Wildlife Habitat Mitigation for the Oldman River Dam Project

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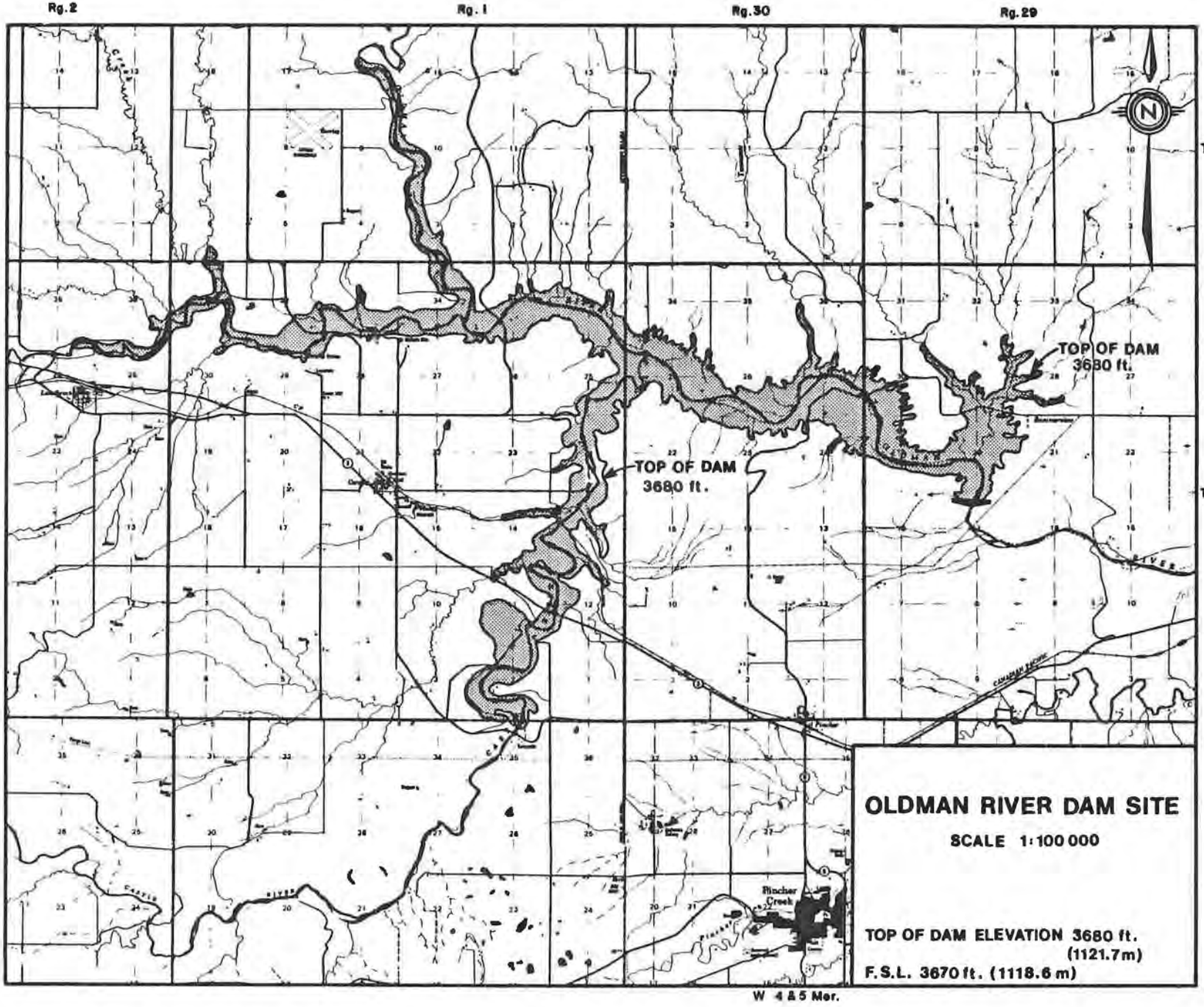
ABSTRACT

To compensate for losses of wildlife habitat associated with the construction and operation of the Oldman River dam in southern Alberta, an extensive wildlife habitat mitigation program has been undertaken. Habitat evaluation procedures were used to determine the amount and types of habitat losses in the reservoir area, and the most important habitat needs of wildlife in the mitigation program. Three major types of mitigation, involving thirteen specific measures, are being employed in the Mitigation Program: habitat protection, habitat enhancement and habitat creation. A concept plan was developed that addresses the biological requirements of wildlife (e.g., movement corridors, core habitat areas and other specialized habitats) in conjunction with existing land uses, the need for a good distribution of projects around the reservoir, and the suitability for establishment of woody vegetation. In total, 65 habitat projects are being developed, as well as additional projects for cliff nesting raptors. Other habitat enhancement and creation projects may be developed as opportunities arise during dam construction and reclamation.

One habitat project, the Glass Project, is discussed in the detail. The project involves a combination of habitat protection (fencing), enhancement of three existing wetland basins, development of a new wetland basin and watercourse, reseeding of cultivated areas with grasses and forbs, and the planting of large numbers of trees and shrubs along the crests and western slopes of the major coulees. The project also includes the installation of a subsurface irrigation and pump system for watering of trees of shrubs, and installation of snow fencing for trapping of snow cover and wind protection.

INTRODUCTION AND BACKGROUND

The Oldman River Dam is currently being constructed a short distance downstream from the confluence of the Oldman, Crowsnest and Castle Rivers in southern Alberta (Figure 1). Once completed, the dam will create a reservoir covering an area of approximately 2420 ha at full supply level (FSL).



General location of the study area for the Oldman river wildlife habitat mitigation plan

Figure 1

Although cultivated fields, pastureland, winter feedlots and farmsteads occupy most of the bottomland areas in these valleys, much of the remaining valley areas and adjacent coulees are locally important habitat for a variety of wildlife species. For example, approximately 350-400 mule deer (*Odocoileus hemionus*) overwintered in and around the reservoir area during 1985-86, with slightly more than half that number being present during the spring and summer months (Allison and Russell 1986). The reservoir area also supports a variety of other mammals and avifauna on a seasonal or year-round basis including white-tailed deer (*O. virginianus*), moose (uncommon) (*Alces alces*), yellow-bellied marmots (*Marmota flaviventris*), badgers (*Taxidea taxus*), beaver (*Castor canadensis*), mink (*Mustela vison*), nesting Ferruginous hawks (*Buteo regalis*), prairie falcons (*Falco mexicanus*) and Canada geese (*Branta canadensis*), mallards (*Anas platyrhyncos*), and common mergansers (*Mergus merganser*) (Young et al. 1986).

Because of the importance of the flooded area to wildlife, Alberta Environment has undertaken a program to enhance existing habitat conditions around the proposed reservoir. Alberta Environment, in association with the Alberta Fish and Wildlife Division and the Local Fish and Wildlife Advisory Committee (LFWAC), retained The Delta Environmental Management Group Ltd. (The Delta Group) to develop practical, effective habitat improvement and creation projects which could be implemented in the region of the reservoir. Recent studies on wildlife numbers, distributions and habitat preferences in the vicinity of the Oldman River Dam (Westworth 1984; Allison and Russell 1985, 1986; Young et al. 1986), as well as information from Alberta Fish and Wildlife Division, the Local Advisory Committee, and field surveys, aided in the selection and design of appropriate projects for the area.

This paper reviews the procedures for developing the Wildlife Habitat Mitigation Plan for the Oldman River area. One recently implemented habitat project, demonstrating the integration of several habitat mitigation techniques, is also described.

STUDY OBJECTIVES

The major objectives of the Wildlife Habitat Mitigation Plan, as recommended by Alberta Environment, Alberta Fish and Wildlife Division and the LFWAC, are to:

- Estimate the current quality and availability of wildlife habitat in the vicinity of the dam and determine the amount of habitat that will be lost from flooding;
- Identify locally important habitats which should be retained for wildlife;
- Identify options for management of bottomland areas that will aid in the maintenance and enhancement of wildlife habitat upstream and downstream of the dam, while also benefiting cattle range;
- Determine if off-site mitigation opportunities for wildlife are possible such as the creation or improvement of wetlands for waterfowl using reservoir water reserves;
- Identify construction sites, such as borrow pits, which can be reclaimed as wildlife habitat, and prepare enhancement plans for these sites which are both compatible with construction activities and cost-effective;

- Identify opportunities for combining agricultural uses of land with enhancement of wildlife habitat;
- In cooperation with Alberta Environment, Alberta Fish and Wildlife Division and the LFWAC, identify the preferred habitat projects on the basis of cost-benefits and prepare site plans and drawings for these projects; and
- Outline a program to monitor the effectiveness of the completed habitat projects in and around the reservoir.

For the purposes of the Wildlife Habitat Mitigation Plan, no rigid study area boundaries were established and all habitat opportunities within a reasonable distance of the reservoir were considered. Wherever possible, lands immediately downstream and upstream of the dam, and along the perimeter of the reservoir (Figure 1) were incorporated into the mitigation plan to ensure that the localized wildlife populations most affected by the dam would realize benefits from habitat enhancement and creation.

HABITAT NEEDS OF WILDLIFE

The Oldman, Castle and Crowsnest River valleys provide a complex of wildlife habitats that are important to the survival of deer, a number of small mammals, upland gamebirds, songbirds, raptors and some waterfowl. The steeply incised portions of the river valleys are largely uncultivated, and provide mule deer and other wildlife with physical protection from the prevailing winter winds, as well as accessible sources of winter browse and food. Canada geese, prairie falcons and feruginous hawks use some of the cliff areas along these three valleys for nesting and rearing of young. Marmots, coyotes and red foxes are also known to den within the reservoir area.

The valleys of the three rivers also serve as local movement corridors for mule deer and white-tailed deer. Data from recent wildlife studies (Allison and Russel 1985, 1986) , as well as from local information sources, suggest that the valleys provide routes from downstream bottomland habitats to winter and summer habitats in the Lundbreck Hills and Porcupine Hills. Flooding of the reservoir area will therefore alter local movement corridors for wildlife (particularly mule deer), as well as reduce the local availability of food and cover for a number of birds and mammals.

The remaining coulees and treed areas above the floodline will provide some cover and food for wildlife. However, because cultivated and pasture land surrounds most of the reservoir, there will not be sufficient alternate tree and shrub habitat for wildlife in the immediate reservoir area following flooding. In particular, mule and white-tailed deer traveling around the reservoir may be forced to travel long distances away from cover, unless some mitigative measures for wildlife are provided.

ESTIMATING LOSSES OF WILDLIFE HABITAT

Although information on the type and amount of habitat to be lost to flooding is required to prepare a mitigation plan, it is not feasible to undertake an assessment of habitat loss for each different wildlife species considered of importance to the area. To simplify the planning process, a key species, mule deer, whose cover needs were considered to represent most needs of a variety of forest and shrubland-dependent wildlife, was selected to determine habitat loss and appropriate improvement projects.

Although mule deer was used as the key species for the development of much of the plan, it must be emphasized that the mitigation plan is not solely for mule deer. Development of tree and shrub cover for mule deer will also benefit a variety of bird and small mammal species. A number of specialized habitat projects such as enhancement or creation of wetlands, creation of nesting islands, modification of cliffs for nesting sites, and construction of rockpiles will benefit raptors, waterfowl and several small mammals.

Estimating Losses of Habitat

The proposed dam will flood approximately 2420 ha of land. The reservoir area is a complex mosaic of nine major plant communities:

Vegetation Community	Total ha in Reservoir[1]	% of Total Reservoir[1]
Douglas fir	61.2	2.4
Limber pine	0.0	0.0
Aspen	10.2	0.4
Cottonwoods	367.5	14.7
Skunkbush - creeping juniper	96.3	3.8
Saskatoon - chokecherry	75.9	3.0
Rough fescue - Parry oat grass	45.7	1.8
Western wheatgrass - June grass	1435.3	57.3
Cultivated fields	408.4	16.3
Disturbed Sites (gravel pits, etc.)	6.2	0.3

1. From Hardy Associates (1986). Note: Areas are based on the area within the takeline of the reservoir (elevation 1121.7 m) not the full supply level of the reservoir (elevation 1118.6 m).

Each of these communities have a different food and cover value for wildlife. To measure the habitat values for mule deer in the reservoir and, hence, determine the nature and amount of mitigation needed to replace such losses, some means of combining the quality and quantity of habitat in the different areas of the reservoir was required.

The U.S. Fish and Wildlife Service (USFWS 1980) has developed a method of measuring the amount or availability of wildlife habitat within a given area, called *Habitat Evaluation Procedures* (HEP). Using information on the habitat needs and preferences of wildlife species, HEP involves the development of simple arithmetic models for specific wildlife species which rate the current value of habitat for that species.

For the Oldman River Project, two models were developed to calculate habitat availability for mule deer within the reservoir area: one for the summer/fall period and one for the winter period. Existing wildlife and vegetation studies for the Oldman River Project provided the necessary information for the development of both models. For example, the type of plant cover, aspect and land form are consistently identified as important habitat variables influencing the distribution of mule deer in the Oldman River area (Allison and Russell 1986), particularly during the winter. In the two habitat models for mule deer, these variables were used in various combinations as the primary factors that determine habitat quality. The plant communities described and mapped for the study area by Hardy Associates (1986), in turn, provided the logical land units for the calculation of habitat

quality and quantity. In all, a total of 179 different land units were identified within the reservoir area.

Because winter habitat is more important to the survival of mule deer than summer habitat, winter values were rated more highly than were the summer values. Therefore, in calculating a year-round rating for mule deer, winter values made up 65% of the year-round value, whereas summer values made up the remaining 35%. Using the summer and winter habitat models and these weighting values, Habitat Suitability Indices (HSIs) for land areas within the reservoir area ranged from 0.0 (no value) for active gravel pits to 0.74 (good to excellent habitat) for a lightly-grazed saskatoon - chokecherry community.

Estimating Habitat Availability

In the Habitat Evaluation Procedures, habitat availability -- a combined measure of the quality and amount of habitat present in the reservoir area -- is measured in units called *Habitat Units* (HUs). HUs are calculated for any given land area, simply by multiplying the HSI value for that land by its area (hectares).

Habitat Losses from Flooding

Based on the number of habitat units that are presently available to mule deer and other shrub and tree associated wildlife within the reservoir area, an estimated **689 HUs** will be lost to flooding. In terms of the specific uses of these habitats by mule deer:

- **38 HUs** provide mostly cover (for example, Douglas fir communities),
- **445 HUs** provide mostly food (communities such as grasslands, cultivated fields and low shrubby areas), and
- **206 HUs** provide both cover and food (communities such as aspen and cottonwood stands and tall shrubby areas).

Because flooding will reduce the availability of forests, shrublands and sheltered slopes occuring within the river valleys immediately upstream of the dam, and because these communities are not abundant in the area immediately surrounding the reservoir (in contrast, food-based habitats such as pastureland and cultivated fields are common), the principal focus of the Wildlife Habitat Mitigation Plan is to enhance or create cover and cover/food habitats for wildlife. Based on the existing mitigation projects and the projected habitat conditions in 3-15 years (i.e., once the individual habitat projects are well-established or mature), it is estimated that approximately 50 HUs of cover habitats, 314 HUs of food habitat and 853 HUs of food/cover habitat can be developed.

Other Wildlife Habitat

For other less abundant wildlife species in the Oldman River area such as raptors, waterfowl and marmots, a modelling approach to estimating habitat losses was not possible nor warranted. As a result, opportunities for habitat creation and enhancement for these groups were investigated in a more opportunistic fashion. It is known that six active prairie falcon eyries, two marmot colonies, some marginal waterfowl habitat, nesting sites for Canada geese, and riparian habitat for ungulates and furbearers will be affected by the dam. As mentioned earlier, specialized habitat projects have also been identified as part of the mitigation plan to benefit most of these species.

METHODS OF CREATING AND ENHANCING WILDLIFE HABITAT

In developing the Wildlife Habitat Mitigation Plan, three major types of mitigation were considered:

- habitat protection
- habitat enhancement, and
- habitat creation

Habitat Protection

As the first step in the mitigation plan, areas of important habitat that would remain after flooding were designated as candidate sites for habitat protection. For example, coulee areas and adjacent shrub communities are important overwintering habitats for mule deer in the Oldman region. However, these same sites are commonly used by cattle as a ready source of water and/or protection from the wind, and without careful management, cattle can destroy or severely reduce the value of coulee habitats for wildlife. Overuse by cattle also prevents regeneration of native trees and shrubs through suckering and reseeding.

Because native tree and shrub cover, particularly thick stands of Douglas fir or dense chokecherry and saskatoon shrublands, offer good winter cover for wildlife, a number of blocks of tree and shrub cover along the reservoir edge have been retained for wildlife projects. In most cases, permanent title or easements for the property have been obtained, and barb wire fences have been or will be constructed to control cattle access. In some areas, cattle use can be permitted on a seasonal basis, but in areas with erosion prone soils or sensitive plant cover, permanent habitat protection will be necessary.

Habitat Enhancement

Five types of habitat enhancement measures were considered for the Oldman River area:

- Range Management
  In areas of native or seeded pasture where cattle and wildlife can jointly benefit from common use of range, two- and four-pasture rest-rotational grazing systems will be implemented to improve range conditions for cattle and wildlife. Such systems help maintain vigorous native pasture while also improving overwinter root stocks of grasses and forbs, and protecting native tree and shrub cover.

- Supplementary Tree and Shrub Plantings
  In coulees and sloped areas that have been heavily grazed or eroded, tree and shrub cover is often in poor condition, with little or no natural replacement with young vigorous plants. Long, irregularly-shaped groupings of tree and shrub seedlings will be planted along local land contours to help re-establish plant cover, as well as improve the buildup of snow over winter. Plantings of trees and shrubs along some coulee breaks will also hasten encroachment by native trees and shrubs up the coulee slope.

  Although commercially available species such as Northwest Poplar may be used to provide some immediate cover, a variety of native species of trees and shrubs are being propagated in nurseries for use by 1990 - 1992.

Species which are now being propagated include cottonwoods, trembling aspen, Douglas fir, limber pine, chokecherry, saskatoon, hawthorne and sandbar willow

- Grass Re-seeding
  In areas where ground covers have been damaged by erosion or severely overgrazed, re-seeding and fertilization of ground covers will be used to quicken the recovery of range. Selected areas of native grasslands will be fertilized and irrigated during spring to summer 1989, and if sufficient native seed is produced, portions of these pastures may be harvested at specific intervals throughout the growing season to obtain a mulch (containing native seed) for use in small disturbed sites and in the vicinity of wildlife projects.

- Wetland Enhancement
  There are several natural wetlands in the Oldman area that, due to the natural drought conditions, are completely or nearly dry. Due to the lack of water, emergent aquatic plants and the shrub fringe are either lacking or in poor condition. Water supplies for these wetlands will be improved through establishment of shelterbelts and snowfences that increase the buildup of snowdrifts overwinter. Water pumps, including wind or solar driven pumps, may also be used to pump water from the reservoir or from nearby checkdams.

- Enhancement of Nesting Cliffs for Prairie Falcons
  Previous surveys in the Oldman River region by Environmental Management Associates have identified active prairie falcon nests within the reservoir area, as well as several potential new cliff sites where nests can be relocated. Suitable sandstone, mudstone and consolidated sand formations outside of the reservoir will be modified using selective blasting techniques, prying of loose rock and/or sand blasting to create nesting cavities for prairie falcons, and nesting ledges for Feruginous hawks and Canada geese.

Habitat Creation

Seven methods of creating wildlife habitat were considered for the wildlife mitigation plan:

- New Riparian Habitat
  Under the anticipated operating regime for the Oldman River project, several areas in the upstream limits of the reservoir will be flooded with 0.5 - 1.5 m of water for a 2-4 week period each spring. Because this flooding is similar to the spring freshet, it may be possible to establish riparian shrub and tree communities and sedge meadows in these sites. In several instances, development of these areas will require low dikes to control the amount and duration of flooding.

  Excess fill material from the construction of new road links around the reservoir will also be used to create benches and wetlands around the reservoir. At full supply level, water in the reservoir will shallowly flood these benches and wetlands.

  Several subspecies of native cottonwoods and sandbar willow are now being propagated for planting in these sites during 1990 and 1991.

- Upland Shrublands and Aspen Groves

  Following flooding of the reservoir, several protected slopes and benches in the three valleys will be retained that are suitable sites for development of upland cover. Dense, irregularly-shaped groupings of native species (e.g., trembling aspen, chokecherry, saskatoon) will be planted in several areas to provide pockets of upland cover around the reservoir. Checkdams will be constructed near many of these sites to provide a water source for subsurface irrigation of the seedlings during initial establishment.

  In several of the borrow pits associated with dam construction, the final pits will be recontoured to create a knob and kettle terrain which, in turn, will provide many areas where upland tree and shrub cover can be established. The rough terrain will also provide physical protection for wildlife, as well as wet depressional sites.

- Contour Plantings of Trees and Shrubs

  Contour plantings of tree and shrubs will be established in a number of exposed areas where wildlife will require movement corridors or protection from the wind. These linear plantings, consisting of native trees and shrubs, will follow local contours and be irregularly shape to take advantage of better growing conditions in bowl-shaped depressions or on north facing slopes. Snow fences will also be used in some sites to help improve the build-up of drifting snow. Regular watering of the seedlings, likely employing a subsurface irrigation system, has been recommended for the first 3-5 years to promote rapid establishment of the seedlings.

- Check Dam Ponds

  Check dams will be used to create small wetland areas in exposed sites around the reservoir that, in turn, provide small pockets suitable for tree and shrub plantings. Several local contractors have successfully constructed and operated check dams for cattle use, and several of these check dams now provide tree and shrub cover and water sources for wildlife. Check dam ponds for wildlife will have shallow shoreline profiles to provide areas for growth of emergent aquatic plants, sedges and shrubs, as well as a deep central water area to ensure a water supply over summer. Shelterbelts and snowfencing will also be used to improve snow catchment.

- Wetland Creation

  In several of the proposed riparian development areas on the Castle, Crowsnest and Oldman rivers, as well as on several terraces adjacent to the reservoir, inflow of water from the reservoir at full supply level will permit regular reflooding of shallow depressions that will be developed as new wetland basins.

  New wetlands will also be created in several shallow depressions in upland areas. Deeper basins have or will be excavated using heavy equipment. Water supplies will be provided from snow catchment and runoff, and in several cases, will be augmented by pumping water from the reservoir. Where adequate space is available in a wetland, earthen nesting islands for waterfowl have or will be constructed.

- New Nesting Habitats

  Flooding of several elevated outcrops along the Castle and Oldman Rivers may create suitable nesting islands for Canada geese. Construction of log

nest cribs will be used on these islands to provide protected nesting sites. One of these islands may also provide an area for deer fawning.

Small earthen nesting islands have or will be constructed in several of the natural and newly-created wetlands around the reservoir. During 1988, two islands were constructed of compacted till. Both islands will be seeded with a grass and legume seed mix in spring 1989 to provide future nesting cover for waterfowl.

- Rockpiles
  Two yellow bellied marmot colonies will be flooded by the Oldman reservoir (Young et al. 1986), and locations for transplanting of these animals have been identified. One is a natural rock outcrop with suitable shrub cover and will require little or no modification. The other will require the building of a small rockpile as a burrow site for the marmots.

A CONCEPTUAL PLAN FOR WILDLIFE HABITAT MITIGATION

The primary goals of the Wildlife Habitat Mitigation Plan will be to provide core areas of cover and food for mule deer and other shrub and tree-associated wildlife, as well as movement corridors along the reservoir edge. To benefit other wildlife groups, the plan also includes the enhancement and creation of wetlands and check dams to benefit water-associated wildlife, and to provide better growing conditions for transplanted trees and shrubs. Special structures such as rockpiles for marmots and cliff enhancement for relocation of prairie falcon nests have also been incorporated in the plan.

Selection of mitigation projects to protect and enhance existing areas of critical wildlife habitat, to enhance existing poor quality areas of wildlife habitat, and to create new wildlife habitat were based on several important criteria:

- *Land Ownership*: Wherever possible, wildlife projects were located on Crown land with low agricultural capability.

- *Distribution of Projects*: To ensure a good distribution of potential mitigation projects throughout the Oldman, Crowsnest and Castle river areas, small and large scale habitat projects were identified in the upstream and downstream areas from the reservoir, as well as in most areas around the reservoir.

- *Compatibility with Existing Habitat*: Habitat enhancement and creation projects were designed to complement existing blocks of important food and cover for wildlife. Development of habitat blocks or movement corridors was also avoided in the vicinity of grain or forage crops.

- *Diversity of Wildlife Needs*: In order to benefit as wide a range of wildlife as possible, while still providing alternate habitat for mule deer, mitigation projects for land-associated and water-associated wildlife were considered.

- *Distance to Other Habitat Areas*: Because mule deer are reluctant to travel long distances away from plant cover or physical cover such as bluffs, blocks of habitat were generally located no more than 1.6 km (1.0 mile) from the next nearest habitat area.

- *Suitability for Tree and Shrub Plantings*: Sites suitable for planting of trees and shrubs (for example, moist northern slopes and bottomlands) were preferred over highly exposed sites where planting success would be questionable.

- *Suitability for Construction of Check Dams*: Good soil moisture is essential to the survival of trees and shrubs in exposed locations in the Oldman region. In exposed areas where tree and shrub cover is required, shallow basin areas that are suitable for construction of check dams were preferred project sites.

As mentioned above, the concept plan is based on a need to first provide core areas of cover and food habitat, and then to provide connecting movement corridors between these sites. Other special habitat types such as wetlands, marmot habitat and nesting cliffs were then provided where opportunities for habitat enhancement or creation were possible.

At present, a total of 65 wildlife habitat projects have been initiated or are planned, ranging in size from less than one ha to over 200 ha in size. Engineering drawings are being prepared for all checkdams, dikes and other water-related structures. Landplan drawings, specifying the location of tree and shrub planting areas, species compositions, wetland modifications, reseeding requirements, etc. will also be prepared for each of the 65 sites. In addition, cliff modifications for raptor and Canada geese nesting sites are being planned for implementation in fall 1988. Dam construction activities and reclamation of construction sites and borrow areas during 1990-1992 are likely to provide additional opportunities for wildlife habitat mitigation.

Implementation of the Mitigation Plan

Early in the construction phase of the project, it was recognized that immediate implementation of the wildlife mitigation program was necessary to ensure completion of construction and revegetation tasks by the end of the dam construction period. This early start allowed:

1. Testing of methods, materials and contractors in various habitat enhancement and reclamation techniques;

2. Integration with land purchasing functions to permit acquisition (or retention) of a sufficient land base to allow development of the mitigation plan according to biological requirements, not land ownership.

3. Taking advantage of opportunities revealed early in the construction schedule such as borrow pit reclamation, haul road design, reservoir clearing guidelines, fencing coordination and disposal of surplus materials (e.g, topsoil, overburden).

The Mitigation Plan was projected over a five year construction schedule (1987 - 1991) to allow most project construction and revegetation activities to be completed by the time of filling of the reservoir in 1991. The following briefly outlines the Mitigation Project Schedule:

1987
- Initiate test program at the Glass Property
- Undertake a preliminary land base assessment (e.g., title, leases, reservations.
- Complete assessment of potential habitat mitigation projects

1988
- Continue test program at the Glass Property
- Select preferred mitigation projects and develop Mitigation Plan
- Complete the assembly of a land base for the Mitigation Plan
- Complete design phase for construction and revegetation
- Begin propagation of native trees and shrubs
- Commence reservoir boundary fencing
- Modify suitable cliffs for raptor nesting sites

1989
- Monitor habitat program at the Glass Property
- Complete the fencing program for habitat protection sites and reservoir
- Construct checkdams and wetlands for most mitigation projects (as land availability permits)
- Establish snow fencing in some tree and shrub planting areas (as land availability permits)

1990
- Complete construction of all checkdams and wetlands
- Initiate planting of native trees and shrubs
- Install emitter irrigation system in required sites
- Prepare habitat designs for borrow pit reclamation
- Monitor vegetation and structure performance on mitigation projects as well as use of projects by wildlife

1991
- Complete plantings of native trees and shrubs
- Implement habitat reclamation programs for borrow pits and other project sites (as required)
- Monitor vegetation and structure performance on mitigation projects as well as use of projects by wildlife

The Glass Project - An Example Habitat Project

Prior to the completion of the Wildlife Habitat Mitigation Plan, a comprehensive wildlife habitat development program was initiated on a 200 ha parcel of land immediately adjacent to the dam construction site. Referred to as the Glass Property, it is comprised of approximately 150 ha of previously cultivated land and 50 ha of native pasture. As a result of recent poor land management, 120 ha of the cultivated land has been subjected to extensive wind erosion. A series of well-established shelterbelts, running east-west and north-south, divide the northern third of the area into four distinct blocks. Two major coulee systems occur in the southern third of the property (Figure 2). Three natural wetland depressions are located in the west-central portion of the property, but because of the extended drought in the Oldman region, have been completely dry for at least the past two years.

Due to the proximity to the dam, all of the glass property will be permanently held by the Crown. Because of the land tenure, the need to restabilize eroding soils, and the existence of natural wetland basins and coulees, the Glass Property provided an excellent opportunity to integrate and test several wildlife habitat mitigation measures.

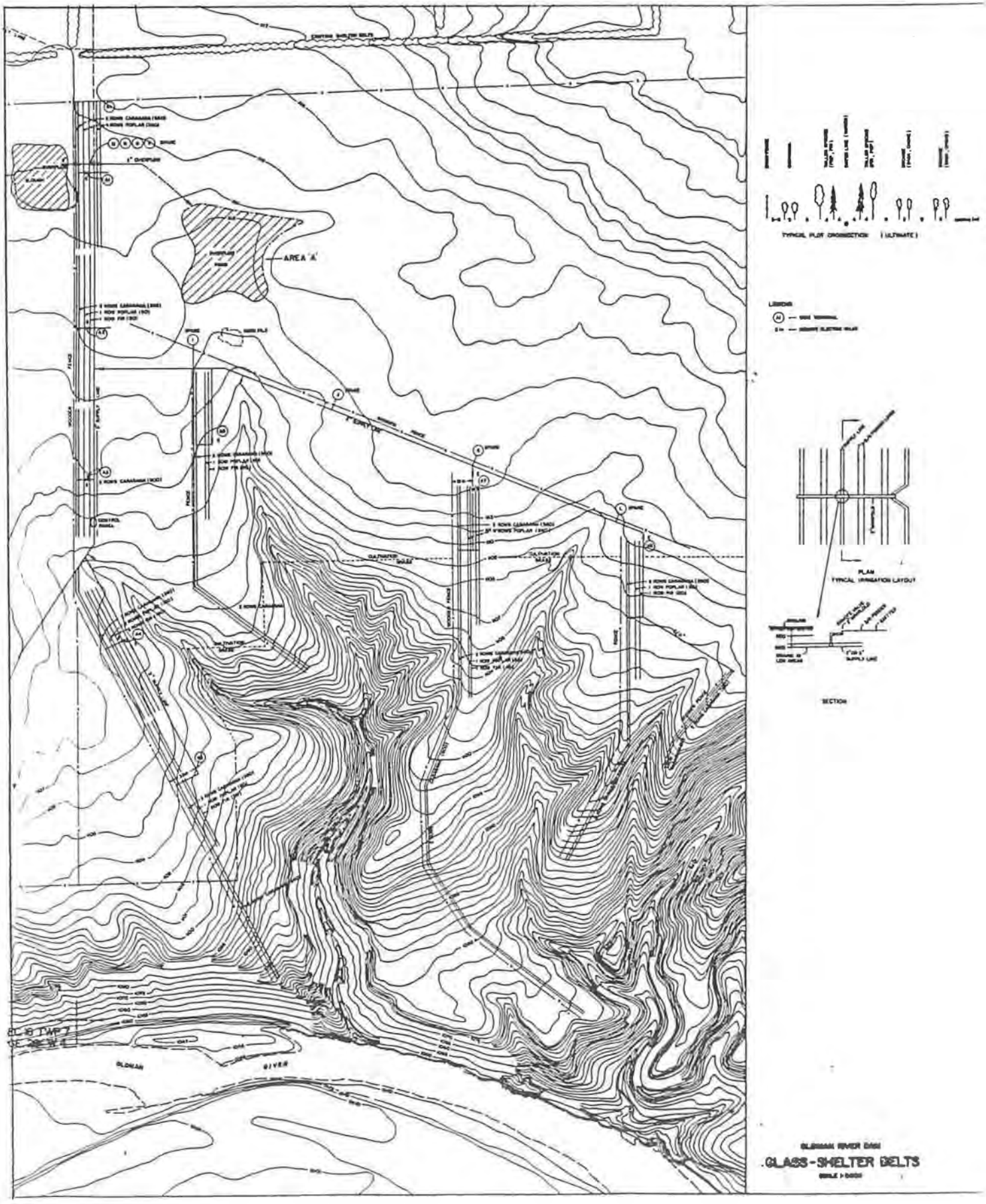

AREA 'A'
PLAN
TYPICAL IRRIGATION LAYOUT
SECTION
GLASS-SHELTER DELTS

Figure 2

Water was considered to be the limiting factor in the initial establishment of tree and shrub cover on the property. Based on the previous experience of local landowners in establishing shelterbelts in similar exposed sites, it is essential that young trees and shrubs receive adequate moisture for a period of at least 3-5 years. Although tree and shrub plantings on the Glass Property were located on north-facing slopes, protected coulees and the lee side of snow fences when ever possible, direct watering of seedlings by subsurface emitter irrigation tubing was employed throughout most of the planting areas. Subsurface irrigation was chosen over truck watering because it is more cost effective, allows seedlings to receive larger volumes of water, permits watering of seedlings on slopes, in the right circumstances can be fully automated, and in light of its lower operating cost, is less susceptible to budget restrictions over the long term.

Construction of the prototype irrigation system began in fall 1987 and was completed in summer 1988. The system is comprised of a 15 HP electric pump to deliver water through a 8 cm diameter PVC pipe to a central control system on the Glass Project, and a network of water lines, control valves and 20 km of subsurface emitter tubing to provide a maximum of 0.5 - 2.0 gal./hr to each individual or pair of tree and shrub seedlings. The central control system is a mechanical timer that operates the control valves on specific water lines, and permits specific units of the irrigation system to be turned off and on in specific sequences over a 24 hour period. The exact duration and sequence of watering will be determined through trial and error during the August - early October period.

In other mitigation projects, we are proposing to use a combination emitter irrigation tubing and checkdams to provide an initial water source for seedlings.

The site was planted with commercial tree species: Northwest poplar, caragana, blue spruce, white spruce and willow. In addition, small native Douglas firs were moved from within the reservoir area to the Glass site to determine their success at transplanting and growing in a different aspect. Tree and shrub seedlings have been and will be planted in different configurations (contour plantings, straight rows, irregular groupings) to provide a diversity of cover and to assess the wind revetment characteristics of snowfencing (which has been erected close to most of the planting areas). The caragana and willow seedlings were spaced at 1 m, the Northwest poplar at 2 m and the blue spruce, white spruce and Douglas fir at 3 m. Rows of seedlings were generally spaced at 4 m or 8 m. A total of 27,000 seedlings have been planted to date. Of this total, approximately 17,000 seedlings will be moved to other sites around the reservoir (on an as-need basis). Native trees and shrubs will then be used to infill-plant in some locations on the Glass Property.

The Glass Property contains two natural wetlands, and two additional wetlands have been constructed in shallow depressions. Bulrushes were transplant as plugs from the reservoir area to one of the constructed wetlands to determine the success of this method. All four wetlands are now being filled from the pumping system, but the option exists to fill the wetlands, as required, by gravity from the reservoir. Snow entrapment by the snowfences and trees/shrubs will also provide a water source in the spring. Earthen islands for waterfowl nesting have now been constructed in two of the wetlands (one natural, one constructed).

The entire site was recently planted with a mix of agronomic grasses and legumes under a winter wheat cover. The mix is comprised of rough fescue, sheeps fescue, western wheatgrass, streambank wheatgrass, alfalfa, and sweet clover.

Snowfencing has been used extensively (4.0 km in total) on the Glass Property to reduce the drying effects of wind on young seedlings, and to aid in the trapping of snow to improve soil moisture conditions in the spring and early summer. As the trees and shrubs become better established, they will further improve snow retention.

MONITORING OF MITIGATION PROJECTS

Following completion of the wildlife habitat mitigation projects, Alberta Environment and Alberta Fish and Wildlife Division have suggested that a monitoring study be undertaken to assess wildlife use of the mitigation projects, and the value of the mitigation projects in replacing lost habitat. A monitoring study would also be useful in evaluating the success of specific techniques and identifying necessary modifications for future project implementation. Details of a monitoring program for the Wildlife Habitat Mitigation Plan have not yet been finalized.

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TABLE OF CONTENTS

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