by prairie species.

Cuthbert et al. (1990) list several species that are considered rare to southwestern Manitoba as having been seen around the Oak-Plum Lakes area. Some of these include the rufous hummingbird, blue-gray gnat-catcher, northern mockingbird, northern cardinal, and yellow-throated warbler. This area is also noted for the Sprague's pipit, Smith's longspur, chestnut-collared longspur, and prairie falcon. Other species of concern such as the Baird's sparrows, loggerhead shrikes, and burrowing owl are found locally within the area although burrowing owls have not been seen since 1992.

Because of the well-interspersed, highly productive nature of Plum Lakes, muskrats are one of the most common aquatic mammals (Ducks Unlimited, 1982). Muskrat houses serve as loafing and nesting areas for ducks, geese and other water birds. Beaver are occasionally found in the Plum Lakes, but as they require aspen or willow for food, and deep water, they are primarily found along Plum Creek. Mink inhabit the wetlands and their edges.

The uplands around Plum Lakes were formerly populated by mule deer, elk, bison and possibly pronghorn antelope prior to settlement in the 1800's. Today, as agriculture has altered the landscape, the only large ungulate in abundance is the white-tailed deer, although a few elk are periodically seen in the general area. In recent years, moose have been observed living adjacent to the Plum Lakes.

According to the Canada Land Inventory, the marshes have severe limitations (Class 6) for ungulate production (Goulden et al., 1968). This is understandable due to the presence of standing water and lack of trees. The edges, however, do harbour deer as they make use of the emergent zone as cover until snow accumulates. True upland areas adjacent to the marshes provide good to very good deer habitat (Classes 2, 3 and 4). No inventories of other mammals have been made although tracks of fox, coyote, raccoon and weasel have been recorded (Ducks Unlimited, 1982).

3.5.2 FISHERIES

When Oak Lake elevations exceed 1410 ft. ASL, fish are known to follow the outflows over the Oak Lake Dam into Plum Lakes. Occasionally, high outflows from the Plum Lakes can attract fish into Plum Creek and the Plum Lakes from the Souris River. These fish movements are usually associated with the spring spawning season and high runoff events. The sport species involved are those native to the area, i.e. northern pike, walleye and perch.

Rarely, sport species are known to overwinter in deeper parts of the Plum Lakes.

Such occurrences usually coincide with ideal survival conditions such as minimal snow cover, clear "black" ice and high water levels. In March 1976, for example, pike were angled from Bigelow's slough. The dissolved oxygen level at the time was 2.0 parts per million (ppm) in seven feet of water. Although 2.0 ppm oxygen is not a high reading, it does allow survival of species that are most tolerant of low oxygen levels.

Fish winterkill can be expected in the Plum Lakes in most years. Some hardy species such as sticklebacks and fathead minnows can survive when sport species cannot but under severe conditions such as low water levels and heavy snow cover, even these species will die. Once eliminated, there will be no fish in the Plum Lakes until high waters return.

There is no effective fishway at the Oak Lake Dam to allow fish trapped in Plum Lakes to return to Oak Lake. A short section of the flat 200 ft. long weir has been modified to allow some stoplog manipulation. In many years, by the time spawning is complete, water flow across the dam has ended or flows are so minimal they are unable to attract fish back to the dam. Also, once the spawning season has passed, fish tend to move downstream rather than attempt to return upstream. Consequently, fish trapped in the Plum Lakes will usually winterkill unless prolonged outflows from the Plum Lakes stimulate downstream movement to the Souris River.

Occasionally, young of the year pike are attracted to Oak Lake when Oak Lake outflows still occur and the elevation drop between Oak Lake and Plum Lake is minimal. In July, 1995, small pike (about 4 inches in total length) were observed using a combination of jumping and swimming to overcome a six inch drop in surface water levels at the Oak Lake Dam. The depth of water flow over the weir was less than one inch. Although a few fingerling pike were swept back over the dam into Plum Lake, it was roughly estimated that about 75 fingerlings per hour successfully crossed the dam to Oak Lake. Due to the short term nature of these observations, the total quantitative fingerling production benefits to Oak Lake could not be estimated. Adult pike were also noted in this area but more were observed going back to Oak Lake.

Over the years, Oak Lake has been the most significant sport fishery in the area southwest of Brandon. In the winter of 1986-87, a fish survey (creel census) (Bruederlin, 1987) was conducted over a four month period on Oak Lake. The estimated harvest of pike, walleye and perch was over 60,000 pounds which provided about 17,000 angler days of recreation and created about \$289,000 of regional economic activity. Beyond this direct expenditure by anglers, the survey also noted an angler willingness to pay a further \$280,000 before they would give up this recreational opportunity. Although fish populations and angler activity have declined in recent years, the Oak Lake fishery is highly prized by area anglers and has yielded trophy sized perch. Lake aeration, to reduce winterkill losses, has been a yearly event in recent times.

Some fish stranded in the Plum Lakes are salvaged by fishermen angling at the beginning of the open water season. Later in the season, vegetative growth and fouled hooks discourage this type of activity.

3.6 WATER

Pipestone Creek with a drainage area of approximately 1780 square miles is the main source of inflow to Oak Lake. Oak Lake spills into the Plum Lakes area which is drained by Plum Creek to the Souris River. Figure 2 indicates the relationship of the area's main surface water features; Oak Lake, Plum Lakes, Sullivan's and Bigelow's Sloughs, Pipestone Creek, Pipestone Creek Diversion and Plum Creek. Other smaller waterways contribute water seasonally to the marsh complex.

Designated provincial waterways in the area include, Pipestone Creek from N 34-8-28W (approximately four miles downstream of Cromer) to the Pipestone Creek Diversion except for the reach through the Oak Lake Indian Reserve, the Pipestone Creek Diversion, Belleview Drain from 22-7-26W to N35-7-23W and Plum Creek from the Kansas City Dam to E31-7-23W.

The hydrology of the Oak and Plum Lakes system is complex. The water level in each lake can be affected by the downstream lake and eventually by the outlet channel Plum Creek. There are two dams in the system but neither are operated. The Oak Lake Dam functions as a fixed crest weir at elevation 1410.0 ft. ASL. Oak Lake can be affected by backwater when West Plum Lake attains a water level of 1410 ft. ASL. West Plum Lake is controlled by a restriction as it enters East Plum Lake, particularly at levels below 1408 ft. ASL. The Ducks Unlimited Kansas City Dam downstream of East Plum Lake is not used or maintained. The entire Oak and Plum Lakes system is drained by and can, under high flows, be controlled by Plum Creek below the Kansas City Dam.

Topographical maps of the Plum Lakes area at a scale of 1:15,000 with one foot contours depicting flooding at various water levels from 1406 ft. ASL to 1410 ft. ASL are presented in Appendix A. The estimated total flooded acreage for each elevation and legal land description is presented in Appendix B.

The Oak and Plum Lakes hydrology is further complicated by seepage through the Oak Lake dyke into the Plum Lakes and by interaction with the Oak Lake Aquifer which underlies the entire area. The Oak and Plum Lakes area functions as discharge area and as recharge area for the Aquifer, depending upon the relative water levels in the surface and groundwater regimes.

3.6.1 RECORDED WATER LEVELS AND FLOWS

The water levels for Oak Lake are recorded at station 05NG008, Oak Lake at Oak

Lake Resort, located at the Oak Lake marina near PR 254, 5 miles south of PTH 1. The water levels for Plum Lakes are recorded at two stations, namely: 05NG809, Plum Lake near Findlay, located 4 miles west and 2 miles north of the junction of PTH 2 and PR 254; and 05NG801, Plum Lake near Deleau, located at the DU dam 2 miles north of PTH 2 on PR 254 and three-quarters of a mile west. Figure 2 indicates the locations of these metering stations.

The recorded water levels on Plum and Oak lakes have fluctuated substantially and similarly over the years. The mean monthly water level of Plum Lakes, for the recorded period of 1954 to 1997, ranged from an elevation of 1403.5 to 1412.0 ft. ASL. During this period the mean monthly water level of Oak Lake varied from 1403.8 to 1411.7 ft. ASL. In general water levels were low during the period from the late 1950s to the early 1960s, high during the period from the mid 1960s to the late 1980s and low since the early 1990s. Both lakes recorded their lowest water levels in 1990 and their highest water levels in 1976. The Oak Lake records are nearly complete during this period, the Plum Lakes records have many gaps. A plot of historical water levels for Oak and Plum Lakes is displayed in Figure 3.

In order to evaluate the effectiveness of various water regulation regimes it was necessary to quantify the area's typical water levels during the spring, summer and fall periods. The historical water levels on May 15, July 15 and September 30 were selected to represent these periods. Frequency curves for May 15 water levels on Oak Lake at Oak Lake Resort, Plum Lakes near Findlay and Plum Lakes near Deleau are displayed in Figures 4, 5 and 6. Frequency curves for July 15 water levels at these locations are displayed in Figures 7, 8 and 9. These curves display the probability in percent of water levels being greater than various elevations. Conditional frequency curves for water levels at Plum Lakes near Findlay on July 15 given a range of May 15 starting levels are displayed in Figure 10, for water levels on September 30 given a range of July 15 starting levels in Figure 11 and for water levels on May 15 next year given a range of September 30 starting levels in Figure 12.

Flows on Pipestone Creek near Pipestone (See Figure 2) have been recorded at station 05NG003 since 1936. The drainage area for this metering station is approximately 1620 square miles. The recorded maximum mean monthly flow for Pipestone Creek near Pipestone for the period of record is 2334 cubic feet per second (cfs) in April, 1976. The long term April, May, June and July mean monthly flows for the period of record are 291, 115, 69 and 49 cfs, respectively. Mean monthly flows during the winter period are commonly less than 1cfs.

The recorded maximum mean daily flow on Pipestone Creek near Pipestone was 5403 cfs on April 12, 1976. The smallest maximum mean daily flow recorded during the spring runoff period was 13 cfs on April 8, 1988. The frequency curve of annual maximum mean daily flows for Pipestone Creek near Pipestone is displayed in Figure 13.

It estimates an annual maximum mean daily flow of 724 cfs to be a 50 percent event (ie. a runoff of this magnitude or smaller will occur, over the long term, in one half of the years).

Flows on Plum Creek near Souris have been recorded at station 05NG007 since 1956. The stations drainage area is approximately 2080 square miles. The recorded maximum mean daily flow was 5368 cfs on April 20, 1976. The smallest maximum mean daily flow recorded during the spring runoff period was 3 cfs on April 9, 1988.

3.6.2 EXISTING WATER CONTROL WORKS

The Oak Lake Dam was constructed in 1964 to regulate the lake to a target level of 1410.0 ft. ASL, for recreational purposes. It consists of a 200 ft. concrete weir at elevation 1410.0 ft. ASL, with two 3.17 ft. wide stoplog bays for riparian flow. The bays are each comprised of 13 stoplogs (4in x 4in x 5ft) with a concrete sill at elevation 1405.67 ft. ASL. The abutment wall is at elevation 1415.60 ft. ASL. The dam has a storage of 31,600 acre-feet and a flooded area of 10,850 acres at elevation 1410.0 ft. ASL. A discharge rating curve for the Oak Lake Dam is displayed as Figure 14. It has a discharge capacity of 675 cfs at elevation 1411.0 ft. ASL. Water Resources Branch reservoir plan no. 96-4-1098A outlines the detailed construction drawings. The provision for riparian flow through the two stoplog bays has not been used since construction.

Ducks Unlimited completed construction of the Kansas City Dam near Deleau in 1958 at the outlet of East Plum Lake in the SW 35-7-24W. The dam consists of eight stoplog bays having a sill elevation of 1406.0 ft. ASL and one six ft. high radial gate resting on a sill at elevation of 1401.86 ft. ASL. The dam operated for a few weeks, but the project became inoperable when appropriate easements could not be obtained from the local landowners. The dam remains currently moth-balled, with the radial gate open.

The Oak-Plum Lakes area is drained by the Plum Creek channel. In 1956, a portion of the Plum Creek channel bed was cleaned-out and deepened. The channel has since silted-in and vegetation has reduced its water discharge capacity resulting in frequent flooding of the land adjacent to the creek during peak spring run-off flows. A profile of Plum Creek from the Kansas City Dam downstream to E5-8-23W is displayed in Figure 15.

3.6.3 WATER QUALITY

Pipestone Creek and Oak Lake Water Quality

Water quality samples from Pipestone Creek and Oak Lake were collected by Manitoba Environment between the months of February and June from 1989 to 1995. Eight sampling locations along Pipestone Creek included (1) the bridge west of Kola, (2) Elliott Bridge at the rural municipality boundary, (3) at Cromer, (4) bridge 5 km southeast of Cromer on PTH 256, (5) at PTH 83, (6) northwest of Belleview, (7) the Pipestone Creek Diversion at rural municipality boundary and (8) Pipestone Creek at the rural municipality boundary. Twelve locations were sampled in Oak Lake. There were three locations at the north end, three locations at the south end and six locations in the central area of Oak Lake.

Pipestone Creek

Samples from Pipestone Creek were collected in April of 1989, April of 1991, March and April of 1992 and February of 1995. Only the 1995 sample included approximately 25 analytes and pesticides/herbicides, whereas 1989 to 1992 focused on nutrients.

Generally, as flows decreased in Pipestone Creek over the winter months, the concentration of dissolved salts increased to a maximum just before spring breakup. Concentrations of these dissolved salts then dropped quickly with increasing spring flows (usually within a week). Nutrient concentrations similarly declined approximately as follows: total Kjeldahl nitrogen from 4.5 mg/L to 1.3 mg/L; ammonia nitrogen from 1.5 mg/L to 0.04 mg/L; nitrate-nitrite-nitrogen from 0.3 mg/L to <0.01 mg/L; total phosphorous from 0.4 mg/L to 0.09 mg/L, and total dissolved phosphorous from 0.3 mg/L to 0.03 mg/L. Nutrient levels tended to increase slightly as Pipestone Creek flowed from Kola to Oak Lake before spring breakup. Once spring breakup began, concentrations were similar in the creek from Kola to Oak Lake.

Other major and minor ion concentrations also fluctuated with the seasons and generally had a range of high and low concentrations before and after spring breakup as displayed in Table 2.

TABLE 2.
PIPESTONE CREEK
ANALYTES SEASONAL FLUCTUATION

Analyte	Before Spring Breakup	After Spring Breakup
Conductivity (uS/cm)	1600-2200	500-700
Total hardness (mg/L as CaCO ₃)	600-800	200-250
Total alkalinity (mg/L as CaCO ₃)	400-500	130-160
Sulphate (mg/L)	400-500	100-150
Sodium (mg/L)	100-130	30-40
Chloride (mg/L)	50-60	10-15
Colour (units)	50-80	25-30
Turbidity (NTU)	25-50	1-5
Chlorophyll-a (ug/L)	40-80	5-7
Silica (mg/L)	15-30	2-5
Dissolved oxygen (mg/L)	11-12	5-7

Federal Government data were available for Pipestone Creek at Cromer for 1989 to 1995. In most cases, concentrations were diluted with the spring runoff, slowly stabilized over the summer months, then increased over the winter months to a maximum prior to spring breakup. Colour and turbidity values increased at spring breakup, then declined to lower concentrations for the remainder of the year. Chlorophyll-a levels tended to increase over the summer and fall months as algal activity peaked, then decreased into the spring months. Both total and fecal bacteria were present in Pipestone Creek all year, but higher levels were present in open water. Total coliform values in these months increased to 100-200 organisms/100 mL compared to 20-50 organisms/100 mL at other times of the year. Fecal coliform values ranged from a high of 100-150 organisms/100 mL to a low of 2-20 organisms/100 mL.

Organochlorine insecticides, organonitrogen herbicides, n-methyl carbamates, polychlorinated biphenyls, organophosphorous pesticides, or phenoxy-acid herbicides were not detected in February, 1995 in Pipestone Creek at the diversion to Oak Lake.

Oak Lake

Samples from Oak Lake were collected in February, March and May of 1989, March and June of 1992 and February of 1995. Each sample was analyzed for approximately 25 analytes and pesticides/herbicides were included only on the 1995 samples. As with Pipestone Creek, the concentrations of dissolved salts increased under ice cover. Major ion concentrations in Oak Lake decreased by approximately half during

the open water months as shown in Table 3.

**TABLE 3.
OAK LAKE
ANALYTES SEASONAL FLUCTUATIONS**

Analyte	Under Ice Conditions	Open Water Conditions
Conductivity (uS/cm)	2000-2400	1200
Total hardness (mg/L as CaCO ₃)	700-900	450-500
Total alkalinity (mg/L as CaCO ₃)	400-500	250-300
Sulphate (mg/L)	750-850	350-400
Sodium (mg/L)	150-200	80-90
Chloride (mg/L)	40-60	20-30
Colour (units)	15-30	10-15
Turbidity (NTU)	2-20	5-20
Chlorophyll-a (ug/L)	1-5	5-30
Silica (mg/L)	20-40	5-10
Nitrate-Nitrite Nitrogen	0.04-0.4	<0.01
Ammonia Nitrogen (mg/L)	0.15-1.5	0.01-0.20
Total Phosphorous (mg/L)	0.2-0.4	0.1-0.2
Total Kjeldahl Nitrogen (mg/L)	2.5-4.5	1.5-2.5
Dissolved oxygen (mg/L)	1-5	10

Dissolved oxygen levels in the lake dropped below 5 mg/L in the late winter months and were often in the 1-2 mg/L range before spring breakup. These levels are too low to meet the Manitoba Surface Water Quality Objectives for aquatic life (47% of saturation).

The pH increased from values just below 8.0 under ice to values above 8.5 in open water as biological activity increased. Nutrients such as nitrate-nitrite nitrogen and silica decreased in open water as they were converted to biomass and consequently reflected by higher chlorophyll-a levels. In February, 1995 pesticides and herbicides were measured, but not detected in Oak Lake. Little or no analyses were conducted for trace metals on Oak Lake or Pipestone Creek by Manitoba Environment. Federal Government data for trace metals were very low, usually at or below detection limits. Aside from dissolved oxygen levels for part of the year in Oak Lake, all other analytes measured met the Manitoba Surface Water Quality Objectives for recreation and aquatic life for the months sampled.

3.6.4 GROUNDWATER

The Oak Lake Aquifer was known since early recorded times. The associated

sand and gravel units cover an area of some 800 square miles lying within the quadrangle formed by Hartney, Melita, Virden, and Griswold. The surficial geology in this area consists basically of medium to fine sand. On the western extremity, particularly in the southwest, coarse sand and gravel form the surface. A fairly extensive zone of clay underlies the west and east central segments of the basin. This clay deposit appears to be related to the Pipestone and Plum Creek channels. The aquifer is bounded on the west and south by glacial till plains. On the north side thin sand plains extend to the deeply incised valley of the Assiniboine River. The eastern side of the aquifer generally blends into an area of silt and clay.

The vertical geology of the aquifer consists of a layer of tan to light grey gravel or silica sand ranging up to 90 feet in thickness resting on sandy silt. The thickness of the sand unit is quite variable over short distances. In one case the aquifer changes from zero thickness, with the silt outcropping, to 50 feet thick over the interval of one mile. The silt in turn rests on dark grey lacustrine clay. As can be seen in Figure 16 the clays were laid down on glacial till. The till was deposited on the Cretaceous shale bedrock that underlies the whole area. A major feature of the bedrock surface is the buried valley that passes through the central part of the aquifer area. This feature at a number of places contains gravel zones 30 feet thick.

One of the main features of the Oak Lake Aquifer is the presence of a large body of open water, Oak Lake which is in direct connection with the aquifer water table. Oak Lake, the Plum Lakes, Plum Creek, the Maple Lakes Drain and the Souris River act as a drain from the aquifer during most portions of the year. In contrast, during the spring meltwater interval, substantial amounts of water infiltrate into the aquifer as a part of "bank storage phenomena" associated with the creeks that cross the aquifer from the west. These phenomena relate directly to the aquifer's water budget.

To estimate aquifer capacity it is assumed the surface inflow to the Oak-Plum Lakes complex from the western streams is balanced by the discharge from the Maple Lakes Drain, Plum Creek and evaporation from Oak Lake. Using this assumption and considering the variation in precipitation between this aquifer and the Assiniboine Delta aquifer water availability estimate from the Oak Lake Aquifer is in the order of 15,000 acre feet per year.

Except for the Hartney domestic water supply, which was established during 1964, the aquifer until 1978, was developed solely for domestic water supply and stockwatering purposes from wells and dugouts. During 1979 an irrigation pivot was installed three miles east of Pipestone. In 1980 three quarter section pivots were established in the southern portions of the aquifer near the Village of Bernice. In 1981 two more units were placed near Pipestone. The last development was the placing of a quarter section unit in the SE 3-7-24W during 1983. In the late 1980's half of these irrigation systems were abandoned but in recent years renewed interest is bringing them

back into production.

From the long term aquifer management perspective, the major contribution of the Canada-Manitoba Aquifer Capacity Agreement (1980 to 1985) was the establishment of a comprehensive groundwater monitoring system. An analysis of the Oak Lake Aquifer has been prepared by the Groundwater Management Section of Water Resources Branch and is presented in Appendix C.

3.7 SOCIO-ECONOMIC CONSIDERATIONS

There are two major socio-economic features of the Rural Municipality of Sifton. The prevalent aspect of the municipality is the agricultural land base, which supports a number of farming activities. The second aspect is a recreational aspect, which is based upon Oak Lake - a large lake which serves as a regional focus for a variety of water-based recreational activities.

3.7.1 AGRICULTURE

Agriculture has been the dominant economic activity within this municipality for the past century, and remains the dominant economic activity. According to the 1996 census, there are 186 farms within this municipality, with a total agricultural production valued at \$12,914,519. (or an average of \$69,433 per farm). The average farm size in this municipality is 893 acres, which is significantly larger than the provincial average of 784 acres.

The major agricultural emphasis is on mixed farming, with less emphasis on crop production and more emphasis on livestock production than many other areas of the province. According to the 1996 census of agriculture, the average amount of land in cereal and oilseed crops, on a per farm basis, is 162 acres which is substantially lower than the provincial average, despite the larger average size of the farm units. The amount of land utilized as pasture, on a per farm basis, averages 438 acres, which is more than double the provincial average of 204 acres. The amount of land utilized for alfalfa and other tame hay production is also significant, and averages 184 acres per farm. The provincial average for alfalfa and tame hay production is 76 acres per farm. Cattle production is quite significant in this municipality, with an average herd size of 142 animals, compared to a provincial average of 106 animals per herd. Although most of this cattle production is beef cattle, there is also a modest amount of dairy, swine and poultry production.

3.7.2 RECREATION

Oak Lake is one of the largest recreational lakes in south-western Manitoba, and provides an attractive setting for a variety of water-based activities, including fishing,

boating, water skiing and swimming. Parks Branch information indicates a vehicle count of over 4,000 vehicles at the provincial park facility during the summer period of 1993.

The clusters of cottage development along the northern and eastern shorelines of the lake contain one of the highest concentrations of cottage lots in south-western Manitoba. It is estimated that there are 435 cottage lots, with 325 of these containing existing cottages. This presents a seasonal population of 1,138 persons, based on an average of 3.5 persons per cottage. Approximately 20 of these structures are used as permanent residences. Cottage development at Oak Lake has increased significantly during the past 30 years, and it is anticipated that more cottage development might occur in future years, based on the supply of existing vacant lots.

Although no detailed analysis of the economic benefits provided by these recreational activities has been undertaken, it is expected that recreational improvements could stimulate significant benefits in terms of purchases of recreational equipment and services, building supplies for cottages, and day-to-day household needs. These benefits would be apparent not only in the local area, but also in larger communities such as Virden and Brandon.

3.7.3 POPULATION

The Rural Municipality of Sifton and the Town of Oak Lake experienced reductions in total population during the 1961-1996 period. The Rural Municipality of Sifton population declined from 1054 to 759 people (a decline of 28%), and the Town of Oak Lake population declined from 430 to 369 people (a decline of 14%). The declines in the Rural Municipality of Sifton are fairly typical of many rural municipalities in western Manitoba during this period. These trends in the rural area have resulted from changes in agriculture, primarily the amalgamation of small farms into larger farms, with an overall decline in the number of farm families. The average farm size in 1961 was 763 acres, compared with the 1996 average farm size of 893 acres. The size of farm families has also been declining, from an average of 3.7 persons in 1961 to 3.2 persons in 1991.

3.7.4 LAND OWNERSHIP

Land ownership within the 53 square mile project area was reviewed in 1992. Ownership pattern reflects the varied interests in the area. The review determined that 219 parcels of land, most a quarter section in size, were held by 56 separate owners. Most parcels were privately owned. The Crown owned 46 quarters most of which were granted annually for hay leases. The Manitoba Wildlife Federation owned seven quarters, the Nature Conservancy of Canada 12 and Ducks Unlimited 6. Cadastral maps at a scale of 1:12,000 showing land ownership names are presented in Appendix A.

4.0 WATER MANAGEMENT OPTIONS

4.1 STATUS QUO

Although the primary function of the Task Force was to explore water management options for the Plum Lakes a status quo option was necessary as a benchmark to compare the options. The status quo option assumes that nothing will be done within the project area to inhibit or promote the wide natural fluctuations of the water level in the marsh. This option presumes that nothing will change in current land use, nothing will change in terms of management of the water regime and there will be no changes in local infrastructure, i.e. no additional pond or dyke construction, no additional culverts, etc. The only factors that would influence yearly change from the status quo water levels would be long term weather trends.

Determination of what water level in Plum Lakes represented the status quo was based on a review of the frequency tables of the range of recorded water levels in the Plum Lakes area. This level was determined to be 1407 ft. ASL. Based on the long term period of record, there is approximately a 50% chance of water levels in Plum Lakes reaching 1407 ft. ASL in any given year in both May and July.

4.2 WATER LEVEL REGULATION OPTIONS

Ten options were explored, the first four were suggested by the Management Board and/or local landowners who responded to questionnaires requesting their input. Options 5-10 include variations suggested by landowners, the Management Board and the Task Force.

4.2.1 WATER LEVEL REGULATION OPTIONS DESCRIPTIONS

The ten options consider the managing of different portions of the Plum Lakes Marsh to different water level regimes. Options 1 to 4 consider managing the Plum Lakes complex including Sullivan's and Bigelow's Sloughs as one unit. Options 5 to 10 consider managing the Plum Lakes area as two enclosed cells, one external cell and Sullivan's and Bigelow's Sloughs as separate cells. A more detailed description of the 10 considered water level regimes follows.

In all options the magnitude of the spring run-off would determine the May 15 water level. In all options water control structures would be operated after July 15 only to reduce water to target levels. Cells would be allowed to go below target elevations after July 15 due to low flow and to evaporation losses. All options would, as discussed later, require some improvements be made to waterway channels and several would require the construction of water control structures.

Options 1, 2, 3, and 4 would manage the water levels in the Plum Lakes complex including Bigelow's and Sullivan's Sloughs as one unit to four different regimes. These options would require an upgrade of the Kansas City Dam and improvements to the discharge capacity of Plum Creek channel through sections 32, 33, 34 & 35-7-24W.

Option 1. Target water levels in the cell would be 1407 ft. ASL on May 15 and reduced to 1406 ft. ASL by July 15.

Option 2. Target water levels in the cell would be 1407 ft. ASL on May 15 and maintained at 1407 ft. ASL up to July 15.

Option 3. Target water levels in the cell would be 1408 ft. ASL on May 15 and reduced to 1407 ft. ASL by July 15.

Option 4. Target water levels in the cell would be 1408 ft. ASL on May 15 and maintained at 1408 ft. ASL up to July 15.

Options 5, 6, 7, and 8 would manage common water levels in the four enclosed cells; Plum Lakes main and lower cells as well as Bigelow's and Sullivan's Sloughs to the same four regimes as options 1 to 4. See Figure 17 for cell locations. These options would maintain a Plum Lakes external cell water free during the growing season by pumping into the Plum Lakes main cell. These options would require Oak Lake, when water levels are greater than elevation 1410.0 ft. ASL prior to June 1, to share water with Sullivan's and Bigelow's Sloughs.

Option 5. Target water levels in the four cells would be 1407 ft. ASL on May 15 and reduced to 1406 ft. ASL by July 15.

Option 6. Target water levels in the four cells would be 1407 ft. ASL on May 15 and maintained at 1407.0 ft. ASL up to July 15.

Option 7. Target water levels in the four cells would be 1408 ft. ASL on May 15 and reduced to 1407 ft. ASL by July 15.

Option 8. Target water levels in the four cells would be 1408 ft. ASL on May 15 and maintained at 1408.0 ft. ASL up to July 15.

Options 5, 6, 7 and 8 would require the construction of several common water control works. These works would include the following:

1. An upgrading of the Kansas City Dam.
2. An upgrade of the Plum Creek channel discharge capacity through sections 32, 33, 34

& 35-7-24W.

3. Control structures to allow water to flow from Oak Lake to Sullivan's Slough, from Sullivan's Slough to Bigelow's Slough and from Bigelow's Slough to the Plum Lakes main cell. See Figure 17 for control structure locations.

4. A dyke south of Bigelow's Slough to separate it from the Plum Lakes main cell. See Figure 17 for dyke locations.

5. Dykes constructed along the south side and southwest corner of Plum Lakes marsh to establish three separate Plum Lakes cells; main, lower and external.

6. A pumping facility to move water from the Plum Lakes external cell to the Plum Lakes main cell.

Options 9 and 10 would manage higher water levels in Sullivan's and Bigelow's Sloughs than in the Plum Lakes main and lower cells. These options would also remove water from the Plum Lakes external cell by pumping into the Plum Lakes main cell and share Oak Lake water with Sullivan's and Bigelow's Sloughs when Oak Lake water levels are greater than elevation 1410.0 ft. ASL prior to June 1. These options would require the construction of the same works as options 5 to 8. Option 10 would employ an alternate location for the dyke that establishes the external cell.

Option 9. Target water levels in Sullivan's and Bigelow's Sloughs would be 1409 ft. ASL on May 15 and maintained at 1409.0 ft. ASL up to July 15. Target water levels in Plum Lakes main and lower cells would be 1408.0 ft. ASL on May 15 and maintained at 1408.0 ft. ASL up to July 15.

Option 10. Target water levels in the four cells would be the same as in option 9. This option considers an alternate dyke location which would result in a larger Plum Lakes main cell and a smaller external cell. See Figure 17.

All options would require some improvements be made to the current waterway regime to meet the target water levels on the target dates. The information in Tables 3, 4 and 5, is derived from the frequency curves in Figures 4 to 12. It outlines the percentage probability that May 15 and July 15 water levels would be equal to or less than the target levels proposed by the various options. The probabilities indicate by percentage, how often over a 100 year period with the existing waterway regime the water level would be equal to or lower than proposed target elevations.

Table 4 demonstrates that the Plum Lake water level on May 15 is equal to or less than 1407 ft. ASL 38 percent of the time. This illustrates that the option 1 and 2 target May 15 water level of 1407 ft. ASL could on average be achieved by the current waterway system 38 percent of the time. Table 4 also demonstrates that the Plum Lake water level on July 15 is equal to or less than 1408 ft. ASL 60 percent of the time. This illustrates that the option 3 and 4 target July 15 water level of 1408 could on average be achieved by the current waterway system 60 percent of the time.

Table 5 demonstrates that the Oak Lake water level on May 15 is equal to or less than 1410 ft. ASL 62 percent of the time. This illustrates that Oak Lake would have sufficient water to share in the spring with Sullivan's and Bigelow's Slough about 38 percent of the time.

**TABLE 4.
PLUM LAKES WATER LEVELS
WITH CURRENT WATER REGIME**

Date	Elevation	Frequency of Equal or Lower Water Level
	(Ft. ASL)	(%)
May 15	1406	27
	1407	38
	1408	53
July 15	1406	33
	1407	44
	1408	60

**TABLE 5.
OAK LAKE WATER LEVELS
WITH CURRENT WATER REGIME**

Date	Elevation	Frequency of Equal or Lower Water Level
	(Ft. ASL)	(%)
May 15	1410	62
July 15	1410	86

Table 6 demonstrates that when the Plum Lakes water elevation on May 15 is 1407 ft. ASL the July 15 water level will be equal to or less than 1406.1 ft. ASL 10 percent of the time. This illustrates that if the Option 1 target May 15 water level was achieved its subsequent July 15 target level could on average be achieved 10 percent of the time by the current waterway system. This table also demonstrates that when the Plum Lake water level on September 30 is 1407 ft. ASL the following May 15 the water level will be equal to or less than 1407.9 ft. ASL 50 percent of the time. This illustrates that if the Option 4 target July 15 water level was achieved its subsequent May 15 often may not be.

**TABLE 6.
PLUM LAKE TARGET WATER LEVELS
WITH CURRENT WATER REGIME**

Date	Starting Elevation	Date	Frequency of Equal or Lower Water Level	
			Frequency	Target Elevation
	(Ft. ASL)		(%)	(Ft. ASL)
May 15	1407	July 15	90	1407.0
			50	1406.6
			10	1406.1
May 15	1408	July 15	90	1407.9
			50	1407.4
			10	1407.0
July 15	1406	Sept. 30	90	1406.2
			50	1405.5
			10	1404.8
July 15	1407	Sept. 30	90	1407.0
			50	1406.4
			10	1405.7
July 15	1408	Sept. 30	90	1407.9
			50	1407.2
			10	1406.6
Sept. 30	1406	May 15	90	1409.3
		next year	50	1407.1
			10	1404.7
Sept. 30	1407	May 15	90	1410.2
		next year	50	1407.9
			10	1405.6
Sept. 30	1408	May 15	90	1411.2
		next year	50	1408.8
			10	1406.5

The current waterway regime in the Plum Lakes area is able to reliably meet the options water level targets 29 - 63% of the time. The limiting portion of the system is the Plum Creek outlet channel. To meet the water management targets would require the discharge capacity of this channel be increased. The magnitude of the increases required by the various options is indicated by the following. During the 1986 spring runoff (a 38% event) the Plum Lakes were at elevation 1408.1 ft. ASL on July 15. To achieve the target water level of 1407 ft. ASL during a comparable runoff would require the outlet channel to convey an average discharge of 60 cfs. To achieve the 1406 target would require an average discharge of 110 cfs. During the maximum recorded runoff in 1976 (a 2% event) the Plum Lakes were at elevation 1410.3 ft. ASL on July 15. To achieve the target water level of 1407 ft. ASL during a comparable runoff would require the outlet channel convey an average discharge of 620 cfs. To achieve the 1406 ft. ASL target would require an average discharge of 680 cfs.

Appendix D displays a copy of a memorandum by Mr. N. Harden of the Water Resources Branch dated November 28, 1994 that details the current and proposed Plum Lakes hydrology and shows simulated water levels for the period of record with the existing waterway system and with the proposed Option 9 water regime.

4.2.2 GENERAL LAYOUT OF PROPOSED WORKS

4.2.2.1 CONSTRUCTION DETAILS FOR OPTIONS 1-10

Options 1 to 4 would require the upgrade of the Kansas City Dam and improvements to the Plum Creek outlet channel. Options 5 to 10 would require the upgrade of the Kansas City Dam, improvements to the Plum Creek outlet channel, the construction of four control structures and 11.5 miles of dyke. Figure 17 displays the dyke and control structure locations associated with the ten options. The various works required are detailed in the following.

To manage the Plum Lakes area as one cell, as in Options 1 to 4, would require the upgrade of the Kansas City Dam and the widening of the Plum Creek outlet channel to increase its discharge capacity.

To manage Sullivan's Slough as a separate cell, as in Options 5 to 10, would require two control structures be constructed. Control structure A, located NW 29-8-24 W would allow water to flow from Oak Lake to Sullivan's Slough during the spring period, if the lake reached its target level of 1410.0 ft. ASL. Control structure B, located SW 28-8-24W would be used to allow water to flow from Sullivan's Slough into Bigelow's Slough to supplement its water level and to drawdown Sullivan's Slough in late fall if required.

To manage Bigelow's Slough as a separate cell, as in Options 5 to 10, would

require a control structure and two miles of dyke be constructed in the middle of sections 17 and 16-8-24W. The dyke would be built to an elevation of 1413.0 ft. ASL. Control structure D, located in 17-8-24W, would allow water to flow from Bigelow's Slough into Plum Lakes main cell and it would be used to drawdown Bigelow's Slough in late fall if required.

To manage the Plum Lakes as three separate cells, as in Options 5 to 10, would require the upgrade of the Kansas City Dam, the widening of the Plum Creek outlet channel and the construction of one control structure and 9.5 miles of dyke. The dyke would be built to an elevation of 1412.0 ft ASL. The Plum Lakes lower cell would be comprised of a dyke running from the SW 32-7-24W to the Kansas City Dam in the SW 35-7-24W. This dyke would be located along the north boundary of sections 27, 28 and 29-7-24W. The dam would be used to control the water level in this cell. The Plum Lakes main cell would consist of a dyke located along the west edge of 11-8-25W, angling off in a south-easterly direction to the west edge of 31-7-24W, south to the west center of 30-7-24W, east through the center of section 30 to the east center of 30-7-24W, then north to the middle of 32-7-24W. The total length of the dyke would be 9.5 miles. Control structure C, located in SW 32-7-24W would be used to control the water levels within this cell. The Plum Lakes external cell would be located outside the main cell dyke in sections 25, 26, 35 and 36-7-25W and in 1 and 2-8-25W. This cell would be maintained dry for agriculture purposes by pumping water into the main cell.

The above water control works are common to all options, with the exception that in Option 10, the south-west dyke location would be approximately one half mile further west.

4.2.2.2 CONSTRUCTION COSTS FOR OPTIONS 1-10

Construction costs for the water control works required by the various options are indicated in Table 7. Options 1 and 2 would require only the works itemized as Plum Lakes; channel excavation, upgrade Kansas City Dam and Plum Creek rock riffles. Options 3 and 4 would require in addition, the works itemized as Plum Lakes; land acquisition, flood easements and land costs. Options 5 through 9 would require all works itemized in the body of Table 7. Option 10 would require in addition to options 5 through 9 a cost for the alternate dyke as noted in the table 7 footnote. The estimates are based on 1996 known or approximate rates for the costs of construction, acquisition, easements, etc.

**TABLE 7.
WATER CONTROL WORKS CONSTRUCTION COSTS**

Area	Works	Costs
Sullivan's Slough	control structures	\$ 199,800
	flood easements	64,300
	land acquisition and easement	19,300
	Subtotal	\$ 283,400
	contingencies	56,700
	engineering	70,900
	Subtotal	\$ 127,600
Total Cost	\$ 411,400	
Bigelow's Slough	control structures	\$ 66,600
	dyke construction	155,000
	land acquisition	1,700
	flood easements	27,000
	land acquisition and easements	8,600
	Subtotal	\$ 258,900
	contingencies	51,800
engineering	64,700	
Subtotal	\$ 116,500	
Total Cost	\$ 375,400	
Plum Lakes	control structure	\$ 91,000
	dyke construction ¹	477,700
	permanent pump facility	500,000
	land acquisition	30,600
	flood easements	511,500
	land costs	153,400
	channel excavation	156,600
	upgrade Kansas City Dam	80,000
	Plum Creek rock riffles	40,000
	Subtotal	\$ 2,040,800
	contingencies	408,200
engineering	510,200	
Subtotal	\$ 918,400	
Total Cost	\$ 2,959,200	
All Three Areas	Total Cost	\$ 3,745,600

¹ Alternate dyke increases costs by \$52,400.

4.2.3 OPTIONS ASSESSMENT

4.2.3.1 WILDLIFE

The Plum Lakes marsh, adjacent to Oak Lake, is a series of shallow marshy basins varying in depth from less than 1 ft. to over 6 feet of water, and cover about 12,000 acres. The marsh functions like many other large, shallow prairie lakes with periodic flooding and droughts. Marshland vegetation within and surrounding the lakes is adapted for these conditions.

A review of reports and files shows that the Plum Lakes area is considered extremely valuable to wildlife, but also acknowledge the local concerns over flooding of farmed lands (Robertson, 1967; Bossenmaier, 1970; Somers et al., 1971; Manitoba, 1975; Carreiro, 1972; Hildebrand, 1982).

The Plum Lakes Marshes are considered a key wetland area for wildlife in southwestern Manitoba (Robertson, 1967; Bossenmaier, 1970; Carreiro, 1972). A Canadian Wildlife Service Report (Poston, et al., 1990) considers the lakes a "nationally important" staging habitat for migrant geese and a "regionally important" concentration site for blue herons. The Manitoba Implementation Plan for the North American Waterfowl Management Plan (Anon., 1988) considers the marshes as key wetlands in the core area of the highest waterfowl productivity in Manitoba. The Manitoba Natural Resources 1974-75 plan (Manitoba, 1975) for the area recognized this and proposed private land securement to overcome the problems in areas where landowners and water level conflict came into play. The Plum Lakes Marsh is rated Canada Land Inventory Class 2Si (Adams and Hutchison, 1968) indicating very high production and staging potential for waterfowl.

The area has held up to 50 breeding pairs of Canada geese, as many as 20,000 ducks undergoing summer molt, over 70,000 staging ducks and more than 100,000 staging geese in some years (Ducks Unlimited, 1986 and Manitoba Department of Natural Resources, 1996). In 1986, the marshes contained many colonial waterbirds including at least 200 eared grebe nests, six western grebe nests, several hundred Franklin's gull nests, a large colony (up to 100 pairs) of black-crowned night herons, and numbers of nesting Forster's terns (Ducks Unlimited, 1986). Robertson (1967) noted over 7,000 American coots in the marshes at one time. The marshes are also important habitat for migrant shorebirds, sandhill cranes and tundra swans.

Plum Lakes, like many prairie marshes, serves as an important refugia for waterbirds displaced by droughts from their traditional breeding areas. These birds, although they do not usually nest, can successfully pass the summer before migrating southward in fall. A variety of other wetland birds, mammals (particularly furbearers), and amphibians make use of the area throughout the year.

In reviewing water levels in relation to wetland-wildlife values, the present situation or status quo was considered a benchmark and the proposed managed levels were viewed as positive or negative in relation to the benchmark. Options were viewed and effects calculated as a percent of the area, or water level event frequency change as compared to the status quo. According to the hydrology, Options 2, 4, 7 and 8 are not really feasible as there is insufficient inflow to permit holding or reaching the proposed water level over the period May through July. Options 1, 3, 5, 6, 7 and 10 were viewed as really possible for management. Discussions on all options are presented below.

a) Wildlife Production Effects

Option 1

In relation to the current regime, the hydrology of the area shows that Option 1 would result in below average water levels each year. The impacts on wetland oriented wildlife are therefore negative. If we assume as noted in the hydrology section, that a level of 1407 ft. ASL is present on May 15, a number of impacts are felt. Firstly, the areas of wet meadow typically now flooded in spring would no longer be wetland habitat. These areas are very rich in food, especially invertebrates, and are critical for building body reserves in many birds for nesting (Weller, 1981). Although this vegetation zone would reestablish over time in the former marsh zone, it would be significantly smaller, an important factor as breeding waterfowl are territorial and space themselves throughout this zone while feeding. This would mean less habitat for waterbirds.

Further, the deep marsh zone, important to overwater nesting birds and as summer brood habitat, would decline in quality and quantity. At a summer elevation below 1407 every year, or 9 out of 10 years, the former deep marsh would disappear. This zone would become overgrown with emergent aquatic plants displacing many wildlife species, either totally or at least by the amount of suitable habitat so altered.

The shallow nature of the marsh under Option 1 could have short term positive effects on migrant shorebirds by providing mudflats and shallows for feeding. Eventually, these areas would vegetate and be avoided by shorebirds. Moulting and migrant waterfowl, especially those looking for open water or interspersed marshes, would also avoid using such an area. In winter, the limited water depths would totally exclude muskrat survival in all but a few areas since by November average water levels would likely be less than 1406 ft. ASL.

Overall, Option 1 would also see a continuation of the haying activities carried out on Crown lands in the marsh in 1992. In an evaluation of these lands in 1993, the authors found less than 5% of these shallow marsh or upland habitats having sufficient residual plant cover to support early or midseason upland nesting waterfowl or most other ground

nesting birds.

Given all of the above factors, Option 1 would have negative impacts on wildlife in at least 9 out of 10 years and at a level of at least 50 -70% below the current average value of the area for wetland wildlife, both quality and quantity of habitat would be negatively affected. These percentages are based on a combination of change of habitat quantity (i.e. % of area affected) and frequency of occurrence of water levels. In years of low water, conditions become optimum for the development of botulism, a deadly disease to all waterbirds and waterfowl. Decreasing water level, shallow water depths and warm weather can combine to create situations that can severely reduce local breeding and/or moulting populations in July or August.

Option 2

An attempt to compromise at Option 2 would be similarly negative as attempting to manage water levels as this option would in reality through evaporation water loss, result in a situation very similar to Option 1 in at least 7 out of 10 years.

Option 3

Under Option 3, a greater area of shallow marsh, deep marsh and open water would be present than under Option 1. Option 3 would remove the high water (+1408.0 ft. ASL) events that now occur. The overall area of valuable marshland when averaged out over a long period would therefore diminish from the current situation. That is, the marsh area would rarely cover lands much above 1408.0 ft. on May 15, whereas before management this would take place between 40 and 50% of the time. Consequently under Option 3 shallow marsh and wet meadow zones would expand, the open water area decline and overall characteristics of the marsh change. This is especially true as under this option a low of 1407 ft. is reached every year (9 out of 10) by July 15 whereas this occurs naturally only about half the time. For a few wildlife species, this would be negative, for the reasons noted under Option 1. The impacts on wildlife, therefore, would be to decrease the value of Plum Lakes for wetland wildlife by 30-50% of the present situation as for habitat quality and at least 20% by quantity (area). Value declines are estimated as in Option 1.

Option 4

Option 4 would not have quite as severe a negative impact as the water levels would decline naturally from 1408.0 ft. This would mean an average mid-July level of 1407.5 ft. which is comparable to what takes place on average now. Only high water events would be eliminated, with a resulting impact on wildlife. Therefore, Option 4 regime would see a more limited negative impact on wildlife, likely at approximately 20% of the current wildlife values of Plum Lakes, as estimated using criteria listed above

under the discussion of Option 1.

Options 5-8

Options 5-8 although similar to Options 1-4 (eg. 5~1, 2~6 etc.) have some additional features which make them more beneficial to wildlife in some localities, but negative to wildlife in others.

The addition of controls to allow Oak Lake water into Bigelow's and Sullivan's Sloughs from Oak Lake would benefit aquatic plant growth initially as it now (uncontrolled) takes substantial time for the water to back into these areas from Plum Lakes. However, because water levels will be managed to 1407/06 in Option 5, 1407/07 in Option 6, 1408/07 in Option 7 and 1408/08 in Option 8 the net gains will be slight, if any. As described in the previous sections Option 1-4 the removal of the upper part of the long term water regime will have varying degrees of impact, all negative.

In addition, the development of the dyked area to the SW effectively removes a portion of the present marsh during summer, spring back flood will still occur. This means that the area will serve spring migrants and breeding pairs of ducks but will be lost as nesting, brood and molting habitats for ducks, as well as other water birds.

As noted below, the estimated area lost is about 10% of the marsh and wildlife values for Options 5-8 are reduced accordingly. This 10% in addition to the losses already attributed to the water management option proposed for the balance of the marsh (ie. Option 5 losses = Option 1 losses + 10% less).

Option 9

Option 9 has both positive and negative impacts on water levels, depending on locality or within which cell. In the southwest area, management for hay production would see the area, flooded in spring, serving as breeding pair habitat much as it does under the "status quo". Once dewatered, areas exposed would prove attractive to shorebirds until they become vegetated. Ground nesting birds, especially waterfowl, would find this attractive cover. Haying in late July would destroy some duck nests as not all would be hatched (Hochbaum, 1944) and many second broods of songbirds (Dale, 1992). This occurs periodically now when haying can occur whereas under management would take place annually.

Also, annual dewatering of the south-west area (about 1000 acres) would result in a loss of wetland area that under the status quo does hold water some years. This loss of area was estimated at about 10% of the total marsh area and loss of frequency at 10% from the status quo; hence an overall loss of wildlife value of about 10%.

On Sullivan's Slough and Bigelow's Slough management of water levels under Option 9 would result in both areas reaching 1409.0 ft. in spring almost 50% of the time. With evaporation loss this means they would be at about 1408.0 ft. in July in years they reach 1409.0 ft and around 1407.0 ft. or less in July most other years. This latter is slightly above the status quo. The higher water years result in a net gain in wildlife value at Bigelow's Slough and Sullivan's Slough in about 50% of years over about 3300 acres which is about 25% of the Plum Lakes marsh area. This suggests a gain of about 12% in marsh "area" and hence wildlife values over the long term. The net gain in wildlife values on Plum Lakes main and lower cell would be slightly less but still close to 10% or approximately 8% to be conservative.

Overall, the impacts and losses on the south-west (-10%) gains on Bigelow's and Sullivan's Slough (+12%) and gains on Plum Lakes (+8%) result in an overall gain in wildlife values of 10% through water management in Option 9.

Modification of Option 9

A proposed addition to this option has been the inclusion of land use adjustment on the east side of Plum Lakes. The proposal suggests that of the sum total of Agricultural crown land plus Wildlife land (D.U., Manitoba Wildlife Federation, and Nature Conservancy of Canada) 1/3 or 33% would be made available for haying annually with the remainder (2/3) left as wildlife cover. Of the total area (68 quarter sections) 2/3 left as wildlife would result in a net gain in wildlife values as the majority of hayable crown (portions of 44 quarter sections) and a variable amount of the Wildlife lands are hayed annually. This total is about 50% of the total lands on average. The net gain then in wildlife cover under this proposal would be 66 to 50% or about 25% in acres of wildlife cover suitable for ground nesting birds. This would add significantly to the value for wildlife of Option 9 and the estimated increase in wildlife over the status quo is about 20-25% when both parts of the option are considered.

Option 10

This option varies little in terms of water levels and only slightly smaller in affected extent of water area. Hence wildlife benefits would be similar if not the same as Option 9. Additional benefits would accrue if the modification shown for Option 9 were included.

b) Economic Evaluation of Production Effects

Status Quo

A review of the most comprehensive economic analysis on Plum Lakes to date (Grower and Kabaluk, 1973), suggests that concepts at that time were limited when

considering all wildlife values, thus a case was made using only waterfowl and muskrat values. The value of the wetlands to other birds, mammals, amphibians, invertebrates and fish was at that time considered inconsequential. We know today this is not the case and all wetland wildlife that use wetlands as part of their life cycle must be considered when considering impacts. Furthermore, Grower and Kabaluk (1973) did not consider wildlife viewing or other recreational uses valid, given their knowledge of the wildlife species and regional, national or international concerns and perspectives of the time. Today, this would not be true as wildlife viewing is growing steadily and there is increasing international concern for wetland wildlife, especially birds. The overall value and role of wetlands in the ecosystem was not considered in 1973, nor was the value of the uses of wildlife mentioned above. In today's terms, all of these values and impacts of development options must be considered.

Duck Production

Under the North American Waterfowl Management Plan, U.S. and Canadian funds are available for wetlands and uplands enhancement and management for wetland wildlife (United States and Canada, 1986). In Manitoba, the Manitoba Implementation Plan (Manitoba, 1988) forms the basis of the provincial plans for delivery. This document outlines options that have net positive effects on waterfowl with costs ranging from less than \$5 up to \$100 per duck with an average of \$26 per duck. This figure then could be considered present "value" accepted as the worth of producing a duck. The value of preserving waterfowl habitat from loss should be comparable and is used as such in this analysis.

Carreiro (1972) estimated that when managed, Plum Lakes could produce 25,000 ducks per year. By way of comparison, a DU study (1982) of the area north of Sullivan's Slough in 1978-81 showed that the area produced an average 0.85 broods of ducks per acre of water (July levels). As this is a managed habitat this could be considered an optimum level. With the area of the Plum Lakes complex at a managed summer water level of about 8000 acres and with 4-5 ducklings fledged per successful brood, an estimated 24,000 - 30,000 ducks could be produced from the area.

Since both Carreiro's (1972) estimate and the late 1970's, (Ducks Unlimited, 1982) waterfowl populations throughout North America, including Manitoba, have declined. A fair assumption, therefore, is that Plum Lakes produces on average one-third less than this figure under the present regime (i.e. unmanaged) or an estimated 8,000 ducks per year. This then would be considered the "status quo" production and at \$26 per bird produced equal \$208,000 value for ducks produced per year.

Waterfowl Staging

Plum Lakes serves as important molting and spring and fall staging habitat for

many species especially prairie ducks and migrant geese and swans from the Arctic. Furthermore, the marsh also serves as a refuge site for birds displaced by droughts where they can survive the summer. Placing a monetary significance on these intrinsic values is difficult in that these marshes increase the birds capability to migrate or their "fitness", in some way. This is not readily measurable, however, as to the degree of increased survival, reproductive output, etc.

A very conservative measure of value of the marshes for staging would be an assessment in terms of birds bagged and hunter effort in terms of expenditures. Although no data exists a conservative estimate would be that each fall approximately 1000 ducks and geese (total) that originate or stage at Plum Lakes are shot on or around the marshes.

Filion et al. (1991) notes that the average expenditure per waterfowl hunter day is \$42.06, and that waterfowl hunters hunt about 10.7 days per season. Canadian Wildlife Service (1995) data indicate that in 1994 hunters in southern Manitoba bagged 14.3 waterfowl during the season. This is about 1.4 birds per day. At an expenditure of \$42.06 per day, 1000 birds bagged would translate into an expenditure by hunters of \$30,000 for the 1000 birds shot per year at Plum Lakes. This is considered a conservative value of the status quo condition for staging waterfowl in terms of hunter return.

Furbearer Production

Carreiro (1972) noted as in 1966 the value of wild furbearers trapped in Plum Lakes was \$14,000. Recent declines in trapping interest and fluctuating world markets negate simply inflating these values into 1995 dollars. However, there has clearly been an increase in economic returns from wild fur as compared to 1966, and a "status quo" value of \$20,000 of fur produced in the Plum Lakes area is probably a reasonable estimate.

Wildlife Viewing

Similarly, other marsh wildlife have taken on an increased, although undefined in economic terms, "value" to Canadians. Filion et al. (1991) noted a willingness by Canadians to pay for wildlife viewing opportunities. The diversity of wildlife at the Plum Lakes area makes it an attractive, albeit understated site for wildlife viewing. This will likely change as Cuthbert et al. (1990) describe Plum Lakes as a premium site in southwest Manitoba for bird watching, one of North America's fastest growing recreational pursuits. Placing a dollar value on this latter aspect is difficult. The values of wildlife other than waterfowl and furbearers were conservatively estimated at about \$25,000 annually in the present or status quo condition.

The economic values of each option as compared to the status quo are summarized in Table 8. The values were calculated for each option using the status quo

dollar value and multiplying by the percent of loss or gain in value for each option as previously outlined. These values are considered as averages and being estimates are not precise but should be considered reasonable given the limited information available and the inability of the Task Force to carry out extensive surveys or estimates of wildlife populations over an extended period of years and under varying water regimes. Imposing any of the proposed options for Plum Lakes would significantly affect wildlife values as compared to the current situation.

**TABLE 8.
ECONOMIC VALUATION OF WILDLIFE IN RELATION TO
MANAGEMENT OPTIONS FOR PLUM LAKES**

Option	Change	Annual Value				Change
		Duck Production	Waterfowl Staging	Other Wildlife ¹	Total	
	(%)	(\$)	(\$)	(\$)	(\$)	(\$)
Status quo	0	208,000	30,000	45,000	283,000	0
1	-60	83,200	12,000	18,000	113,200	-169,800
2	-50	104,000	15,000	22,500	141,500	-141,500
3	-30	145,600	21,000	31,500	198,100	-84,900
4	-20	166,400	24,000	36,000	226,400	-56,600
5	-70	62,400	9,000	13,500	84,900	-198,100
6	-60	83,200	12,000	18,000	113,200	-169,800
7	-40	124,800	18,000	27,000	169,800	-113,200
8	-30	145,600	21,000	31,500	198,100	-84,900
9	+10	228,800	33,000	49,500	311,300	28,300
10	+10	228,800	33,000	49,500	311,300	28,300

¹ includes furbearer production and wildlife viewing.

4.2.3.2 AGRICULTURE

Fluctuating water levels lead to wide variations in agricultural production from farmlands in the Plum Lakes Marsh area. This production is almost entirely in the form of hay for winter cattle feed. High water level conditions prevent haylands from being harvested due to water on the fields or lack of equipment access.

Variable production causes uncertainty for farms which rely on marsh hay supplies. Farmers must make untimely reductions in herd size and/or make emergency arrangements for alternative feed sources in low production years. This limits net farm income and development opportunity.

As noted in section 3.3.1.1 and in appendix E, lands subject to flooding and poor drainage in the Plum Lake area are prone to salinity which limits their productivity and the choice of crops that may be grown. Higher water levels would lead to increased salinity because there would be less opportunity for salts to be leached downwards. The geographic extent of this increased salinity would be governed by the changing water table levels as affected by local topography and soil types. Some lands currently not prone to salinity could then be subject to this condition.

Native forages can generally tolerate high levels of salinity and therefore their yields would likely not be affected. Flooding and accessibility would continue to be the limiting factors for successful haying and pasture conditions in any particular year. On the other hand, annual crops and certain tame forages are less tolerant of salinity. Fields on the periphery of the Marsh used for annual cropping and improved forages may have increased levels of salinity with higher water levels, especially in depressional areas, which may negatively affect crop selection and yields.

a) Forage Production Effects

Some 42 quarter sections (or parts of quarters) of Crown lands in the marsh are used regularly for hay and would be affected by water level changes (Manitoba Department of Agriculture, 1993). These parcels contain approximately 3100 acres of hayland. Additionally, there are 77 quarters of privately owned lands, predominately used for forage production, that are also affected by water level changes within the marsh. The Crown lands are used exclusively for native hay production, while the private lands support native pasture, and native and tame hay production.

Water management options were reviewed for their impact on forage production within the immediate area of the marsh. Acreage affected was derived from the flooded area/elevation data from the contour survey. It was assumed that forages could only be harvested from lands that were at least one foot above water, ie. if the water level were at 1406 ft. ASL, then hay could only be harvested down to the 1407 ft ASL contour.

Option 1 was used as a baseline from which the production effects of the remaining options could be estimated. This option provides a combination of higher spring water levels (1407 ft. ASL on May 15) and subsequent drawdown to 1406 ft. ASL. At the 1406 ft. ASL water level, 2,000 acres of Crown and 2,300 acres of private land would not be available for hay production. In reality, these acres are almost always

unavailable for haying. The acreage available for forage production under each of the options was subsequently estimated as discussed in the following section.

Detailed information on native hay yields on Crown lands in the marsh from 1977 to 1987 (Table 9) indicated that the best production year in this period of record

TABLE 9.
NATIVE HAY PRODUCTION 1977 to 1987
ON CROWN LAND IN PLUM LAKES MARSH IN TONS/YEAR

Legal Description	77	78	79	80	81	82	83	84	85	86	87	Total
NE 31-7-24W	35	32	24	21	19	20	19	16	6	46		238
NW 31-7-24W				40	35	30		46	40			191
SE 32-7-24W	12	45	22	37	35	30	17	66	42	32		338
SW 32-7-24W	3	10	4	110	160	126	56	171	133	4	120	897
NE 5-8-24W	53	28	55	13	22	8	25	20	40	30	20	314
NW 5-8-24W	50	45	46	50	50	50	35	25	30	63	55	499
SE 6-8-24W	25	33	16	35	26	30	25		13	15	12	230
SW 6-8-24W				30	22	20	21	40	40			173
NE 6-8-24W	10	16	7	50	35	30	25	27	40	27	35	302
NW 7-8-24W					25	30		40	10			105
SE 8-8-24W	11	23	12	8	19	21	8		19	8		129
SW 8-8-24W	41	29	15	10	30	29	14		10	15	10	211
NE 9-8-24W		54	49	30	28	27	16		25	9	15	253
SE 9-8-24W	25	45		72	100	108	52	115	120	37		674
NW 9-8-24W	25	49	53	31	28	30	20		35	13	15	299
SW 9-8-24W		26	14	15	27	31	10		39			162
NW 17-8-24W	71	80	71	31	43	52	50	48	26	52	34	558
SE 17-8-24W	28	35	45	55	55	158	70	106	81	55	32	720
SW 17-8-24W	15	17	16	8	11	10	12	11	7	10	7	114
NE 18-8-24W	14	15	13	11	16	17	15	15	8	19	12	155
SE 18-8-24W	18	19	17	11	43	54	36	38	8	29	22	295
NE 36-7-25W	45	90	65	89	108	208	66	180	131	33	118	1133
NW 1-8-25W	24	25	19	13	14		10	13	9	10		137
SE 1-8-25W	15	22	20	32	37	82	21	71	29	19		348
NE 2-8-25W	33	85	90	70	87	60	56	135	64	64	40	784
NW 2-8-25W	33	50	40	25	84	5	48	73	40	49	24	471
NE 10-8-25W			33	55	70	55	26	40	70	30		379
NW 11-8-25W	18			50	35	35	16	36	30			219
SW 11-8-25W	18	75	45	30	63	50	60	50	60	28	12	491
NE 12-8-25W					17			10	5			32
SE 12-8-25W				18	18			50	11			97
SW 12-8-25W				20	13	10		10	10			63
SE 15-8-25W	45	42	18	15	25	15	24	25	25	30	30	284
SW 15-8-25W	120	75	60	37	55	65	40	65	60	75	50	702
Total Tons/Year	787	1065	869	1122	1455	1496	892	1542	1331	802	671	
Water Condition	wet	wet	wet	dry	dry	dry	wet	good	dry	wet	wet	
July 15 Water Level (+1400)	7.6	7.6	8.8	NA	NA	NA	8.2	6.5	5.2	8.1	8.1	

NA - Not Available

was 1984 when 1542 tons of native hay were harvested. Assuming that this production came from the 3100 acres of Crown lands indicated earlier, the average production was almost exactly 0.5 tons/acre.

Yields on private lands are higher due to a more intensive level of management and the use of some tame forages. It was subsequently assumed that forage yields on private lands average approximately 0.75 tons/acre. Even though some of the private lands are used for pasturing, total forage production would be similar to the haylands.

b) Economic Evaluation of Production Effects

Existing Average Annual Production

The first step in evaluating the effects of the various options upon the local agricultural industry was to estimate the average annual total production of forages under existing conditions.

At a July 15 water level elevation of 1406.0 ft. ASL, there are 3,100 acres of Crown lands and 7,500 acres of private lands that can be harvested, a total area of 10,600 acres. Assuming yields of 0.5 tons/acre on the Crown lands and 0.75 tons/acre on the private lands, as previously indicated, total forage production is calculated at 7,175 tons/year.

However, under existing hydrological conditions, the probability of obtaining this level of production is estimated to be no higher than 29%, ie. only 29 out of 100 years is this tonnage available. It was also assumed that this was the maximum tonnage obtainable under the existing regime.

At a July 15 water elevation level of 1407.0 ft. ASL, the total production area is reduced to 9250 acres, for an annual forage volume estimated at 5,713 tons. The probability of obtaining this level of production or higher is estimated to be no more than 45%, ie. 45 out of 100 years.

At a water level on July 15 of 1408 ft. ASL, only 4,150 tons of forage are estimated to be available for hay or pasture. This level of production or higher is estimated to occur with a probability of 63%. The production of 4,150 tons was also assumed to be the minimum level in the study area. This information is summarized in Table 10.

TABLE 10.
FORAGE PRODUCTION IN STUDY AREA
WITH EXISTING CONDITIONS

July 15 Water Level	Frequency of Lower Water Level	Crown Land	Private Land	Combined Total Forage		
		Area Harvested	Area Harvested			
(Feet)	(%)	(acres)	(tons/year)	(acres)	(tons/year)	(tons/year)
1406	29	3100	1550	7500	5625	7175
1407	45	2200	1100	6150	4613	5713
1408	63	1400	700	4600	3450	4150

A plot of the above frequency/production information indicated that the average annual production of forages in the study area under existing conditions is approximately 5,500 tons. This average level of production subsequently formed the basis against which the various options were compared. This level of production may be considered as the status quo option.

Potential Production with Developments

Modification of the hydrologic regime by the construction of a dam and channels under Options 1 to 4, supplemented with dykes, water control structures and pumping facilities for Options 5 to 10, would have significant effects upon the level of forage production in the study area. These production effects are summarized in Table 11 for each of the 10 options evaluated.

Column four presents the total production that could be expected for each option if the July water level targets were achieved. These levels were reduced by 10%, as shown in column five, to acknowledge the fact that water control structures and associated works will likely not be successful 10 out of 100 years in reducing water levels to the desired target. An engineering design standard that could tolerate a failure rate of, for example, one in 100 years, can only be justified for residential flood protection due to the substantially higher construction costs that would be involved.

The change in average annual production that could be expected with each of the options is shown in the sixth column. These estimates were derived by subtracting the existing average annual production, 5,500 tons, from the tonnage indicated in column five. As shown, the production effects could be both positive or negative.

Four options would lead to increased forage production in the study area. Both options with a target level of 1406 ft. ASL, namely Options 1 and 5, are in this grouping. At a water level of 1407 ft. ASL only Options 6 and 7, which have dykes and pumping facilities, would realize increased production. The level of annual increased forage production ranged from 564 to 1,374 tons.

The remaining six options would lead to decreased production, ranging from 291 to 1765 tons less than existing levels. All options with a July water level target of 1408 ft. would have diminished forage production relative to existing conditions.

The average annual value of these production changes was estimated by multiplying the amount of gain or loss by \$40/ton. This unit value for a ton of forage, derived in a report prepared by Manitoba Agriculture, represents the cost associated with replacing a ton of hay made unavailable through flooding. This report is displayed in Appendix E. These costs relate to transportation, higher purchase costs for outside hay relative to haying costs in the Marsh, and the investment costs associated with idled/under-utilized haying equipment for Study Area farmers. On this basis, average annual values ranged from minus \$70,600 for Option 4 to \$54,950 for Option 5.

**TABLE 11.
FORAGE PRODUCTION IN STUDY AREA WITH DEVELOPMENTS**

Option Water Levels	Land Owner	Area in Forage	Maximum Forage Production	Average Annual Forage Production	Change in Average Annual Production	Value of Change
		(acres)	(tons/year)	(tons/year)	(tons/year)	(\$40/ton)
status quo	Crown	3100				
	Private	7500				
		<u>10,600</u>		5500		
1 1407/06	Crown	3100	1550			
	Private	7500	5625			
		<u>10600</u>	<u>7175</u>	6458	958	\$38,300
2 1407/07	Crown	2200	1100			
	Private	6150	4613			
		<u>8350</u>	<u>5713</u>	5142	-358	-\$14,320
3 1408/07	Crown	2200	1100			
	Private	6150	4613			
		<u>8350</u>	<u>5713</u>	5142	-3598	-\$14,320
4 1408/08	Crown	1400	700			
	Private	4600	3450			
		<u>6000</u>	<u>4150</u>	3735	-1765	-\$70,600
5 1407/06	Crown	3200	1600			
	Private	8050	6038			
		<u>11250</u>	<u>7638</u>	6874	1374	\$54,960
6 1407/07	Crown	2450	1225			
	Private	7350	5513			
		<u>9800</u>	<u>6738</u>	6064	564	\$22,550
7 1408/07	Crown	2450	1225			
	Private	7350	5513			
		<u>9800</u>	<u>6738</u>	6064	564	\$22,560
8 1408/08	Crown	1900	950			
	Private	6450	4838			
		<u>8350</u>	<u>5788</u>	5209	-291	-\$11,640
9 varied levels	Crown	1600	800			
	Private	5350	4013			
		<u>6950</u>	<u>4813</u>	4332	-1168	-\$46,720
10 same as # 9	Crown	1300	650			
	Private	4950	3713			
alternate dyke		<u>6250</u>	<u>4363</u>	3927	-1573	-\$62,920

Enhanced Productivity

Forage yields of 0.5 and 0.75 tons/acre, for Crown lands and private lands respectively, had been assumed in the analysis associated with Tables 8 and 9. With the greatly improved hydrologic regime associated with the options having dykes and pumping facilities (Options 5 to 10), it is quite conceivable that productivity would be enhanced on those private lands located outside of the three cells. These would be those lands located in the external cell, approximately 4,800 acres. Productivity would be enhanced through a combination of reduced flooding, improved local field drainage (to reduce salinity and water-logging) and more intensive cultural practices using, for example, better forage species and higher levels of fertilizer input.

Table 12 shows the results of this enhanced productivity. Substantial increases in overall production are realized. Option 8 even shows a production reversal - in Table 11, it had a level of production approximately 300 tons/year lower than existing conditions; in Table 12, it now has a substantial increase of nearly 800 tons/year.

**TABLE 12.
FORAGE PRODUCTION IN STUDY AREA WITH DEVELOPMENTS
ENHANCED PRODUCTIVITY**

Option Water Levels	Land Owner	Area in Forage	Maximum Forage Production	Average Annual Forage Production	Change in Average Annual Production	Value of Change
		(acres)	(tons/year)	(tons/year)	(tons/year)	(\$40/ton)
5 1407/06	Crown	3200	1600			
	Private	8050	7238			
		<u>11250</u>	<u>8838</u>	7954	2454	\$98,160
6 1407/07	Crown	2450	1225			
	Private	7350	6713			
		<u>9800</u>	<u>7938</u>	7144	1644	\$65,760
7 1408/07	Crown	2450	1225			
	Private	7350	6713			
		<u>9800</u>	<u>7938</u>	7144	1644	\$65,760
8 1408/08	Crown	1900	950			
	Private	6450	6038			
		<u>8350</u>	<u>6988</u>	6289	789	\$31,560
9 varied levels	Crown	1600	800			
	Private	5350	5213			
		<u>6950</u>	<u>6013</u>	54112	-88	-\$3,520
10 same as # 9 alternate dyke	Crown	1300	650			
	Private	4950	4813			
		<u>6250</u>	<u>5463</u>	49167	-583	-\$23,320

4.2.3.3 OTHER IMPLICATIONS

Several different resource management scenarios are being considered for the Plum Lakes area. An economic evaluation of the benefits of each of these scenarios would include agriculture, wildlife, recreation and construction and management activity components. The agriculture and wildlife components have been dealt with in the previous two sections.

Recreational Benefits

These benefits would be measured in terms of opportunities for incremental

recreational activities. (For the purpose of this discussion, the economic impact of some types of recreation, such as hunting, has been included under wildlife). Other types of recreational activities would include hiking and wildlife viewing. It is felt that these types of recreational benefits would be fairly constant for each of the various resource management options under consideration, with the exception of those options which result in a significant decrease in wildlife habitat (such as option 5). Some minor increases in recreational benefits may be possible in situations where there is an increase in wildlife benefits. Enhanced wildlife habitat will create more favourable conditions for incremental recreational activities, such as eco-tourism.

Due to a lack of information, it is difficult to accurately forecast any increased economic activity resulting from incremental recreational activities associated with any of the proposed options. However, it is felt that significant recreational benefits will not likely be experienced unless recreational facilities are developed, such as hiking trails and/or a visitor's centre, along with a promotional campaign to heighten public awareness of the area. As these types of facilities are not proposed in the project descriptions for any of the options, the economic impact of any increased recreational activity will likely be fairly neutral and constant among most of the options being considered.

There are several other factors that suggest a fairly low level of incremental recreation-based economic activity. Firstly, the level of the local population is relatively low, and there are no major cities in the vicinity which would generate a significant increase in visitor traffic to the project. Secondly, there are no major tourist facilities in the vicinity of the project, which would act as "receptors" for any incremental economic activity, other than a campground and small convenience store at Oak Lake Resort. It is anticipated that any expenditures for goods and services will most likely occur at the visitors' points of origin, rather than near the destination.

Construction and Management Activity Benefits

The construction of any project generates economic benefits from the actual construction activity. This would include the installation of structures, earthworks and other related activities. These activities would generate direct benefits such as salaries for construction workers and sales of equipment, materials and supplies such as fuel. There would also be an economic ripple effect, as construction salaries would generate spending power used for the purchase of other personal and household items. For the most part, these represent one-time costs which occur when the project is constructed. The economic benefits from construction activities would generally be proportional to the budget of the project which is undertaken, and would be highest if local contractors are utilized. The utilization of non-local contractors would result in many of the economic benefits occurring at the contractor's base of operations.

In addition, there may be ongoing maintenance costs and benefits related to the operation and maintenance of the project. These costs could consist of salaries and equipment expenses, or private contract costs to perform periodic maintenance operations. These costs would vary depending upon the scope of the project. The benefits would be of a similar nature to those outlined above, such as employment of maintenance personnel. However, a project such as this is not expected to have a significant annual maintenance budget, with the exception of those options which include pumping of water, which could have significant energy-related expenditures.

Over the long term, the most important economic considerations would be related to agricultural benefits or costs, and wildlife benefits or costs. Economic benefits from construction activity would be generally proportional to the cost of the selected option, and may have some short term local impact. Benefits from incremental recreational activities and maintenance activities would be considered as relatively minor in comparison, and relatively constant among most of the options under consideration. However, there are significant intangible benefits in providing an extensive area of wildlife habitat in this region of Manitoba, where agriculture dominates the landscape. Decisions on the preferred management option(s) should extend beyond traditional economic concepts, to include some of these intangible values

5.0 SUMMARY ECONOMIC EVALUATION

5.1 BENEFIT-COST COMPARISONS

The basic procedure for assessing the economic feasibility of a project is to compare the present value of project benefits to the present value of project costs. Present values can be visualized as the lump sum of money at present which is equivalent to a stream of funds over a period of time. Discount (interest) rates serve to translate those costs and benefits accruing in the future to the current lump sum equivalents. If the present value of benefits is greater than the present value of costs, an economically feasible project is indicated.

It is current standard practice by the Province of Manitoba in the economic analysis of water management options to use a discount rate of 5% and a project life of 50 years. As well, all monetary benefits and costs are considered to be expressed in constant current dollars, hence the discount rate is assumed to a real rate of discount (all inflationary effects removed).

The two standard parameters calculated for benefit-cost comparisons are net present values (NPV) and benefit–cost (B/C) ratios. The NPV of a project is obtained by subtracting the present value of costs from the present value of project benefits. The NPV should therefore be positive for an economically feasible project. The magnitude of the NPV indicates the “loss” or “profit” that might be realized. The B/C ratio is obtained by dividing the present value of project benefits by project costs. A ratio of unity or larger therefore signifies economic feasibility. All other things being equal, and with a limited budget, those projects with the highest B/C ratios should be implemented first.

Table 13 summarizes the benefit/cost analysis of the 10 options developed for the Plum Lakes. Note that the modifications to 9 and 10 were not analyzed as costs were unavailable.

Benefits

In Table 13, Column 2 presents the annual agricultural benefits or disbenefits identified for each option as shown previously in Table 11. For options 5 to 10, those values representing the higher levels of productivity were used. Column 3 presents the total of annual wildlife benefits and disbenefits for waterfowl, furbearer production and wildlife viewing, as identified previously in Table 8. Column 4 provides the total present value for agriculture and wildlife. These benefits and disbenefits, varying according to the effect each option has for those interests, are monetary values that would be realized or lost over the 50 year life of the project.

**TABLE 13.
PLUM LAKES
BENEFIT-COST COMPARISONS**

Option	Benefits		Total Present Value ¹	Costs		Present Value	Net Present Value	B/C Ratio
	Annual Agriculture	Annual Wildlife		Capital Construction	Annual Maintenance & Operating ²			
	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	
1	38,300	-169,800	-2,400,654	401,070	20,054	767,165	-3,167,819	-3.13
2	-14,320	-141,500	-2,844,638	401,070	20,054	767,165	-3,611,804	-3.71
3	-14,320	-84,900	-1,811,353	1,409,545	70,477	2,696,172	-4,507,525	-0.67
4	-70,600	-56,600	-2,322,154	1,409,545	70,477	2,696,172	-5,018,326	-0.86
5	98,160	-198,100	-1,824,497	3,570,190	178,510	6,829,046	-8,653,543	-0.27
6	65,760	-169,800	-1,899,346	3,570,190	178,510	6,829,046	-8,728,393	-0.28
7	65,760	-113,200	-866,061	3,745,495	187,275	7,164,369	-8,030,430	-0.12
8	31,560	-84,900	-973,771	3,745,495	187,275	7,164,369	-8,138,140	-0.14
9	-3,520	28,300	452,382	3,745,495	187,275	7,164,369	-6,711,987	0.06
10	-23,320	28,300	90,915	3,821,475	191,074	7,309,703	-7,218,789	0.01

¹ Discount rate 5%, project life 50 years.

² 5% of capital construction cost.

Costs

Columns 5, 6 and 7 summarize the project costs. Capital costs are those that would be incurred to put the project in place. These costs (construction works, land, engineering design and contingencies) are already in the form of a present value because they are incurred at the beginning of the project. These costs have been itemized for each option and are presented in Appendix F. It is prudent in project planning to make allowance for annual maintenance and operating costs. These were assumed to be 5% of the capital costs. These are provided in column 6. Column 7 provides the total of the capital costs and maintenance/operating, with the latter converted to the present value equivalent.

Benefit-Cost Comparisons

The last two columns in Table 13 provide the net present values and the benefit/cost ratios for each of the options. No economically feasible options are identified. Options 1 to 8 have negative benefits, hence were clearly infeasible. Costs greatly exceed the expected project benefits for options 9 and 10. In other words, the “status quo” remains the most feasible of all the options under review in this analysis.

This conclusion confirms the economic analysis conducted some 25 years earlier in the Grower and Kabaluk study (1973). Their study of alternative water level management identified two options, in addition to the “do nothing” option, with economic merit. One involved minor downstream works with insignificant net benefits, the other a major permanent raising of water levels. The latter, however, considered the wildlife benefits to be greatly enlarged. In today’s perspective of wildlife management for multiple species, the permanent raising of water levels is not considered to be a positive gain in the Plum Lakes area. In fact, wildlife benefits are now considered to be less with a permanent raising as compared to the status quo, given the land use pattern assumed to be associated with each option.

Because none of the projects analyzed in the benefit-cost analysis were economically feasible, it was not deemed worthwhile to assess project implications any further. This would include such considerations as the likelihood of increased salinity on some lands peripheral to the project. Subsequent assessment of the full range of potential project environmental impacts, both positive and negative, is not necessary due to the lack of practical and feasible water level alternatives to the status quo.

6.0 ALTERNATIVES TO WATER MANAGEMENT

Water management works are costly and typically permit control only within a specified range of elevations. Extreme droughts and floods continue to occur and the physical works may only modestly alleviate their effects. Additionally, water management developments, when analyzed as to their benefits or disbenefits, often overlook intrinsic factors to difficult to accurately quantify. Some examples are the dollar value of wildlife or aesthetics, as well as factors such as long term effects on water tables, especially at the extreme end of events such as drought and floods.

In the nearby Hunter-Maple Lakes area local residents claim management at a lower water level may have had some negative long term effects on both hay quantity and groundwater levels.

As an alternative to additional water management works, various opportunities exist to develop and protect the Plum Lakes area's natural resources. With respect to agriculture, opportunities exist to reduce, over the long term, the financial instability associated with variation in hay yield on most flood prone lands. The most obvious would be adjustment of some of the Crown land leases frequently affected by high water events, to exclude these lands from haying during most years. Depending on the amount of land involved, swapping of the low-lying public haylands for less flood-prone lands owned by conservation agencies would result in a more predictable supply of better quality hay, albeit of a slightly lower average quantity than may have been cut some years under present conditions.

A major benefit would be preservation and maintenance of some existing specific habitat types. This could be particularly significant to Manitoba's Strategy on Natural Lands and Special Places (Manitoba, 1992). It would also be in line with Canada's strategy to protect biodiversity (Canada, 1995). Presently, the Souris Till Plain contains "few large blocks of contiguous Crown land" (Manitoba, 1992) with the Plum Lakes area being one the largest. By designating the Crown land at Plum Lakes for conservation purposes and by obtaining agreements on the private land in conservation agency hands, the Province could demonstrate the collective commitment of several conservation agencies towards preserving a significant area in natural habitat. At the same time, carefully regulated agricultural use would be permitted, at least periodically.

Land use considerations should provide for the continuation of haying, while ensuring that the natural region (Souris Till Plain) is well represented, and the biodiversity of the area is preserved. Both Federal and Provincial governments recently agreed to these principles, particularly with regard to aquatic areas including freshwater wetlands (Manitoba, 1992).

In order to meet these conditions and maintain or increase the local economy, some alternative

types of development should be considered. The Plum Lakes are only 6 miles south of the TransCanada Highway, and they are adjacent to Oak Lake which has recreational facilities. The TransCanada can provide a locally unexploited source of tourist traffic to experience local features of natural and cultural interest and within which to rest. Facilities for overnight accommodations and to promote and interpret the features of this marsh complex could be developed. Such development in addition to the traditional recreational pursuits such as sport hunting would provide for sustainable use of the Plum Lakes marshes. Only Whitewater Lake, which is an additional half day's drive southeast of this site, has comparable natural features.

The biological diversity of the Plum Lakes eco-zones or plant communities, ranging from marsh through grassland to woodlands and sand-dune areas, supports a great variety of wildlife. These are key elements which provide a basis for the eco-tourism industry (Weaver, Glenn and Rounds, 1995). In fact this report notes the Oak Lake area is one of Manitoba's "choice" eco-tourism sites; alongside Churchill, Hecla, Whiteshell, Spruce Woods, and Riding Mountain. Eco-tourism also can form a basis for locally developed businesses such as bed and breakfast, seasonal interpretive centres, guided field trips such as canoeing, horse and wagon tours, winter snowmobile, dogsled or cross country skiing. Cottage industries such as crafts or local specialty goods are a possibility. Community developed services to support these could include walking or riding trail development, an information centre, and local works such as viewpoints or boardwalks in the marsh.

A variety of funding sources from both industry and government are available to assist in such community developments. Some examples are the Manitoba Sustainable Development Innovations Fund, Rural Adaptation Council, Manitoba Rural Economic Development Initiative, Manitoba Watchable Wildlife Program, Environment Canada Action 21, and Shell Canada's Environment fund. Development would be evolutionary in nature, depending on such factors as financing, entrepreneurial initiative and promotion.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 DISCUSSION

There is little doubt that the Plum Lakes area is important to a myriad of wildlife species and to the agricultural community that has depended for generations upon the haylands of the area. The common denominator of the marsh/upland ecosystem - water - and optimum levels for wildlife versus agriculture, has been the subject of controversy and study for decades.

The Minister of Natural Resources appointed the Oak and Plum Lakes Management Board after a review of the issue by the Manitoba Water Commission in 1983. The Board was directed to examine options and recommend actions that would alleviate or solve the area's water management problems. The Plum Lakes Multidisciplinary Resource Management Task Force was formed in 1986 to undertake a quantitative study of a variety of water management options for the area. It has sought the advice and assistance of the Management Board throughout the study and has generated considerable information and technical data on the area. With the completion of this report the Task Force has completed its assigned tasks of evaluating the water management options.

The costs related to achieving each water management option were generated using standard engineering specifications for construction and maintenance of the required works and the resultant benefits or disbenefits to agricultural and wildlife production were calculated using standard economic procedures. Economic values of wildlife were based on published literature or extrapolated from such sources wherever possible.

Throughout much of the Plum Lakes study area the resource development interests of wildlife and agriculture, with regard to preferred water level management regimes, are unfortunately contrary. Generally, agricultural benefits are increased by lower water levels with agricultural disbenefits increased by higher water levels. The reverse is generally true for wildlife. Agricultural benefits and disbenefits are highly variable depending on the water level regime. Wildlife benefits are only positive for substantially higher water levels.

As indicated in Table 13, none of the management options examined have positive benefits for both wildlife and agriculture under the same water management regime. Except for options 9 and 10, the total of agriculture and wildlife benefits are negative resulting in benefit-cost ratios that are also negative, indicating projects that would have ongoing annual disbenefits and therefore should be considered no further. For options 9 and 10, benefit-cost ratios are much lower than unity, indicating infeasible

projects due to inadequate benefits relative to costs.

In one portion of the study area the above contrary circumstances do not hold. In the area around Sullivan's and Bigelow's Sloughs higher water levels would have significant benefit to wildlife habitat, little disbenefit to agricultural activities and could be reliably maintained with relatively inexpensive water control structures.

7.2 CONCLUSIONS

The Plum Lakes Task Force concludes that this large wetland ecosystem does not allow for the design of a water level management development mutually beneficial to both wildlife and agriculture. The Task Force further concludes that the Plum Lakes Marsh ecosystem should be maintained without major works and the "status quo" water regime should be allowed to prevail. Allowing the water levels to fluctuate with prevailing climatic conditions will see periods of extremes of both flood and drought as well as periods of moderate levels. Allowing this system to fluctuate naturally, without intervention, will ensure some years of excellent forage production for agriculture, as well as some years of scarcity and reduced production and availability. Wildlife species will also see period of optimum habitat and resulting production as well as years of marginal production. Overall, the "status quo" approach to water management in the Plum Lakes Marsh will, over the long term, maintain the degree of biological diversity that it now encompasses.

The task force also concludes that a beneficial water level management development may be feasible in a small portion of the study area. Water levels in the Sullivan's and Bigelow's sloughs could possibly be managed to benefit wildlife without impacting negatively on surrounding agricultural activities and without requiring major water control works. Such a project would provide no relief to the existing problems in the Plum Lakes Marsh and, therefore, was not evaluated during this study. The information gathered during this study could, to a large degree, be used to conduct an evaluation of such a project's feasibility.

Water levels in the Oak and Plum Lakes system can under high flows be controlled by Plum Creek below the Kansas City Dam. To prevent worsening of the flooding around Plum Lakes it is particularly important that proposed upstream drainage projects be evaluated on a watershed basis as specified by Manitoba's water policies (Manitoba, 1994).

Opportunities do exist for land use adjustment that will rationalize the most sustainable and appropriate use of the natural resources in the Plum Lakes Marsh area. Adjustment of Crown Land hay leases on flood prone land is one possibility. A second is the exchange of higher elevation, conservation agency-owned lands, for lower elevation, flood prone, privately owned lands. Done independently or in combination, these

possibilities could ensure agricultural production and increase wildlife habitat in the area.

An eco-tourism development would seem to have significant potential in recognition of the biological diversity of the area, its regional uniqueness and close proximity to the TransCanada Highway, and the amount of land owned by the Crown and conservation agencies.

7.3 RECOMMENDATIONS

The Plum Lakes Multidisciplinary Resource Management Task Force recommends to the Minister of Natural Resources the following.

1. That water levels in the Plum Lakes Marsh be allowed to rise and fall through cycles of drought and flood without further intervention that would affect the current water regime, such as the construction of new roads and ditches or the alteration of existing water control works.
2. That future consideration be given to cellular development of the Sullivan's and Bigelow's slough area as a "stand alone" project if local interests and land owners are receptive to the concept and subject to a benefit-cost analysis.
3. That the Province of Manitoba, in concert with conservation groups and local residents, promote the Oak-Plum Lakes Marsh complex as a feature natural attraction having high eco-tourism potential.
4. That consideration be given to affording the Plum Lakes area designation or status to maintain the ecological integrity, the biological diversity and the agricultural resources of the area.
5. That the West Souris River Conservation District pursue alternatives to water management to reduce the problems associated with high water levels, to meet the needs of agriculture and biodiversity and to manage the Crown and conservation agency lands in the Plum Lakes area as a single complex.
6. That the West Souris River Conservation District be apprised of the findings of this study to assist them in long term planning for this part of the District.
7. That the findings of the Plum Lakes Multidisciplinary Resource Management Task Force be communicated via this report to the Oak and Plum Lakes Management Board and via "open houses" to the public in the region.

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