THE UNIVERSITY OF MANITOBA

METHODS AND GUIDELINES FOR MANAGING WATER IN THE LANDSCAPE: a Demonstration Project

BY

JANICE M. TALBOT

A PRACTICUM

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

MASTER OF LANDSCAPE ARCHITECTURE

FACULTY OF ARCHITECTURE
DEPARTMENT OF LANDSCAPE ARCHITECTURE
THE UNIVERSITY OF MANITOBA
WINNIPEG, MANITOBA

January, 1996

THE UNIVERSITY OF MANITOBA

FACUTY OF GRADUATE STUDIES

COPYRIGHT PERMISSION

METHODS AND GUIDELINES FOR MANAGING WATER IN THE LANDSCAPE: A DEMONSTRATION PROJECT

BY

JANICE M. TALBOT

A Thesis/Practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements for the degree of

MASTER OF LANDSCAPE ARCHITECTURE

ABSTRACT

Wise water management is an important and timely issue requiring input and knowledge from the landscape architecture profession. Issues such as drought, contamination, and diminishing water resources provide the reasons to increase the knowledge on the subject. Managing water in the landscape, in the context of this project is defined as *the act or manner of managing, handling, directing or controlling water that falls on the landscape or is added through irrigation methods*. This practicum project provides a number of methods and guidelines aimed at managing landscape water, and demonstrates their application by applying the ideas to a demonstration site.

The conceptual design for the demonstration site divides or "de-constructs" the site into nine zones, and represents a meshing together of traditional design elements with water management methods such as turf area reduction, vegetation that can withstand water stress, and water redirection in order to demonstrate a design concept that works towards managing water. The project compares the existing maintenance costs with costs that may be incurred when a number of water management methods are incorporated. It was found that the conceptual design would be slightly more costly to maintain than the existing design. However, it is important to focus on the benefits of managing landscape water such as the opportunity to use the existing water for plant growth, augmenting or replacing the need for additional manual irrigation, redirection of water to the groundwater, the overall benefit to the environment, and potential opportunities to educate park users to the benefits of water management. As well, the proposed design provides a more aesthetically pleasing environment.

The author acknowledges that further testing and analysis would be useful to assess detailed cost savings, and recommends further demonstration project which apply water management methods to site design.

ACKNOWLEDGMENTS

I would like to begin by extending my gratitude and thanks to my practicum committee starting with Professor Charlie Thomsen for his assistance from project inception to conclusion, Dr. Bill Remphrey for his practical knowledge, editing skills, and useful scientific outlook, Professor Carl R. Nelson Jr., and last, but not least, retired Professor Hugh Knowles for his critical review of the project and assistance from the beginning.

Thank you to the City of Edmonton Parks and Recreation and Planning and Development Departments for base mapping and information on the Parks Maintenance Management System. As well, thank you to John Konwicki, Department of Renewable Resources (formerly Department of Soil Science), University of Alberta, for completing the soil tests.

I would also like to thank to my family for their support and encouragement during this project. I would like to welcome Barbara and Alexandra to the family.

I would like to sincerely thank Dippan Shukle for his constant support, understanding and encouragement throughout the project, and the many friends who believed in me.

Remembering always D.T. (Cody) for his strength, good listening ability, and friendship - You'll always be with me.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF DRAWINGS

LIST OF TABLES

APPENDICES TABLES

1.0 PROJECT OVERVIEW

1.1 INTRODUCTION

> ***Water is essential to life...it is therefore essential that we learn and practice the fundamentals of water conservation.***[1]

Managing water in the landscape for its best use and subsequent conservation is an important and timely issue. When discussions arise regarding the application and use of landscape water some people continue to think of water as a free commodity - a virtually limitless resource. However, many agree the resource needs to be managed, protected and conserved, but may question what can be done. This practicum presents an information source that begins to answer this question, and in the process demonstrate ways to better manage landscape water.

To manage landscape water, that is the natural precipitation on a site, requires a wide knowledge base of methods and guidelines that provide direction and guidance for responsibly handling the resource. Managing landscape water may be defined as *the act or manner of managing, handling, directing or controlling the water that falls on the landscape or water that is added to the landscape through irrigation methods. Managing landscape water in the landscape requires skills in managing or directing water using the best judgment possible.*

[1] Thomsen, C. 1993. "Water Conservation and the Prairie Landscape". The Prairie Garden.

1.2 GOAL AND OBJECTIVES

The goal of the practicum project is *to provide information to assist in more effectively managing water on-site, and demonstrate the application of this information to an existing site.*

The objectives of the project are to:

1. ***educate and introduce*** *landscape architecture students and professionals, municipalities, and those interested in managing, conserving and protecting the water resource to the ever-increasing knowledge base on water management;*

2. ***identify and recommend*** *water management methods and guidelines to follow and implement when working with on-site water;*

3. ***demonstrate*** *how the methods and guidelines may be applied to an existing site;* and

4. ***analyze*** *the effectiveness of applying the proposed water management methods and guidelines to a specific site.*

1.3 PROJECT METHODOLOGY

1. Pertinent issues relating to water management were researched and documented in three support studies. The first reviewed current literature on water management. The second researched plant material considered by experts to have a certain degree of water stress tolerance (see Appendix 1). The third examined methods to manage water, many of which are outlined in Chapter Two.

2. A set of Water Management Guidelines was derived using the format and information from the *Xeriscape Gardening* principles (see Chapter 3).

3. A community park in Edmonton, Alberta, was chosen to demonstrate the application of a number of the water management methods.

4. Inventory information and current maintenance practices for the demonstration site were obtained from the City of Edmonton Planning and Development and Parks and Recreation Departments. The inventory information is illustrated on a number of drawings including **Built Structures**, **Surrounding Land Uses**, **Hydrology**, **Topography**, **Slope Analysis, Existing Vegetation**, and **Location of Soil Tests**.

5. Site constraints and opportunities for managing landscape water within the demonstration site were analyzed and summarized on the **Synthesis** drawing.

6. The conceptual design of the site discussed and illustrated on the Concept Plan.

7. The site was "de-constructed" into nine zones according to existing use, potential water regimes, and the opportunities for educating site visitors. The de-construction is illustrated on the **Site Zoning** drawing

8. An analysis was carried out to compare the maintenance of the proposed water management design with the existing maintenance regime carried out by the Edmonton Parks and Recreation Department.

9. Finally, the management methods, guidelines and findings, as applied to the demonstration site, are summarized and documented into report form.

2.0 LITERATURE REVIEW

Six subjects comprise the literature review, each of which describes a specific aspect of water management. The first, **2.1 Managing Water - The Local and Global Reasons** outlines reasons why managing water is becoming an important aspect of site design. The second **2.2** ***Xeriscape Gardening*** discusses a series of principles that may be utilized when working with on-site water. **2.3 Site Planning and Design** as the third topic, identifies the basic principles of assessing and planning a site in order to manage water. **2.4 Plant Selection,** discusses the importance of choosing plant material with a high tolerance to water stress as a method to manage, work with and utilize natural precipitation. The fifth topic, **2.5 Managing On-Site Water**, describes management methods such as dry wells, dutch drains, and downspout collection systems. The final topic, **2.6 Site Maintenance**, explores maintenance strategies and techniques which can be incorporated to better manage landscape water.

2.1 MANAGING WATER - THE LOCAL AND GLOBAL REASONS

> ***It's not difficult to see that water is the lifeline of the nation; our very existence depends on it. So it is vital to conserve water, find ways of replacing it,... and try not to pollute the water we do have.***[2]

Many reasons exist at both local and global levels that call for governments, landscape architects, designers, and individuals interested in working with water to be cognizant of the importance of managing the resource. Media and written sources discuss issues

---

[2] Addkison, R. and D. Sellick, 1983. Running Dry - How to Conserve Water Indoors and Out. New York, NY. Stein and Day.

that affect water availability such as global warming, pollution, contamination, and droughts. Speculation is that the greenhouse effect and global warming may result in decreasing amounts of water. As temperatures rise and noticeable shifts in climatic patterns emerge, some areas may experience less rainfall and warmer temperatures. Other predictions include potential coastal area flooding and less water entering drainage basins. Some experts believe that changes to the amount of available water is currently happening and cite Africa as an example of increasing temperatures and ever-decreasing amounts of water (The World Commission on Environment and Development, 1987). Contamination of water may occur from chemically saturated runoff from agricultural fields, golf courses, and residential yards, all of which threaten water quality. Another potential source of contamination is the disposal of raw sewage directly into nearby surface water bodies. The Canadian media in 1992 estimated that, at that time, approximately a third of all Canadian communities were disposing of raw sewage in this manner (CBC news report).

Many countries experience difficulties supplying their citizens with potable water. In some countries, such as the United States, residents of some states live with water rationing as a way of life (The World Commission on Environment and Development, 1987). Luckily, in Canada, water is abundant, but many people use water from the tap without much thought of it origins, potential realities of water pollution, contamination, water shortages, or droughts. In the late 1980's, with 1988 being a significant year, decreasing amounts of water resulted in droughty conditions in areas of the prairie provinces. In municipalities, such as the City of Edmonton, a potential water shortage for the summer of 1994 was anticipated. In response, the City instituted an "odd/even" system for lawn watering correlated to civic addresses. This water rationing continued on into the summer of 1995 and is anticipated to be recommended for summers to come.

If the potential for water contamination, shortages and droughts is not enough to heighten society's awareness and responsibility to manage water, one aspect - *the cost of purchasing water* - usually does. Generally, in the summer months, water consumption increases with approximately 50% of this water used for lawns and gardens (University of Saskatchewan, 1992). During the "drought of 1988" the University of Saskatchewan (1992) estimated that nearly 75% of the water consumed during that summer was utilized for garden and lawn watering. The initial cost to purchase treated water, which is used for outdoor watering is substantial for most home owners and municipalities. The cost for a lush green landscape is even higher given that most storm water systems direct the treated water used for landscape watering back into the sewer system where it is processed and treated again.

Responsible water management then requires an understanding of the reasons for managing water, including being cognizant of future potential limitations of the resource due to the reasons discussed above, or municipality recommended programs aimed at managing and limiting the use of water. Once those responsible for managing and using water have a better understanding of the issues and management options available, the potential exists for managing the resource more effectively.

2.2 XERISCAPE GARDENING

Planning and carefully designing a site is important when dealing with managing landscape water. In current popular literature an approach referred to as *Xeriscape Gardening* provides a series of principles that when implemented together offer a holistic approach to managing and conserving landscape water. A brief discussion of *Xeriscape Gardening* is important at this point to ensure the reader fully understands the concept.

> ***Xeriscaping* is a holistic approach to wise water management that integrates all facets of landscape design.**[3]

The process of managing landscape water begins by looking at a site with an understanding of it as a whole unit. The term "*Xeriscape*" is a registered trademark of the National Xeriscape Council, which is a non-profit volunteer organization that promotes the integrity of *Xeriscape Gardening*. The first part of word "*Xeri*" comes from the Greek word "xeros" which means dry, and the term *Xeriscape Gardening* has come to mean quality, water efficient landscaping.

[3] Stroud, T. 1987. "Xeriscaping...xeri-what?" Ground Maintenance. pp. 74-82.

The intent of *Xeriscape Gardening* is presented in the following seven principles (Ellefson et al. 1992):

1. ***Site Planning and Design*** advocates understanding the physical site characteristics and undertaking a thorough site inventory including but not limited to existing vegetation, built structures and utilities, topography, hydrology, soils and existing uses. In *Xeriscape* landscapes, site design links together existing and intended uses while working at managing on-site water.

2. ***Soil Improvements*** advocates knowing soil characteristics and potentially improving the soil's water holding capability and absorption. Soil tests determine if amendments are required and what types should be added.

3. ***Practical Amounts of Turf*** recommends limiting the amount of turf appropriate for the use or activity. As turf tends to be the one of the highest water users in the landscape, limiting the amount will potentially reduce water requirements. However, in some instances such as playing fields, turf remains the best choice.

4. ***Selecting the Appropriate Plants*** is the fourth principle. Some plants utilize water more efficiently than others and survive better in dry conditions. These types of plants should be selected for *Xeriscape* designs.

5. ***Efficient Irrigation*** advocates well planned irrigation systems to meet the water requirements of on-site vegetation. Irrigation methods include but are not limited to hand watering, surface or underground soaker hoses, or automated systems.

6. ***Mulching*** recommends using a variety of mulch material to cover and cool the soil, reduce evaporation and weed growth, and lessen erosion. *Xeriscape* enthusiasts recommend both organic and inorganic types of mulches, depending on the desired results and/or site specific requirements.

7. ***Maintenance*** as the last principle, advocates working towards a landscape which requires a minimal amount of maintenance. As *Xeriscape* landscapes tend to be healthier, they require less pruning, weeding, fertilizing and watering.

2.3 SITE PLANNING AND DESIGN

Site planning and design has been described as being at either ends of a continuum where planning represents a general, long-range look at a site; design is detailed and specific. For water management designs, one goal is to plan and design the site to reduce overall water requirements and maintenance (Ellefson, Stephens and Welsh, 1992).

To work towards managing water, a design method referred to as "zoning" or "hydrozoning" is useful for water management designs (Ellefson, Stephens and Welsh, 1992; Thomsen, 1993; University of Saskatchewan, 1992). Zoning divides a site into a series of zones that locates plants with similar cultural requirements (i.e., water, sun, shade) together. When grouping plants, the more water stress tolerant plants should be placed on the prevailing wind in order to shelter less tolerant plants. Other physical design features may be incorporated into the zone design, such as wind breaks, in order to reduce evaporation, and prevent soil and plants from drying out (University of Saskatchewan, 1992).

Site grading may also be successfully utilized to trap water on-site rather than allowing it to run off-site and enter the stormwater system (Ellefson, Stephens and Welsh, 1992). Knowing existing topography, with low spots where water will drain provides opportunities for taking advantage of site water and replenishing groundwater. A site may be graded to better direct water to a location where it can be most useful such as planting beds or large expanses of turf.

2.4 PLANT SELECTION

Selecting plants that meet the design requirements and take advantage of and thrive on natural precipitation is important in managing landscape water. To assist in selection, knowing the meaning of Latin terms utilized in Botanic names, and plant physiological characteristics is useful.

2.4.1 Drought Physiology

Drought physiology can be defined as *"the study of the activities and life processes which occur in plants during periods of drought"*. The life processes affects a plant's ability to survive through times when water is not readily available. The cohesion-adhesion-tension theory is useful in explaining water movement within plants and the resulting water deficit damage. Water movement through plants is associated with transpiration, with water being absorbed by osmosis through the roots and transported via the xylem to every part of the plant. A water deficit gradient is established once water vapor is lost from leaves, which is passed on from cell to cell. If a water deficit exists in the leaf cell, the adjoining cell must provide a specific amount of water. This exchange of water continues until root cells receive the message that more water is required. The process results in the roots needing to absorb more moisture. As well, air pockets may form in the xylem cells with decreasing water uptake. This decreases the capillary action of water, drawing it from the roots to the stems and leaves, and eventually the cycle is broken. Once broken, it is very difficult to re-establish and drought stress results. If water is not available for an extended period of time, death progresses from cell to tissues, to the organs, and eventually the whole plant (Rankin, 1994).

Photosynthesis is affected by the reduction or removal of water. Cell composition is mostly water by which carbohydrates are transported through the sap which may plug the phloem cells. Without water, food movement is halted and the plant must rely on reserves. If healthy, the plant will have an abundance of reserves, allowing it to survive and replace loss of leaves.

Within the process of photosynthesis, chlorophyll acts as the catalyst in the chemical reaction. During times of drought, chlorophyll production is inhibited (Rankin, 1994). Respiration uses oxygen to break down carbohydrates to supply food for the plant. Water vapor is given off, but if photosynthesis is disrupted or decreased due to lack of water, respiration will be affected as well. Cell death occurs if respiration is greater than photosynthesis (Rankin, 1994).

The sum of these processes, metabolism, will vary with plant type. Some mesophytes and xerophytes have different and varying carbon dioxide use efficiency. For example, some true xerophytes (e.g. *Sempervivum* spp.) have metabolisms that allow them to open their stomata during the night, resulting in absorption of carbon dioxide which is stored until daylight. As well, metabolism processes such as enzyme activity and hormone production may alter during times of drought, as can cell division, resulting in decreases in leaf size and number (Rankin, 1994).

Physiological factors, both internal and external affect the rate of transpiration. External factors include the amount of radiant energy absorbed by the plant, temperature and relative humidity, atmospheric pressure, pollution and soil characteristics. Internal factors include size, position, and location of the leaves, as well as leaf anatomy (i.e., cuticle thickness, double epidermis, size and aperture of the stomata). Other internal factors include plant age and health, as well as its ability to retain water or transpire (Simpson, 1981). Table 2.1 outlines many of the mechanisms that aid in water stress tolerance, followed by the mode of action which makes it possible.

TABLE 2.1 - *PHYSIOLOGICAL CHARACTERISTICS FOR WATER STRESS-TOLERANCE*

MECHANISM	MODE OF ACTION
Improved Water Uptake	Extensive root system. Efficient root system.
Control of Transpirational Loss	Reduced leaf area. Cuticle changes to reduce water loss. Change in leaf configuration and hairiness. Reduction of stomatal numbers and size or sunken stomata. Control of stomatal aperture.
Water Storage in Plant Tissue	Stems, leaves, roots.

SOURCE: Simpson (1981)

2.4.2 Latin Names as Key to Water Stress Tolerance

Latin terms within Botanic nomenclature may be useful in selecting plants for water management designs (Taylor's Guide, 1990). Table 2.2 provides a list of characteristics that plants most often possess that can withstand water stress, and lists corresponding botanical nomenclature or Latin terms used to describe these conditions.

TABLE 2.2 - *CORRESPONDENCE -WATER STRESS AND BOTANICAL NAMES*

CHARACTERISTICS	BOTANICAL NOMENCLATURE
Hairy leaves	*tomentosum* *tomentosus* *pubescens* *villosus* *mollis*
Silvery leaves	*argentea*
White or gray bloom on the leaves	*glauca*
Coarse or stiff hairs	*hirsutata* *hirta* *hispida*
Long, narrow leaves	*angustifolia*
Thread-like leaves	*filamentosa*
Creeping or spreading	*repens* *reptans* *horizontalis* *patens* *procumbens* *divaricatus*
Meadow or field growing plants	*pratensis* *campestris*
Growing in sandy places	*arenaria* *arenarius*

SOURCE: Taylor's Guide (1990)

2.4.3 Plant Species With Water Stress Tolerance

Choosing plant species that possess some ability to withstand water stress can assist in managing landscape water as these plants survive and in many cases, thrive on the natural amount of rainfall without additional irrigation (Nehrling and Nehrling 1968; Williams, 1993; Currah, Smreciu and Van Dyk, 1983). A series of lists provided in Appendix 1 offer suggestions for plants with a greater water stress tolerance.

Choosing to reduce turf grass amount and replace it with other plant material is useful in managing landscape water. Grasses used most often on the Canadian prairies tend to be very high water consumers. Traditional "bluegrass lawn" requires approximately 18 gallons of water per square foot per growing season to thrive. A portion or all of a turf grass area may be replaced with native grasses and wildflowers, drought-tolerant shrubs or groundcovers, woodchips, or areas of gravel and boulders (Thomsen, 1993).

2.4.4 Native Plant Selection

Selecting native plants or those that have adapted to growing under the harsh conditions of the Canadian prairies also represent good choices for managing water. Using native plants in design tends to enhance the natural regional environment and provides a living geographical heritage. Use of native plants tends to reduce maintenance costs as these plants are adapted to growing in the specific climate and will not require such procedures such as covering in the fall or winter. Native plants have adapted to the varying and natural water regime, and tend to survive short-term drought conditions. Whatever plant material chosen, the aim is to manage on-site water by utilizing a series of informed choices.

2.5 MANAGING ON-SITE WATER

2.5.1 Weather Forecasts

Even in years of normal rainfall, it's wise to read weather forecasts. [4]

Watching weather forecasts is an age old method of working with and managing water. A heavy rain of 8-10 cm (3-4 inches) should sustain healthy plants for about 10 days. Being cognizant of potential precipitation is especially important when using automatic sprinkler systems which are programmed to start and turn off regardless of the amount of natural precipitation falling. If rain is forecast, manual irrigation systems should be shut off and natural rainfall utilized. Some systems are equipped with water sensors which detect a certain level of natural falling water and trigger the system to shut off, thus providing a good choice for better water management (Addkison and Sellick, 1983).

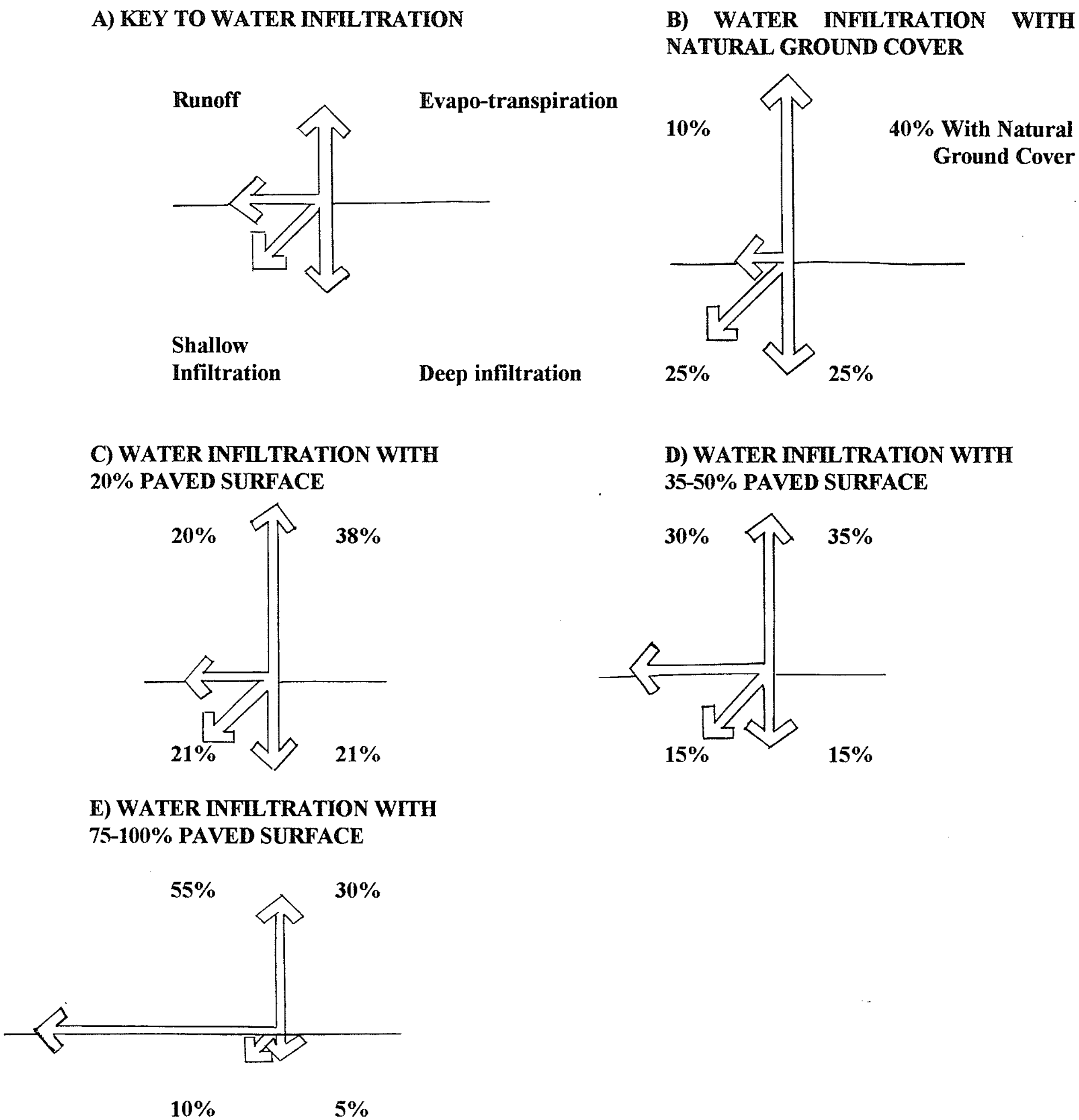
2.5.2 Water Infiltration

Catching and holding the water that falls naturally is an important step in managing water. The ground acts as a sponge allowing water to percolate into the groundwater

[4] Addkison R. and D. Sellick. 1983 Running Dry - How to Conserve Water Indoors and Out. New York, NY. Stein and Day.

system (Thomsen 1993). Figure 2.1 illustrates decreasing amounts of water absorption as paved areas are increased (Tourbier and Westmacott, 1981).

FIGURE 2.1 - *CHANGES IN WATER INFILTRATION WITH INCREASED AMOUNTS OF PAVED SURFACES*

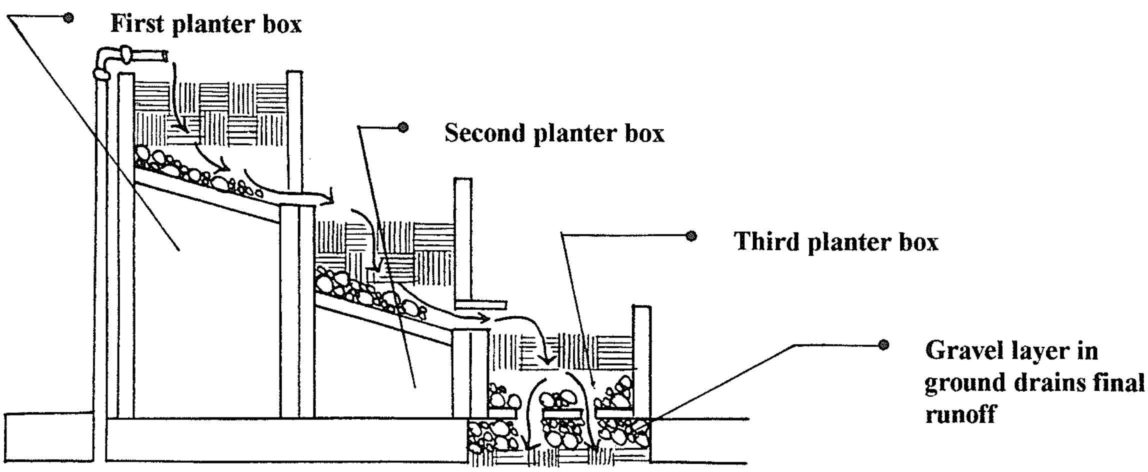


SOURCE: Tourbier and Westmacott, 1981

2.5.3 Stepped Planter Boxes

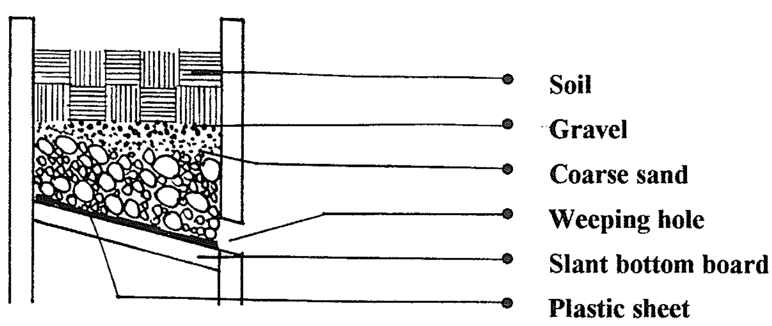
Stepped planter boxes offer an effective way to use and re-use landscape water. Water is channeled from the top box to the next box and through to the bottom planter box. which is designed with weep holes to assist in draining excess water. The water may be directed to an underground storage area composed of sand or gravel or distributed to other site locations. Figure 2.2 illustrates the planter box system. Figure 2.3 details the construction of an individual planter box.

FIGURE 2.2 - ***STEPPED PLANTER BOXES***



SOURCE: Addkison and Sellick, 1983 (figure not to scale)

FIGURE 2.3 - ***PLANTER DETAIL***



SOURCE: Addkison and Sellick, 1983 (figure not to scale)

2.5.4 Irrigation Systems and Components

A number of irrigation applications may be applied to site design, including pumps to redirect water, soaker systems, planter box irrigation, drip irrigation methods.

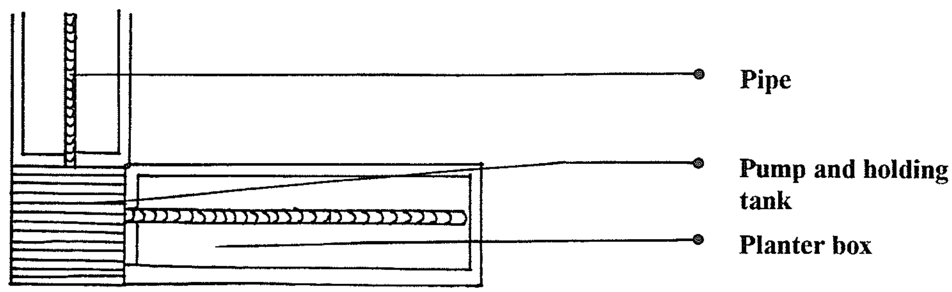
2.5.4.1 Pumps

To circulate and distribute water to areas of higher water needs, pumps may be incorporated into irrigation systems. Pumps and their accompanying systems need not be complicated or large in size. In actuality, pumps used in the landscape are usually quite small and require little space. Pumps may be attached to a garden hose complete with a built in filter, and be designed to suction water from a container down to a depth of 3.18 mm (1/8 inch) (Addkison and Sellick, 1983).

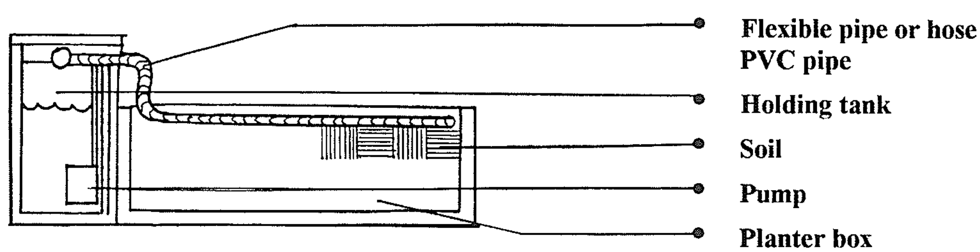
Recommended landscape pumps are stationary, self-priming, and submersibles. Stationary pumps are useful when watering only one area. Self-priming pumps supply complete systems, moving as much as 300 gallons of water in an hour, and are capable of watering numerous areas at once (Addkison and Sellick, 1983). Submersible pumps are used to direct water from gray or municipal water sources to holding tanks. Figure 2.4 details a pump and planter box in three parts. Part A) shows the location of a planter box and pumping system, which becomes a self-contained watering system. Part B) shows a detail of a hose; the pump connection is shown in part C).

FIGURE 2.4 - *PUMP WITHIN A PLANTER BOX*

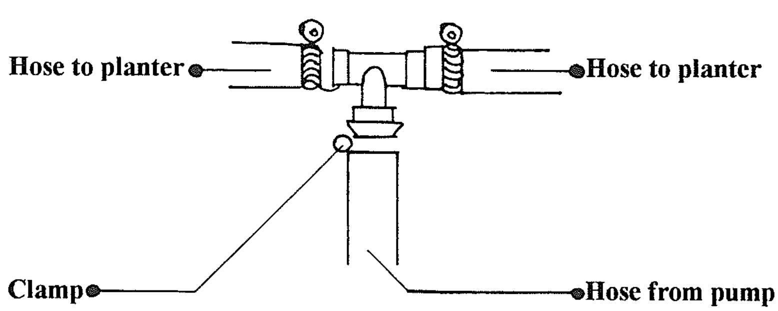
A) PLAN OF PLANTER BOX AND PUMP LOCATION



B) SECTION OF PLANTER BOX AND PUMPS



C) DETAIL OF HOSE AND PUMP CONNECTION

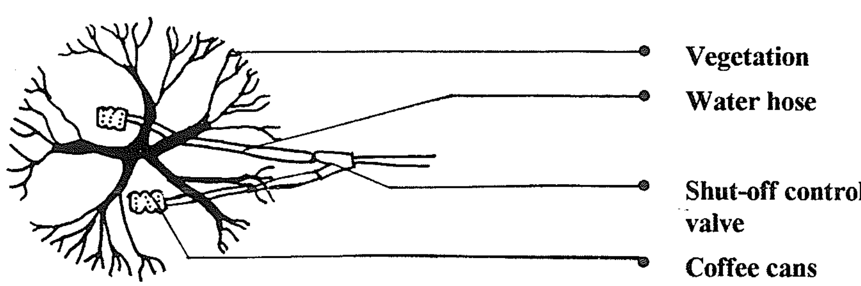


SOURCE: Addkison and Sellick, 1983 (figure not to scale)

2.5.4.2 Soaker System

Soaker systems are used to direct water to locations in the landscape where it can be the most useful, resulting in a more efficient use of the resource. Different types of water sources may be used with the soaker system such as municipal water supply or water collected from a drain pipe. Successful use of soaker systems will depend on the size of the area to be irrigated, however, due to their intricacy, these systems may be most effective at the residential scale of design. For residential applications where the home owner is able to clean out the system and watch for problems, common household recyclables such as a coffee can to make an effective soaker device for trees and shrubs (Addkison and Sellick 1983). The coffee can is attached to a water hose with a siamese shut off valve used to supply two separate soaker cans. Soakers are placed on the soil halfway between the trunk and the tree's drip line. Figure 2.5 illustrates a simple way of designing and applying a soaker irrigation using a coffee can.

FIGURE 2.5 - ***SOAKER IRRIGATION- Residential Application***



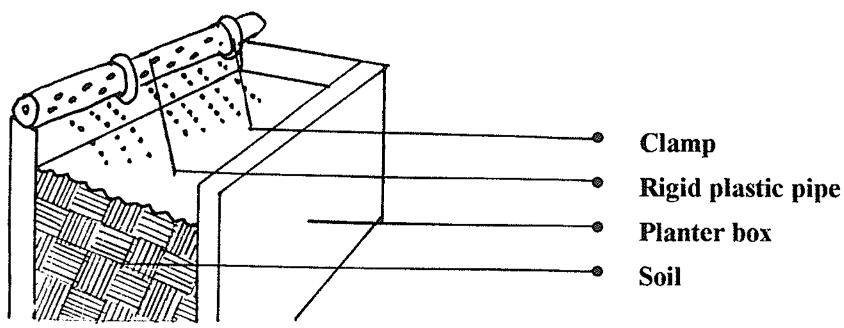
SOURCE: Addkison and Sellick, 1983 (figure not to scale)

2.5.4.3 Planter Box Irrigation

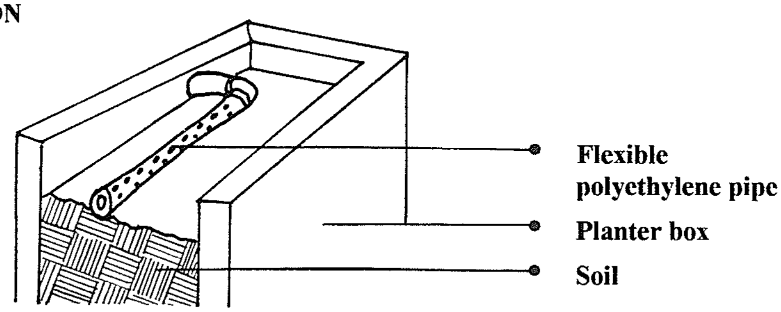
Planter box irrigation is a simple method of applying drip irrigation to planter boxes by attaching a sprinkler hose at one of three positions on the planter. As Figure 2.6 shows, A) is on the outer edge of the planter; B) is at soil level; and C) is under the soil surface. This system directs water to the location where it is most beneficial to plant material.

FIGURE 2.6 - *THREE METHODS OF PLANTER BOX IRRIGATION*

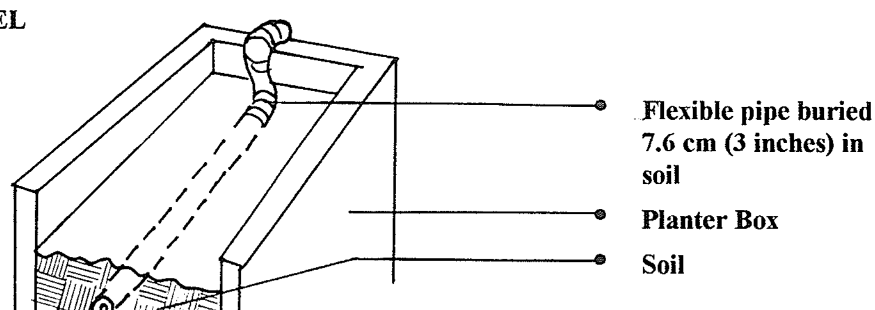
A) PIPE ATTACHED TO THE SIDE OF PLANTER



B) SOIL LEVEL IRRIGATION



C) BELOW SOIL LEVEL



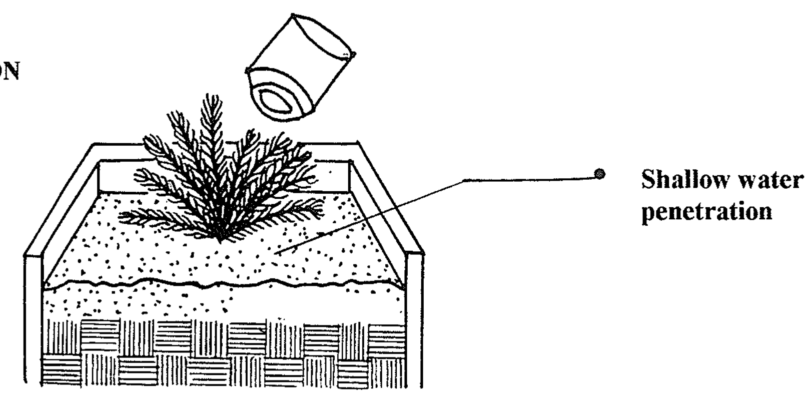
SOURCE: Addkison and Sellick, 1983 (figure not to scale)

2.5.4.4 Drip Irrigation

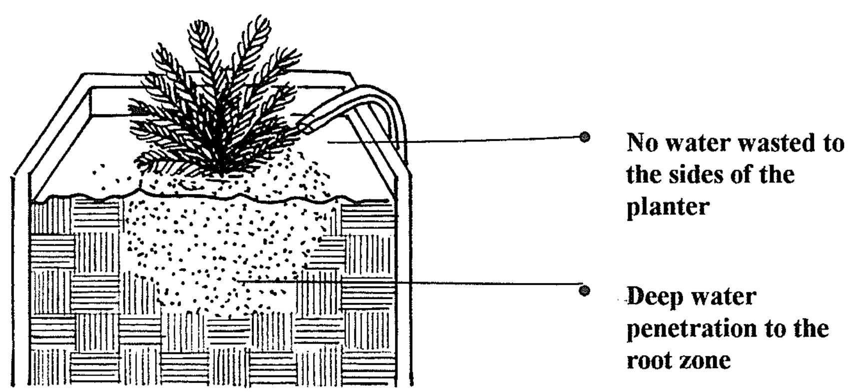
Drip irrigation is an efficient method of supplying water to plant roots where it can be best utilized. As Figure 2.7 A) illustrates, when water is applied in a flood irrigation method to the surface of the planter, the top portion of the soil becomes saturated, leaving the root zone potentially dry. Figure 2.7 B) illustrates potential water penetration with a drip irrigation system, supplying plant roots with the majority of available water.

FIGURE 2.7 - *FLOOD VERSUS DRIP IRRIGATION*

A) FLOOD IRRIGATION



B) DRIP IRRIGATION



SOURCE: Addkison and Sellick, 1983 (figure not to scale)

2.5.4.5 Use of Gray Water

Gray water has been used by gardeners in times of unpredictable summer rains or prolonged droughts to supplement traditional watering regimes, and has been used to compensate for undersized or malfunctioning septic tanks (Addkison and Sellick, 1983). Kourik (1995) discusses two studies which estimate the amount of gray water generated by households. The first study estimates between *52* and *65%* of the total water generated in the interior of houses may be utilized as a gray water source. However, the other study which assessed eight graywater systems, each with retrofitted plumbing in older housing, reported substantially lower number between *2.2* and *11%.* An explanation for the low numbers is that when retrofitting older houses and using existing gray water sources, such as a master bedroom bathtub or washing machine, costs may be prohibitive, resulting in the exclusion of these water sources ,and less available for landscape irrigation. If gray water is used, insufficient pressure to properly flush the system may result. This should be assessed by a plumbing expert before gray water sources are used for landscaping purposes. Landscape architects may wish to advise clients to only use gray water in new houses (Kourik, 1995).

When using gray water for irrigation purposes, water must not be allowed to stand overnight in the system or pool on the ground surface to reduce the potential health risk for disease. It is recommended that graywater be applied by underground drip irrigation systems to avoid potential problems. As a rule, gray water from dishwashers will include food particles, residue from soaps and detergents, as well as the possible human pathogens. Soaps and detergents usually contain sodium salts which can accumulate in the soil, damaging soil structure, killing soil bacteria and root hairs, and producing alkaline condition not conducive to most plant growth (Addkison and Sellick, 1983).

If gray water is used, and the use continues for some time, pH level should be checked. If pH is over 7.5, the soil may be overloaded with sodium. Gypsum may be added to the soil at a rate of two pounds per 30 square metres (per 100 square feet), per month (Addkison and Sellick, 1983). Fresh water applied to the soil will also help flush out excessive salts. Rain as well, will contribute to the leaching out of sodium ions. Fresh and gray water can be combined when irrigating to increase the length of time before build-up becomes a problem.

Utilizing gray water as a irrigation source may require lifestyle changes including the elimination of cleaning products containing chlorine bleach and boron. Powdered laundry detergents usually have sodium based fillers and additives, which should also be avoided if planning to use the washing machine as a gray water source. Biodegradable products may be a safer choice.

Some municipalities prohibit the reuse of water for health or other reasons and outline these restrictions in their plumbing code regulations (Addkison and Sellick, 1983). However, some governments such as the state of California, have legalized gray water use for landscape irrigation (Kourik, 1995). Knowledge of existing legislation and regulations governing the area in which the use of gray water is planned for landscape irrigation purposes is necessary.

2.5.4.6 Harvesting Water From Roof Downspouts

By all means take the time to catch rainwater. Few people realize that catching rainwater in a deluge is a difficult task; it falls too fast. But most rains are slow and steady so water can be salvaged by using some of the efficient methods detailed below.[5]

The water falling on roof tops, down the gutter and into downspouts may be a useful source of water for landscape irrigation. Downspouts may be disconnected from municipal sewer systems and the water redirected to the landscape. These ideas may be applied to new and existing buildings.

One advantage of managing water through redirection of rooftop water is the potential reduction of overloading conventional storm water systems, thus reducing flood peaks and floods downstream. In existing combined sewer

---

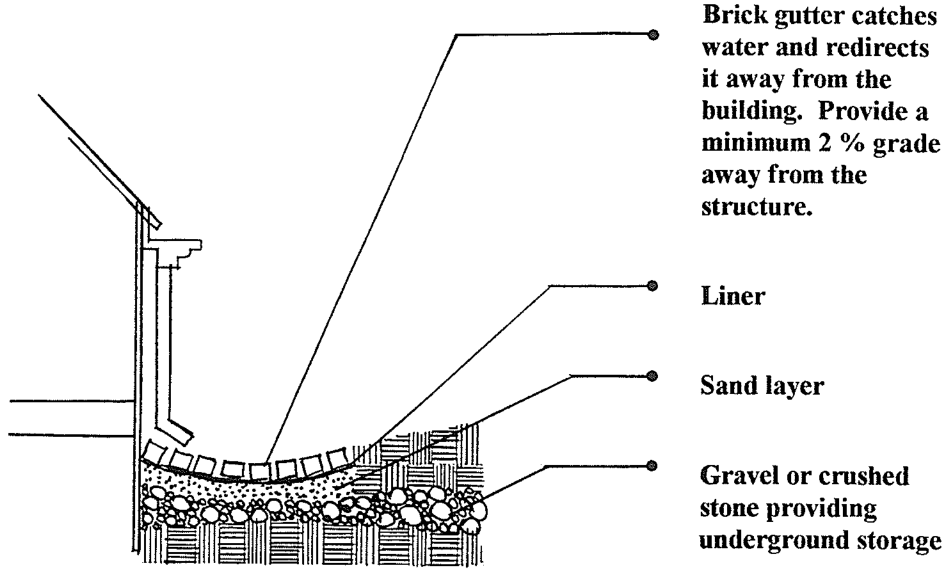
[5] Addkison R. and D. Sellick. 1983 Running Dry - How to Conserve Water Indoors and Out. New York, NY. Stein and Day.

systems, where sanitary and storm waters converge together, treatment costs will be reduced as less storm water is introduced into the system. Another advantage to disconnecting downspouts from sewer systems and redirecting water into the landscape is the potential for increased infiltration into the groundwater system (Tourbier and Westmacott, 1981).

A disadvantage of disconnecting downspouts from the sewer system is that increased amounts of above ground water could potentially cause erosion and flooding problems on-site or on adjacent properties. These potential problems have to be carefully dealt with at the detailed design stage. Another problem is potential seepage of water into basements if water is not properly directed away from buildings. In some cases, homeowners or municipalities may find costs too prohibitive to modify existing downspouts, especially if major changes are required to the existing roof or downspout system, or to existing landscaped areas (Tourbier and Westmacott, 1981). As well, many stormwater collections systems rely on the "flushing" action of runoff water to clear the system. If the system is not flushed out properly, it may become plugged with sediment or sewage.

To utilize rooftop water as an irrigation source, downspouts may be disconnected near ground level and connected to an elbow thus directing the discharge water to its intended location. The water can be discharged into an infiltration trench or seepage area, gravel-filled trenches, or directed through the use of a gutter, trench, or pipe to irrigate other areas of the site. As discussed above, ensure the redirected water does not drain into neighboring properties, or basements by incorporating a minimum 2 % grade away from buildings (Tourbier and Westmacott, 1981). Figure 2.8 shows a downspout collection system where water from the downspout is directed to a brick gutter swale which allows water to drain to an underground holding area, where the water then may seep into the surrounding ground.

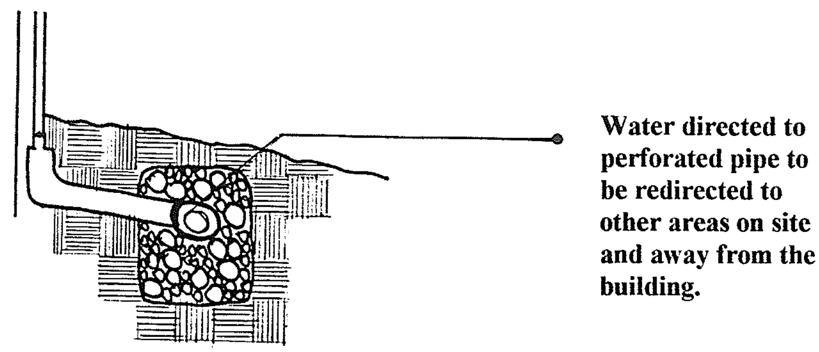
FIGURE 2.8 - ***TYPICAL DOWNSPOUT COLLECTION***



SOURCE: Tourbier and Westmacott, 1981 (figure not to scale)

Another option is to connect the downspouts directly to a perforated pipe which runs the length of a gravel filled trench or dutch drain. The system can be designed to drain directly onto a concrete apron or gravel trench, into the planting bed, or as Figure 2.9 illustrates to an underground perforated pipe which discharges water directly to a planting bed or another part of the site.

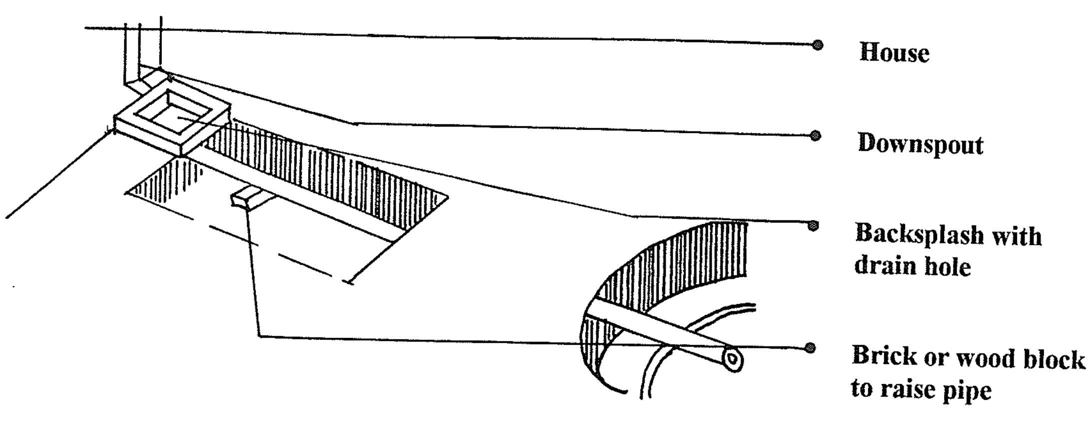
FIGURE 2.9 - ***DOWNSPOUT WATER REDIRECTED VIA UNDERGROUND PIPE***



SOURCE: Tourbier and Westmacott, 1981 (figure not to scale)

Figure 2.10 details an underground system that directs water to a holding area that may be natural vegetation, dutch drain or another type of holding tank.

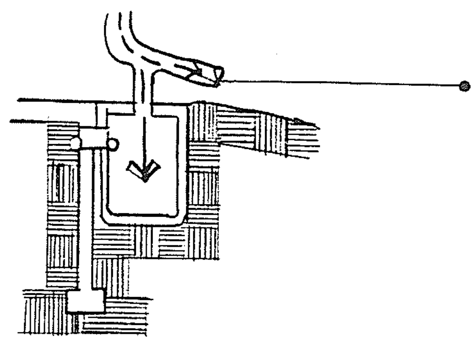
FIGURE 2.10 - ***DETAIL OF AN UNDERGROUND SYSTEM***



SOURCE: Addkison and Sellick, 1983 (figure not to scale)

Sediment traps are useful additions to downspout collection systems, and may be used in conjunction with a roof gutter system or incorporated into ground level systems, as detailed in Figure 2.11. Sediment traps will require periodic cleaning.

FIGURE 2.11 - ***DETAIL OF A SEDIMENT TRAP***



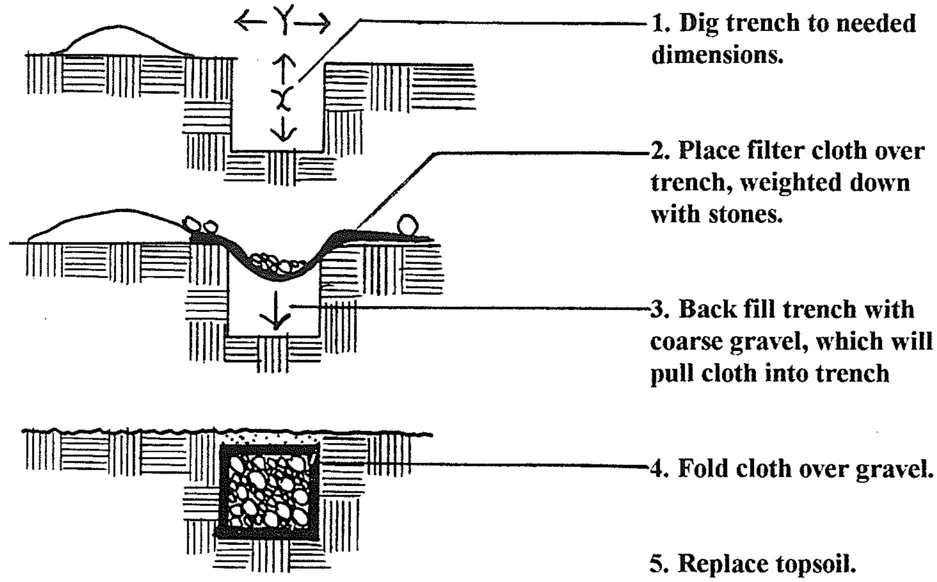
The dotted arrow shows water direction during normal rain conditions. During major storms the fill up and the water would then overflow.

Source: Tourbier and Westmacott, 1981 (figure not to scale)

2.5.4.7 Dutch Drains

A dutch drain can be defined as a ditch, trench or pit filled with stone, broken brick, gravel, rubble or the like, used to collect runoff, and are useful for retaining water on-site (Morrow, 1987). Dutch drains need to be kept clean, with maintenance minimized by using filters of gravel, cloth or paper which limits infiltration of fine particles. Figure 2.12 details the construction of a dutch drain.

FIGURE 2.12 - *DETAIL OF DUTCH DRAIN CONSTRUCTION*



SOURCE: Tourbier and Westmacott, 1983 (figure not to scale)

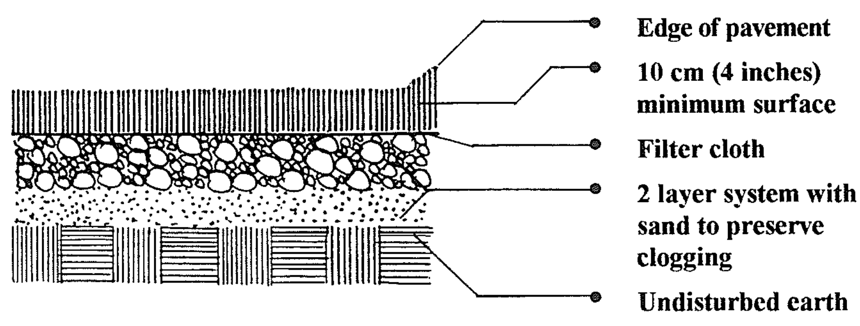
2.5.5 Porous Pavement

Pavements that allow water to drain through them and potentially be directed to other areas of the site or to the groundwater system are useful in managing landscape water. Porous pavement differs from convention asphalt in that porous has a void volume of about 15 % as compared to 2-3% for conventional asphalt. When porous pavement paving is utilized in design, it should be used on well or moderately-well drained soils. Sloping sites or sites with poor drainage may require special design considerations. As well, bedrock depth should be greater than 1 metre (3 1/2 feet) (Tourbier and Westmacott, 1981).

Advantages of porous pavement are potential reductions in runoff from paved areas, reduction of local flood peaking effects, and potential replenishing of groundwater. Roadside vegetation may improve due to increased water availability. As porous pavement tends to have less water pooling on the surfaces, potential skidding and slipping by pedestrians is reduced (Tourbier and Westmacott, 1981).

The main problem with using porous pavement in cold climates, such as the Canadian prairies is the potential for water to accumulate underneath the pavement and cause heaving problems due to freeze and thaw cycles. To alleviate this, ensure water is not stored directly under the paving itself but is directed away from the pavement area to a location such as an adjacent planting bed, a dry well or dutch drain. Figure 2.13 shows a typical or standard section of porous paving.

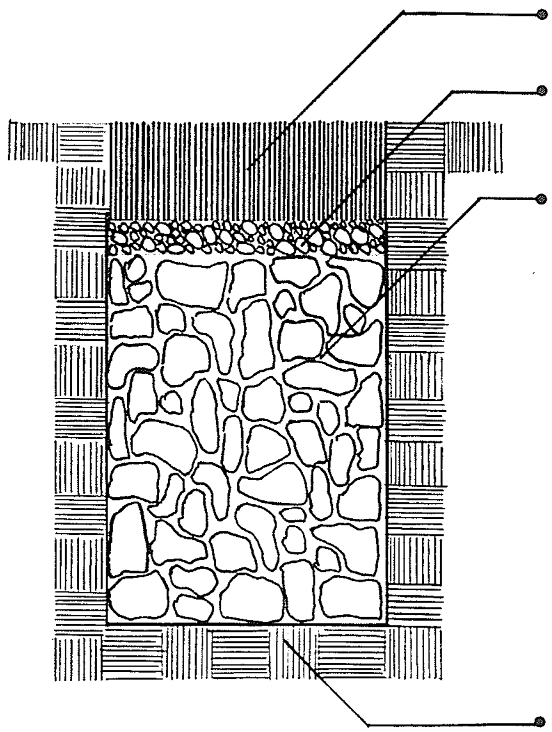
FIGURE 2.13 - ***TYPICAL POROUS PAVING SECTION***



SOURCE: Tourbier and Westmacott, 1981 (figure not to scale)

When installing porous paving, a shallow rolled asphalt curb is often used and the typical curb omitted. Porous asphalt pavement is typically laid in four layers as detailed in Figure 2.13.

FIGURE 2.14 - *STANDARD SECTION OF POROUS PAVING*



The first is a wearing course 5.1 - 6.3 cm (2 - 2 1/2 inches) thick.

The second layer is 5.1 cm (2 inches) of 1.2 cm (1/2 inch) clean, washed crushed stone.

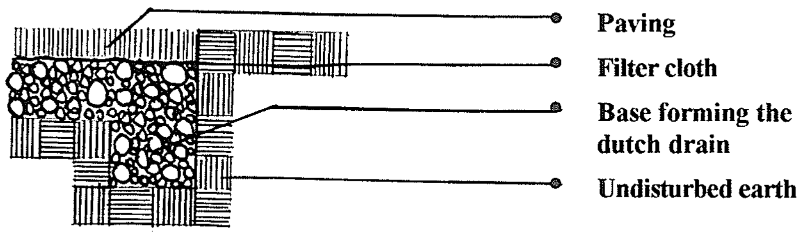
The third layer is the reservoir base course which is to be laid to a minimum of 22.8 cm (9 inches) deep. (This dimension will vary according to required bearing capacity, reserve capacity and soil drainage). This minimum depth should consist of clean, washed crushed stone to a maximum 6.3 cm (2 1/2 inch) size, ideally 5.1 cm (2 inches), laid in four 7.6 cm (3 inch) lifts, which are not rolled or otherwise compacted so that 40 % of this layer remains as voids. Soil and clay especially need to be kept out of this layer to retain the above mentioned void space.

The fourth layer is the subgrade or the undisturbed subsoil. This layer should also not be compacted during construction. Tests should be carried out stating the soil's permeability, load bearing capacity, resistance to frost heaving, and permeability.

SOURCE: Tourbier and Westmacott, 1981 (figure not to scale)

Where soils are poorly drained, a dutch drain may be used at the porous paving edge, as shown in Figure 2.15. In this application, water accumulating in the dutch drain should be directed away from the pavement due to freeze/thaw problems discussed above.

FIGURE 2.15 - ***ADDITION OF DUTCH DRAIN TO POROUS PAVING***

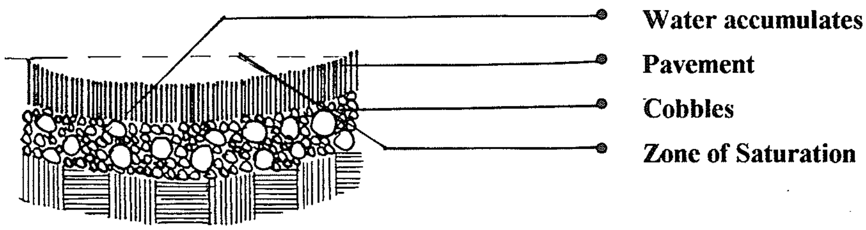


SOURCE: Tourbier and Westmacott, 1981 (figure not to scale)

On sites with a slope greater than 5%, porous paving is not recommended. On shallower slopes a runoff swale may be gravel filled and accept runoff or a tile drain may be used in the base of the swale to assist in removing excess water and improve water movement and drainage (Tourbier and Westmacott 1981). This is detailed in Figure 2.16.

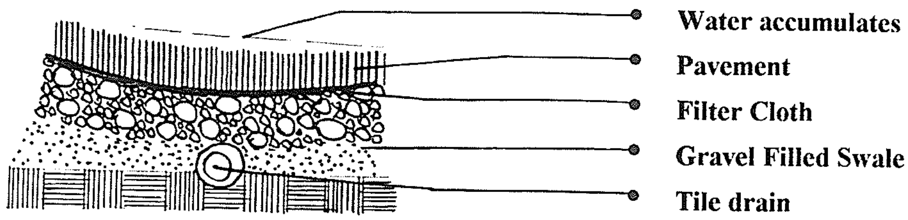
FIGURE 2.16 - ***USE OF A TILE DRAIN WITH POROUS PAVEMENT***

A) BEFORE PLACEMENT OF A TILE DRAIN



SOURCE: Tourbier and Westmacott, 1981 (figure not to scale)

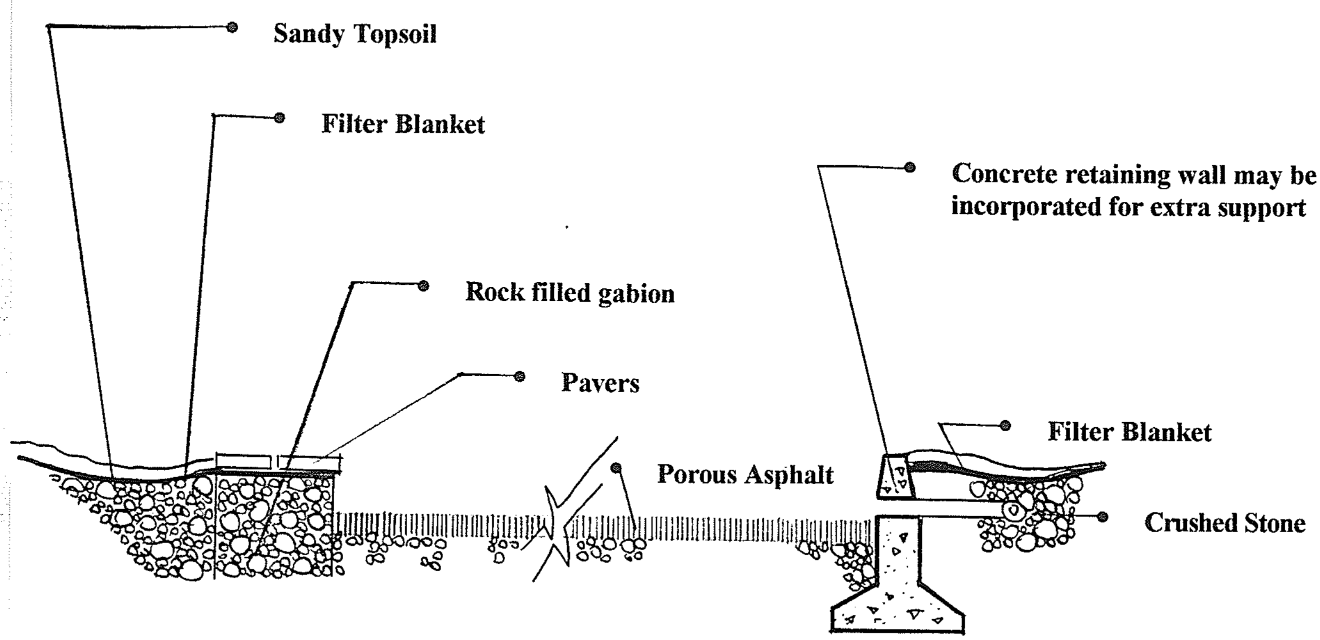
B) AFTER PLACEMENT OF A TILE DRAIN



SOURCE: Tourbier and Westmacott, 1981 (figure not to scale)

Another use of porous paving is in a sports application such as a basketball court. In this application, on-site water is designed to drain through the pavement and be directed to a storage area. Figure 2.17 shows a typical cross-section of a basketball court with porous asphalt paving.

FIGURE 2.17 - *BASKETBALL COURT WITH POROUS ASPHALT PAVING*



SOURCE: Tourbier and Westmacott, 1981 (figure not to scale)

2.5.6 Modular Paving

Modular paving may be used to manage on-site water by providing drainage opportunities from walking surfaces and re-directing water to areas where it is most beneficial for plant material. Modular paving should be used on well to moderately-well drained soils and should not be used on steep slopes unless specifically designed for a terraced area. Modular pavers such as precast concrete lattice blocks, brick or plastic* may be used in site design applications.

One advantage of using modular paving is in large grassy areas where paving blocks such as lattice blocks allow grass to grow between the holes and become established. Using a combination of modular paving and grass lessens the visual severity of large paved areas. Using this type of paving in some applications adds physical stability that is able to support pedestrian traffic and vehicles. Modular pavers are flexible, can withstand minor movements, and may be lifted to access underground utilities, if required. As well, creativity can be executed in the layout and design of areas paved with modular paving due to the variety of patterns (Tourbier and Westmacott 1981).

In most cases, skilled labor is required to lay modular paving which is a disadvantage and results in a more costly choice when compared to other types

* Plastic paving products were not researched for this project.

of paved surfaces. Certain bricks may be rough as a walking surface for some user groups especially if gaps or joints remain between the pavers. As well, these gaps may provide the opportunity for weed growth which may require weed control. Chemical treatment may cause other problems such as potential contaminants traveling into above or below ground water systems.

Three types of modular pavers are recommended for water management designs: **1)** concrete blocks; **2)** modular bricks or concrete pavers; or **3)** precast concrete perforated pavers (Tourbier and Westmacott, 1981).

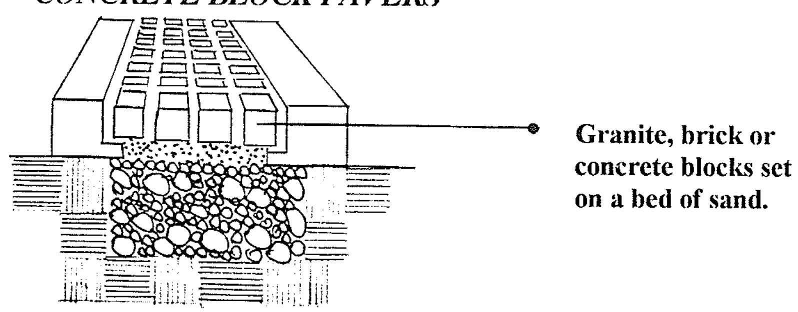
1) Concrete Blocks may be lattice concrete or monoslab concrete blocks. Lattice concrete blocks are useful for informal grass areas which accommodate parking, for lining grass channels, and erosion control ramps. Where high porosity is required the blocks should be laid on a bed of gravel or crushed aggregate followed by a layer of fines and gravel. Where erosion control is the motive, blocks may be laid directly on the soil and screened with topsoil. Monoslab concrete blocks may be used for driveways, parking areas, erosion control on slopes, banks and waterways. It is recommended to use the rough side of the blocks for these applications. For footpaths, sidewalks, bike trails, tree grates, malls and patios, the smooth side is recommended.

2) Modular bricks are usually placed on a bed of gravel and topped with a 5 cm (2 inch) layer of coarse sand. Modular bricks come in a variety of specifications. The comprehensive strength is usually 7,500 to 10,000 psi which is adequate for areas where greater support is required. This strength provides greater support than lattice blocks would.

3) Precast concrete perforated pavers are placed over a precast concrete lattice block, and may be fabricated to a number of specifications. One main use of perforated pavers is for large applications where warping would not be acceptable. Pavers are laid on a base course of gravel of the necessary depth to provide adequate water storage and 5 cm (2 inches) of coarse sand.

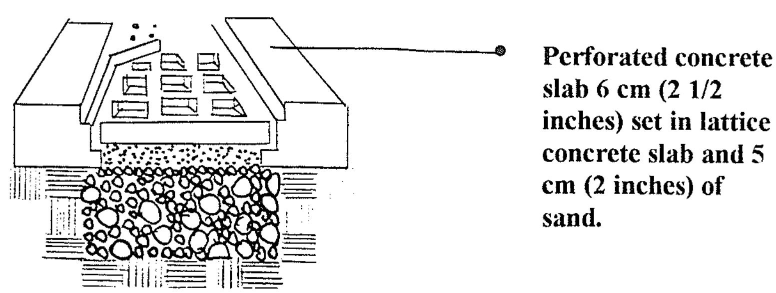
Figure 2.18 details the use of granite, brick or concrete blocks as a porous pavement. Figure 2.19 details modular paving useful for grass swales. Required maintenance may involve the blocks be lifted and the sand filter cleaned out.

FIGURE 2.18 - ***DETAIL OF GRANITE, BRICK AND CONCRETE BLOCK PAVERS***



SOURCE: Tourbier and Westmacott, 1981 (figure not to scale)

FIGURE 2.19 - ***DETAIL OF PERFORATED CONCRETE SLAB PAVERS***



Source: Tourbier and Westmacott, 1981 (figure not to scale)

2.5.7. Multi - Use Dry Impoundments

Multi-use dry impoundments are designed to cover large areas of a site, and when properly designed will form extensive sheets of shallow water over the area. These impoundments are referred to as multi-use as they store water underground but also allow surface uses to continue. Multi-use dry impounds are useful in directing flow to a specified area, reducing downstream flow amounts; allowing on-site water storage, replenishing groundwater, and providing water for plant material. Generally, multi-use dry impoundments are most compatible with informal and non-intensive open space uses.

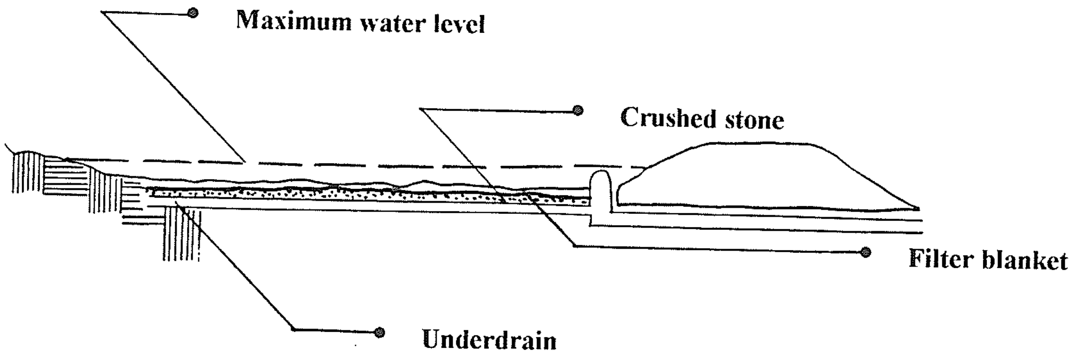
Multi-use dry impoundments should be designed on well-drained to moderately-well drained sites which are not steep, but gently rolling. A large land base is required to allow sufficient space for shallow water dispersal during peak storm times. Paved parking areas may be used as part or all of a multi-use dry impoundment drainage area (Tourbier and Westmacott, 1981).

One advantage of using multi-use dry impoundments is, given their shallow gradient, the area is easily maintained by conventional machinery and management methods. Disadvantages include possible sediment accumulation requiring periodic removal, requirement for a larger land base, and interruption of original intended use when inundated with water (e.g., if used as a playing field) (Tourbier and Westmacott, 1981).

The multi-use dry impoundment should be designed large and shallow. The impoundment can be designed using berms or other earth dams which direct and contain water flow during storm flood times. If the area is to be turf, grass species which are tolerant of brief periods of heavy water inundation should be chosen, such as fescue due to their hardiness and drought resistance. If the soil drains well and water is eliminated quickly, no further attention is required. Sites which are less well-drained may require tiles or perforated pipes set 25 cm (1 foot) deep and 2.5 m (10 feet) on center. Water from these drains may be discharged into a dry well, dutch drains, or directed to areas that will benefit from added amounts of water The area around the multi-use impoundment basin should be covered with vegetation and be designed to eliminate potential erosion problems (Tourbier and Westmacott, 1981).

Costs for installing the impoundments will vary depending on the area chosen, site characteristics such as the surface (paved or grass), and the slope or terrain. Costs include installation of the underdrain system such as a dry well or dutch drain, if required. To reduce maintenance requirements, the site should be designed with a slope ratio not exceeding 1:5. Maintenance will include periodic removal of accumulated sediment (Tourbier and Westmacott, 1981). Figure 2.20 details a multi-use dry impoundment.

FIGURE 2.20 - *MULTI-USE DRY IMPOUNDMENTS*



SOURCE: Tourbier and Westmacott, 1981 (figure not to scale)

2.5.8 Parking Lot Catchment and Temporary Storage

Parking lots may provide a source of water for plant material but will require special management. Catching and temporarily storing water from parking lots is most applicable in existing urban areas but may be useful in overflow parking areas which are not used on a regular basis. Using parking lots for temporary water storage may reduce peak runoff being discharged downstream and reduce costs associated with conventional stormwater sewer methods. If the parking lot is paved with porous material, such as porous asphalt or paving bricks, increased soil infiltration is an additional bonus. Sediment will be retained in the parking lot, reducing the amount traveling downstream where it may cause filter blockages or sedimentation problems. When sediment accumulates, it will have to be removed (Tourbier and Westmacott, 1981). If a sufficient depth exists, frozen parking lots may be used for outdoor recreation opportunities such as skating.

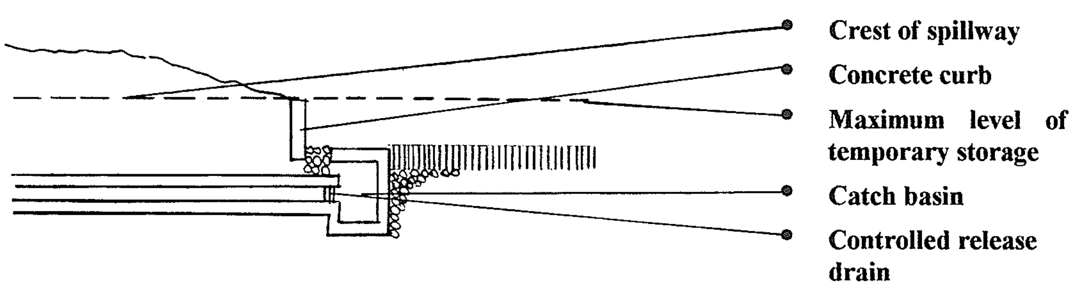
Disadvantages of temporarily storing water in parking lots include the possible inconvenience to parking lot users if standing water remains. Vehicles may be damaged if water levels rise significantly during heavy rain storms. As well, oil and fuel residue from vehicles may contaminate the standing water. Water stored on parking lots and directed to the landscape will have to be directed through a filtering system to alleviate potential contamination.

When using parking lots for temporary water storage, signs should be placed on site which warn uses of potential flooding during peak storms. The choice whether to use the parking lot can then be made by site visitors. The maximum water depth allowed to accumulate should be kept to 20 cm (8 inches) to ensure water does not seep into car interiors or immerse car axles which may potentially remove oil and fuel residues from the underside of the vehicles (Addkison and Sellick, 1983). The area should drain fairly quickly after a storm, be filtered, and directed to a planting bed, grassed area, or the groundwater system. In new parking lots, these design considerations should be incorporated in the initial design (Tourbier and Westmacott, 1981). Deep water storage may also be accommodated by infrequently used parking lots and may allow water accumulation at depths greater than 20 cm (8 inches), with special design considerations applied in these instances.

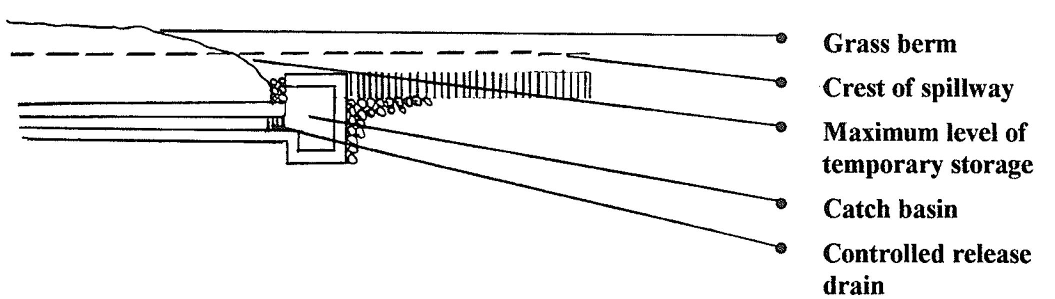
Costs include installation of the standard parking lot, sluice, a controlled release drain, emergency spillway, and any additional curbing, according to the design. Periodic maintenance activities include sweeping to collect any sediment and debris, and cleaning of the release drain (Tourbier and Westmacott, 1981). The following figures show parking lot storage. Figure 2.21 A) shows shallow storage with a concrete curb, which is used to detain the water to the parking lot area. Figure 2.21 B) illustrates shallow storage as well, relying on a grass berm for containment.

FIGURE 2.21 - *PARKING LOT - SHALLOW STORAGE*

A) WITH CONCRETE CURB



B) WITH GRASS BERM



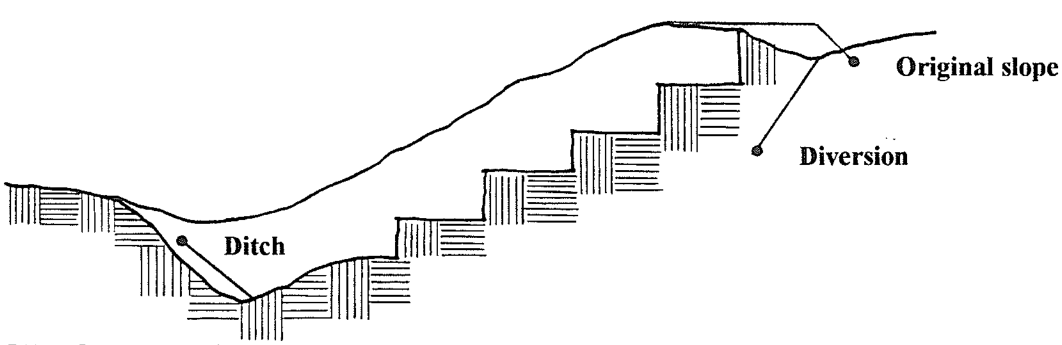
SOURCE: Tourbier and Westmacott, 1981 (figure not to scale)

2.5.9 Terraces

Terraces are used as a soil conservation technique and are also effective for managing on-site water. Design specifications allow for potential interception of down slope flowing water, erosion reduction, and groundwater recharge. Terrace design however, in most instances requires large tracts of land and should not be designed too shallow to ensure water is not standing for long periods of time which may pose problems for pedestrians traversing the site (Tourbier and Westmacott, 1981).

Serrated cut terraces, as detailed in Figure 2.22 alter the shape and contours of a hillside. These terraces look somewhat like steps and are designed this way in order to provide level areas which slow water movement and allow percolation into the hillside rather than moving downslope and causing potential erosion. Serrated cut terraces may be used in conjunction with other water management methods such as stepped planter boxes to control water with less alteration to existing contours.

FIGURE 2.22 - ***SERRATED CUT TERRACE***

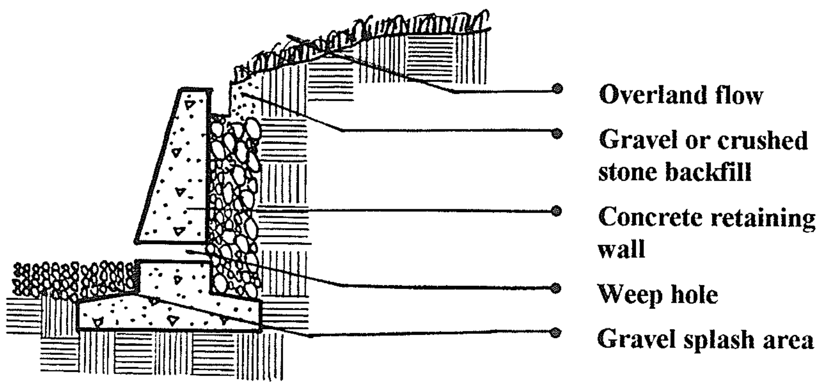


SOURCE: Tourbier and Westmacott, 1981 (figure not to scale)

2.5.10 Retaining Walls

Retaining walls may be incorporated into slopes to permanently stabilize them, creating gentle or flat areas above the wall, with runoff being directed onto and behind the wall. The wall should be designed with weep holes to allow runoff to escape. Figure 2.23 illustrates the design of a retaining wall complete with a weep hole.

FIGURE 2.23 - ***DRAINAGE FOR RETAINING WALLS***



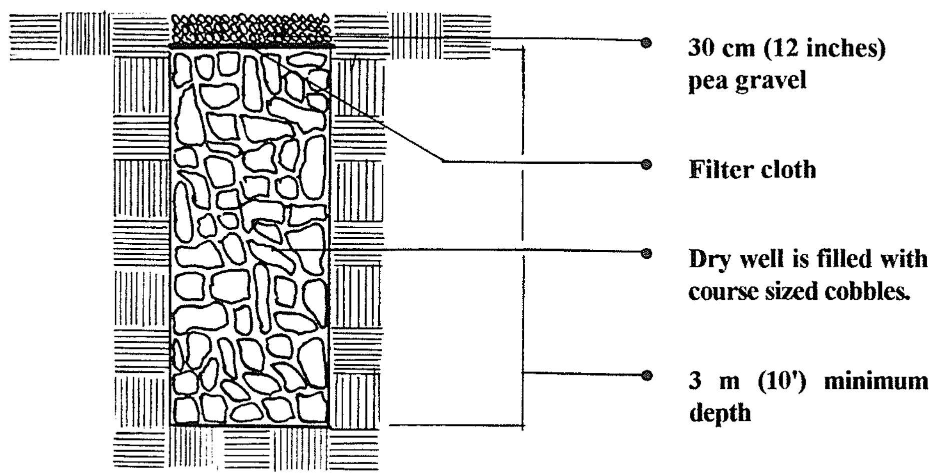
SOURCE: Tourbier and Westmacott, 1981 **(figure not to scale)**

2.5.11 Dry Wells

Dry wells, which are dug approximately 3 metres (10 ft.) deep and usually filled with porous gravel or rock material, are designed to receive runoff after the preliminary downpour. They should be located on sites that are not too steep, on well-drained soils, and where bedrock is not too shallow.

The advantages of dry wells include reducing flood peaks by providing storage and maintaining groundwater yields. Their placement may be accomplished without highly skilled labor. Dry wells are easily executed by excavating and backfilling with gravel or stone. Disadvantages include possible rehabilitation measures if the dry well become heavily silted. As well, implementation of this type of water management method is limited to sites with specific criteria, as outlined above (Tourbier and Westmacott, 1981). Figure 2.24 details a dry well.

FIGURE 2.24 - *DETAIL OF A DRY WELL*



SOURCE: Adapted from Studio Project, University of Manitoba, 1992 (figure not to scale)

2.6 SITE MAINTENANCE

One of the Xeriscape landscaping's truisms is the higher the water requirement of a landscape, the higher the maintenance needs will be. [6]

Landscape maintenance may be described as a series of interrelated tasks including weeding, fertilizing, pruning, mowing, and pest control with proper water management the key to reducing maintenance requirements.

2.6.1 Weeding and Fertilizing

Allowing fallen leaves to remain and decay on the ground provides a natural fertilizer, a food source for soil organisms, and insulates the soil. Leaves serve as a mulch to reduce competition from weeds, and reduce site maintenance requirements in the fall (Thomsen 1993).

Weeding is one chore most people dislike. Planting beds in their disturbed state and enhanced soil mixture are ideal locations for undesirable plant species. Over-watering encourages plant growth of not only the desired plants but undesirable ones as well. Proper amounts of water will reduce the likelihood of pests and disease, and pruning and weeding requirements. Planting annuals, perennials and groundcovers close together also reduces weed growth as these plants compete with and shade out young weed plants.

---

[6] Ellefson C. , T Stephens and D. Welsh. 1992. Xeriscape Gardening - Water Conservation for the American Landscape. New York. NY. MacMillan Publishing Company.

Fertilizers, used in conjunction with the results of a soil test which verifies the need for specific additions (Harapiak, 1986), is important for site maintenance. If applying fertilizers, avoid possible burning and other damage to new plants, and potential nitrogen deficiency that occurs with fresh organic mulch by using a slow release granular fertilizer with a relatively high nitrogen content. This will assist in balancing any potential deficiency (Ellefson, Stephens and Welsh, 1992).

2.6.2 Pruning and Mowing

When we hear of Kentucky bluegrass, which requires thirty-five to forty inches of water (including natural precipitation) each year, blanketing our cities that receive 14 inches of rainfall per year, we know there must be a better way. [7]

Mowing is often a required maintenance activity for residential yards and municipal parks. Mowing, by its very action encourages plant growth and frequent mowing does not allow enough time for the plant to mature. By not reaching a state of maturity, the plants are in a stressed condition with less defenses and more susceptibility to insects and diseases. To alleviate this, turf grass should be kept at a longer length in order for it to be closer to maturity,

---

[7] Ellefson C. , T Stephens and D. Welsh. 1992. Xeriscape Gardening - Water Conservation for the American Landscape. New York. NY. MacMillan Publishing Company.

to shade the roots, and reduce of soil moisture evaporation (Ellefson, Stephens and Welsh, 1992).

The type of mower affects the health of turf grass as well. Mowing with a standard lawn mower tends to rip and tear the grass leaves which increases potential for disease. Mowing with a sharp, reel type or rotary blade lessens or eliminates damage to the leaves. Low growing groundcovers may be utilized in the place of turf grass in some areas which will reduce mowing requirements. In some instances, such as play surfaces, grass is still the best alternative.

2.6.3 Pest Control

The more diverse the landscape environment, the less likely is the possibility of a major disaster from an attack of disease or insects.[8]

Pest control is an exercise in assessing what conditions may lead to pest infestations, and correcting the underlying problem (Ellefson, Stephens and Welsh, 1992). For example, monocultures may provide an environment where pests live and thrive, due to the abundance of food crop that attracted the pest. A pest control method known as Integrated Pest Management (IPM) recognizes that control over one species population will have an effect on other

[8] Ellefson C. , T Stephens and D. Welsh. 1992. Xeriscape Gardening - Water Conservation for the American Landscape. New York. NY. MacMillan Publishing Company.

components of the whole system or environment. It is important to ensure a proper balance results and natural checks are in place in order to have a well functioning ecosystem. All possible pest control options should be considered before one is taken (Knowles, 1989).

2.6.4. Soil Maintenance

The key to maintaining soil is first, having an understanding of the existing soil type on-site. As soil's structure (particle size), pH or salinity are very difficult to alter, it is best to work with existing conditions as much as possible. This may be achieved by not changing soil characteristics and by choosing plant material that will thrive in existing conditions (Ellefson, Stephens and Welsh, 1992). Soil characteristics are discussed below.

i) Particle Size

The term *particle size* denotes the soil's texture or structure and measures clay, silt and sand amounts. Soil's particle size influences its structure and water-holding capacity (Harapiak, 1986). For example, sandy soil drains easily and quickly after a rain, warms up quickly in the spring, and is easy to work with. However, because of rapid water movement through these soils, nutrients are also leached out. Sandy soils tend to have low moisture-holding capacity, need to be watered and fertilized more often, and may be subject to wind and water erosion when not covered by vegetation.

Conversely, clay soils tend to have poor drainage resulting in a reduced amount of oxygen for vegetation use. These soils tend to restrict root growth and thus shallower roots grow as compared with sandy soils. Plants may heave in a heavy clay soil due to the soil's tendency to contract and expand with freeze/thaw cycles. With little or no vegetative covering, clay soils tend to crack or crust. However, clay soils have higher nutrients and water holding capacity than sandy soils (Ellefson et al. 1992).

ii) pH

You cannot control the factors that made the soil the way it is, such as the underlying material, the amount of rainfall and the chemical reading of your rainfall or irrigation water.[9]

Soil pH is a measure of the relative concentration of hydrogen ions and hydroxyl ions in the soil solution which indicates the active acidity of the soil. Measuring pH provides an accurate indication of the availability of essential nutrients. A pH below 7.0 is considered to be acidic. When the pH level is

[9] Ellefson C. , T Stephens and D. Welsh. 1992. Xeriscape Gardening - Water Conservation for the American Landscape. New York. NY. MacMillan Publishing Company.

between 6 and 7.5, phosphorus, calcium, potassium and magnesium are most available for plant use. A pH reading above 7.0 is considered to be basic or alkaline (Harapiak, 1986). When the pH is over 8.0, phosphorus, iron and many trace elements are no longer available for plant use. As the quote above indicates, pH and the factors resulting in soil conditions are beyond a designer's or gardener's control. It is important then to select plants which grow and thrive within existing pH levels, and not work at altering them (Ellefson, Stephens and Welsh, 1992).

2.6.5. Use Of Mulches

Mulching ... is a very good thing. In fact with a few cautions, there's almost nothing bad to say about mulching.[10]

Organic mulch used in planting beds is an effective way to manage landscape water. Organic mulches are preferred over inorganic ones as organics add nutrients to the soil through their disintegration, improving quality and water holding capacity of the soil. As mulch tends to be dark in color and provides a fragmented, uneven surface, reflective light is reduced resulting in cooler areas around plant stems and leaves, and less evaporation results. Mulch helps regulate temperature by sealing moisture around roots which is especially important for winter protection. Mulch protects seeded area and newly planted

[10] Ellefson C. , T Stephens and D. Welsh. 1992. Xeriscape Gardening - Water Conservation for the American Landscape. New York. NY. MacMillan Publishing Company.

seedlings, and by covering the soil, sunlight is blocked, thus germination of weed seeds is reduced. This results in less competition from weed plants for moisture, less weeding and less water required. As well, by slowing down rainfall and absorbing it, mulch helps to control erosion. Mulch also reduces soil compaction and crusting (Ellefson, Stephens and Welsh, 1992).

One disadvantage of adding organic mulch is potential nitrogen deficiency as mulch material decomposes due to bacterial activity (Tourbier and Westmacott, 1981; Ellefson, Stephens and Welsh, 1992). Some types of partially composted mulches (mushrooms or manure) may be high in salts. These mulches may still be used, but should be applied in the fall to allow winter precipitation to wash away excessive amounts (Ellefson, Stephens and Welsh, 1992). Mulched beds may be a fire hazard or a favorable habitat for rodents, snails, slugs, etc. Over-mulching, that is applying too thick a layer, or under-mulching - too thin a layer, should be avoided. Too thick lessens water penetration and oxygen exchange, thus both are not available for plant utilization. Too thin a layer will not inhibit weed growth as effectively, and not retain enough moisture. Non organic mulches, such as rock, gravel or plastic keep excessive heat in, and do not allow sufficient moisture to seep into or out of the soil (Ellefson, Stephens and Welsh, 1992). Table 2.3 provides a list of the most common mulch material and information for their successful usage.

TABLE 2.3 - *TYPES OF MULCH AND APPLICATION RATE*

MULCH MATERIAL	QUALITY STANDARDS	APPLICATION RATE/100 sq.ft.	REMARKS
Compost or straw manure	Well shredded, no course material.	400 to 600 lbs	Excellent moisture conservation. Resistant to wind blow.
Peat Moss	Dried, compressed, no course material.	200 to 400 cu. ft.	Excellent moisture conservation but is subject to wind blow. Apply 2-4 inches thick.
Pine Straw or needles	Air dried and free from fine material.	50 to 90 lbs	Resistant to wind blow and decomposes slowly.
Sawdust, Green or Composted	Free from course material.	83 to 500 cu. ft.	Slowly decomposes. Treat with 35/lbs/ nitrogen/ ton. Apply 1-7 inches thick.
Wood Chips or shavings	Green or air dried, free from course material.	500 to 900 lbs	Resistant to wind blow. Treat with 12 lbs /nitrogen/ ton. Apply 2-7 inches thick.
Leaves/ leaf mold	Shredded or partially rotted leaves are easiest to use.	**	Lets some water in and improves water holding capacity. Additional nitrogen may be needed. *
Grass Clippings	Partially decomposed, no weed and feed.	**	Lets some water in. Acceptable to remain on the grass unless it has become matted. *
Newspaper	Six to eight sheets, weigh down with soil or sand.	**	Keeps some water in, controls erosion. Decomposes quickly. *
Snow	**	**	Nature's best mulching material. Excellent insulator against cold and drying winds. Keeps plants in dormancy during midwinter warm spells. *

Note ** Not applicable or information not available.
SOURCES: Tourbier and Westmacott, 1981; * (Ellefson, Stephens and Welsh, 1992).

To summarize, this chapter presents information on a number of key aspects of managing water in the landscape, as advocated by experts in the fields of horticulture, landscape architecture, Xeriscape Gardening and irrigation systems. This information provided the catalyst for developing the water management guidelines as presented in the next chapter, **Chapter Three - Water Management Guidelines**.

3.0 WATER MANAGEMENT GUIDELINES

3.1 GUIDELINE FORMATION

The water management guidelines are derived from and closely related to the precepts embodied within the seven *Xeriscape Gardening* principles, as outlined by Ellefson et al. (1992), Stroud (1987), University of Saskatchewan (1992), and other authors. The water management guidelines recognize the validity and soundness of *Xeriscape Gardening*, and from these principles recommends four guideline categories as illustrated in Table 3.1.

TABLE 3.1 - WATER MANAGEMENT GUIDELINES

WATER MANAGEMENT GUIDELINES **	*XERISCAPE PRINCIPLES* *
1. Site Planning and Design	***Site Planning and Design***
2. Plant Selection	***Practical Turf Area*** ***Appropriate Plant Selection***
3. Managing On-Site Water	***Efficient Irrigation***
4. Site Maintenance	***Soil Analysis*** ***Mulching*** ***Appropriate Maintenance***

Sources: * Ellefson et al. (1992)
** Proposed by the author

3.2 GUIDELINES

The following guidelines are applicable to the design of new sites or renovations to existing sites, and may be applied at most scales of projects - large or small.

3.2.1 Site Planning and Design

The first water management guideline category, **Site Planning and Design**, encompasses the ideas and concepts behind the *Xeriscape Gardening* principle of the same name. The objective of this category is **to carefully plan and design the site for the best and most appropriate water management.** This category represents the first step of designing a project with water management initiatives and includes a thorough inventory of site conditions, surrounding land uses, and existing and intended uses. An analysis and synthesis of the inventory information is recommended in order to provide a summary of limitations and opportunities for managing on-site water and for the final site design. Water management design advocates studying the following topics:

i) Inventory the surrounding community and the site's location within its neighborhood including adjacent green spaces and open areas with potential runoff onto the site.

ii) Inventory existing uses and structures. Hard surfaces such as parking lots, paved areas or buildings may offer water harvesting possibilities which may be worked into the design to benefit on-site vegetation and groundwater systems. Existing water sources or features may be enhanced and/or used to educate site visitors.

iii) Inventory site topography and hydrology. Analyze slope aspect, identifying east, west, south and north facing slopes which is important for water management as south and west slopes tend to be drier; north and east are usually wetter and colder. From the topographic map, analyze site hydrology including water flow direction, low spots where water drains to, and potential locations for natural water collection.

iv) Inventory existing site plant material. Ascertain which existing plant material is drought tolerant or can survive water stress, and which ones will survive given existing water conditions.

v) Analyze and synthesize the inventory information to determine relevant information for managing on-site water, opportunities for harvesting, replenishing of groundwater, or areas where additional irrigation may be required.

Design as the second aspect, takes into account many aspects of creating better places to live while managing water, and brings water management initiatives securely into the realm of landscape architecture. The following guidelines give guidance to the processes of managing on-site water and impress upon the importance of a thorough understanding of a site and its intended uses.

Guidelines:

3.2.1-A ***Ensure all pertinent inventory elements crucial to managing on-site water are collected and mapped. These elements include, but are not limited to, hydrology, topography, existing vegetation, built structures, utilities, and circulation patterns.***

3.2.1-B ***Analyze the inventory information and synthesize the data to determine areas where water management methods may be most effectively applied.***

3.2.1-C ***Plan and design the site using the theory of zoning which arranges and defines areas according to the potential for harvesting and collecting water. This includes grouping plant material with similar water requirements together into specified zones.***

3.2.2 Plant Selection

Practical Turf Areas and *Appropriate Plant Selection* are grouped together under the second guideline category **Plant Selection** with the intent being to select all plant material concurrently. This category includes selecting plants that are better able to survive on natural precipitation, and choosing plant species that have some degree of water stress tolerance.

The objective of this guideline category is **to select the site vegetation most appropriate to the site level design, to decrease the amount of additional water added to the site, and work towards creating a more ecologically balanced environment.**

Plant material choices will influence the amount of additional water needed on site and includes selecting trees, shrubs, perennials, annuals, wildflowers and turf species. The following guidelines advocate wise selection of trees, shrubs, wildflowers, annuals, perennials and turf species.

Guidelines:

3.2.2-A ***Select plant materials appropriate to the existing and or planned design intent.***

3.2.2-B *Select turf species that will thrive and survive on the natural amounts of water falling on-site, as well as meet the design intent and wear requirements of site users.*

3.2.2-C *Choose plants appropriate for the soil type.*

3.2.3 Managing On-site Water

Managing On-Site Water, as the third guideline category encompasses the *Xeriscape Gardening* category of "*Efficient Irrigation*" and advocates the potential incorporation of harvesting and utilizing on-site water. Recommendations include replenishing groundwater systems, holding water on-site, directing water for its best use, and using irrigation systems, where appropriate. Managing on-site water includes ways to collect or harvest on-site water, and advocates using irrigation systems, whether automated or manual.

The objective of these guidelines is **to manage and conserve on-site water for the benefit of the plant material, groundwater system, and the environment.**

Guidelines:

3.2.3-A *Utilize water falling on-site for the best possible advantage by incorporating harvesting and collecting techniques to the site design.*

3.2.3-B *Recharge groundwater systems by planning for water to remain on-site and percolate into the ground.*

3.2.3-C *Incorporate irrigation systems into the site, where appropriate. Ensure irrigation systems are used to augment natural precipitation and are turned off in times of rain.*

3.2.4 SITE MAINTENANCE

The fourth and final water management category, **Site Maintenance**, is similar to the intent of the **Xeriscape Gardening** principle *Appropriate Maintenance* in that it advocates continued general site maintenance. The water management guidelines, however, incorporate two other *Xeriscape Gardening* principles - *Mulching* and *Soil Analysis* under **Site Maintenance** with the intent being to incorporate all maintenance activities under one category. Maintenance activities include but not limited to mowing grass, maintaining irrigation systems, pruning and fertilizing if necessary, the addition of mulches, and periodic soil analysis and augmentation, when required. The objective of this category is **to recommend management practices that may be applied to the landscape to aid in managing water and resulting in a healthier landscape.**

Guidelines:

3.2.4-A *Test the soil to determine: 1) Electrical Conductivity (EC) of the soil. If EC is high, incorporate subsurface drainage to aid in the leaching down and out of the root zone of excessive salt; 2) particle size and texture (i.e., sand, silt, or clay): and 3) pH.*

3.2.4-B *Apply mulches to decrease evaporation, minimize erosion, improve aeration, regulate soil temperature, protect new seedlings, add nutrients to the soil, and increase the soil's water holding capacity.*

3.2.4-C *Avoid soil compaction to the soil which inhibits water movement. Soil compaction may be avoided by using mulches, limiting the movement of machinery on site, limiting pedestrian movement to designated circulation patterns, etc.*

3.2.4-D *Maintain site in a healthy condition to minimize stress on plant material which affects health and results in less drought tolerance.*

3.2.4-E *Maintain irrigation systems and management methods to ensure proper functioning which result in best usage of water.*

3.2.4-F *When mowing turf grass, adjust the mower for longer grass length to encourage deeper root growth and increases the ability of the plants to survive in dry or droughty conditions.*

3.2.4-G *If applying fertilizer, use the minimum required as over fertilizing may encourage weeds.*

3.2.4-H *Plant annuals, perennials and ground covers close together in order for them to compete with and shade out weeds.*

To summarize, the guidelines cover aspects of site planning and design, plant selection, managing on-site water, and site maintenance. These guidelines, in conjunction with the management methods are used to demonstrate potential application of managing on-site water through the use of a demonstration site, as described in Chapters 4 and 5. The site inventory to follow will assist in demonstrating the application of this information to site specific design.

4.0 SITE INVENTORY AND ANALYSIS

In the preceding chapters, water management methods and guidelines for managing landscape water have been discussed and provided as information. In order to demonstrate the potential usefulness of the information, a site was chosen named Riverdale Park in the heart of Edmonton, Alberta, Canada. This demonstration site, with its diverse attributes, offers opportunities to demonstrate many of the management methods discussed in the previous chapters.

4.1 DESIGN METHODOLOGY

- The Riverdale Park site was chosen as the demonstration site as it offered opportunities for creative and interesting water management design. If the project was built, the location of the site would offer the opportunity to educate a wide spectrum of city residents.
- Background information was obtained from the City of Edmonton Parks and Recreation, and Planning and Development Departments. Base mapping included locations of exiting buildings, utilities, parking lot, play structures, topography, vegetation, and surrounding land uses. The Parks and Recreation Department also provided site specific information regarding the Parks Maintenance Management System (PMM System) which details current maintenance carried out on the site.
- The information was inventoried and analyzed. Soil samples were taken and analyzed.
- Analysis results are presented on the **Synthesis** drawing, which provides information on the opportunities for managing water and suggests site limitations.
- The **Concept Plan** * summarizes the conceptual site design. It shows the design

* **NOTE**: This conceptual design project is theoretical in nature. The project is intended to demonstrate the application of water management methods and guidelines. At this time, no plans exist in the Parks and Recreation Department to incorporate the ideas presented here to the existing park facilities.

intent such as the shale walkway and boardwalk bridges, dry streambed, trees and shrubs.

- The site was divided or "de-constructed" into nine zones according to existing use, opportunities for water management, and design potential. Each zone is detailed on a separate drawing, and demonstrates appropriate water management methods(s) for the zone.
- The final drawing, **Planting Plan,** summarizes the planting scheme for the park site.

4.2 SITE LOCATION

The 1.5 ha Riverdale Park site is situated in the centrally located river valley community of Riverdale, in Edmonton, Alberta. It is bound on two sides by roadways - to the west is 94 Street and to the north is 100 Avenue. Marking the eastern boundary is an existing outdoor skating rink, and to the south is the North Saskatchewan river valley and park system.

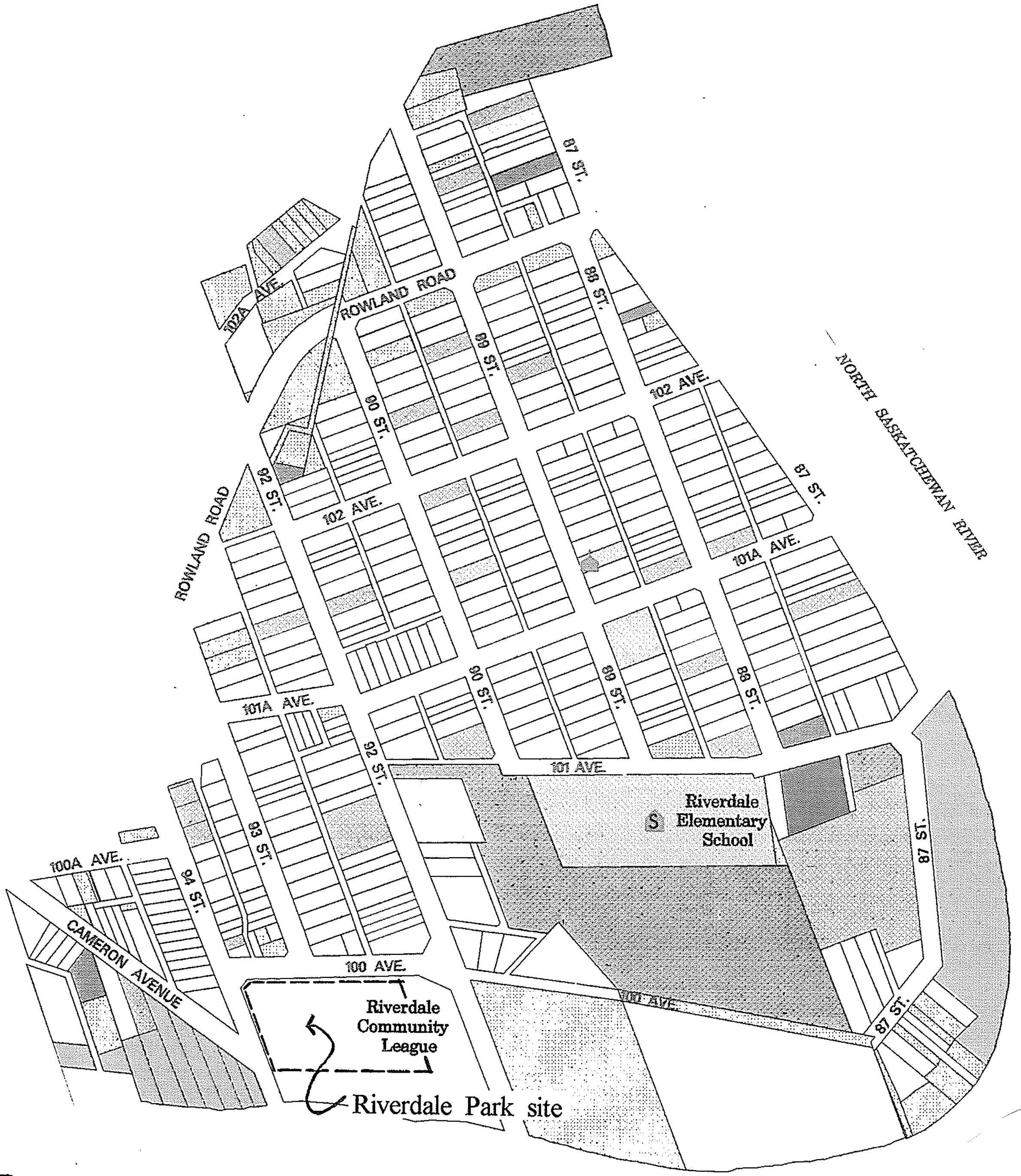
4.3 SURROUNDING LAND USES

The site is surrounded to the north and west by single family residential development, which has existed since the turn of the century. East of the site is an undeveloped site known as the J. B. Little Lands, which is a former soft-mud brick production site (Godfrey, 1993). Proposals have been submitted to the City of Edmonton for residential housing development on the Little lands. At the time of printing of this project, no plans have been finalized for development.

Immediately south of Riverdale Park, separated by a chain link fence and the alleyway is the North Saskatchewan River and bank, comprising part of Edmonton's famous river and valley park system. Riverdale Elementary School is located in close proximity and provides additional playground and open space opportunities. Figure 4.1 shows the existing land uses for the community of Riverdale and shows the open space/recreational areas, the main roads, and the location of the park within the city.

The site is situated in the western part of the community with the general lay of the land rising from the east to the west part of the community. Although the site lies adjacent the North Saskatchewan River, the site is not within the 1:100 year flood line *, thus flooding is not considered a serious problem.

* The delineation of the 1:100 year floodplain provides a boundary that indicates areas that have a 1 in 100 chance of flooding in any one year. (City of Edmonton Land Use Bylaw, No. 5996, 1980)



LEGEND

- One Unit Dwelling
- Two Unit Dwelling
- Multi Unit Dwelling
- Apartment
- High Rise Apartment
- Other Residential
- Commercial
- Industrial / Utilities
- Transportation
- Open Space / Recreation
- Park
- Institutional
- School
- Religious Assembly
- Hospital
- Agriculture
- Vacant / Undeveloped

FIGURE 4.1

EXISTING LAND USES

NORTH

NOTES:

Base map courtesy of the City of Edmonton Planning and Development Department

4.4 SITE INVENTORY

The demonstration site's physical location, surrounding land uses, as well as general and specific inventory information were collected and analyzed. The inventory and analysis stage documents the existing resources and features of the project area to allow for identification of limitations and opportunities as shown on the **Synthesis** drawing. The following information outlines general inventory information for the Riverdale Park site and the Edmonton area.

4.4.1 AREA INVENTORY INFORMATION

General inventory information for the Edmonton area and Riverdale Park site are detailed in this section and summarized in Table 4.1.

TABLE 4.1 - INVENTORY INFORMATION AND ITS RELEVANCY TO WATER MANAGEMENT

INVENTORY CATEGORY	*INFORMATION REGARDING THE DEMONSTRATION SITE*	*RELEVANCY TO WATER MANAGEMENT*
Geology	The demonstration site is a typical river terrace, which may experience seasonal fluctuations in groundwater table. There may be weak and compressed silt and clay lenses, which may affect percolation rates (Godfrey, 1993). Some materials may lack cohesion or cementation and thus would be susceptible to water and wind erosion (Alberta Agriculture, no date).	Types of geology may affect percolation rates and may be susceptible to wind and water erosion.

(Table 4.1 Continued)

INVENTORY CATEGORY	*INFORMATION REGARDING THE DEMONSTRATION SITE*	*RELEVANCY TO WATER MANAGEMENT*
Region	The City of Edmonton and the demonstration site is within the Boreal Forest region (per. comm. H. Knowles, 1994) and borders on the Parkland region (Alberta Agriculture, no date). The Parkland/boreal forest regions have greater amounts of precipitation but cooler summers and colder winters than the more southerly grassland area of the Province (Alberta Agriculture, no date).	The location of the site dictates plant survival, amount of available water, hours of sunshine, and length of days. These variables affect plant hardiness and limit plant selection for water management designs.
Temperature	The mean January temperature is -8 to -12 degrees Celsius. Winter temperatures are severe and prolonged. The mean July temperatures are 16-20 degrees Celsius (Alberta Agriculture, no date).	The range in temperatures restricts the diversity of woody plants that may be grown due to the harsh year round exposure to extremes, thus the species that may be selected for water management are limited.
Precipitation	In Alberta, precipitation is not uniformly distributed. Generally, 50-60% of annual precipitation occurs during the growing season, mostly as rain. Average of 40-50 cm (16-20 inches) (Alberta Agriculture, no date).	The amount of precipitation occurring may not provide adequate supply of moisture for growth of some plants, resulting in limited plant choice or supplemental irrigation requirements. A layer of snow covering the soil reduces wind and water erosional effects. Catching snow on site increases potential soil moisture. The disadvantage of trapping snow is that soil temperature will be slightly lower in the spring (Alberta Agriculture, no date).
Wind	Winds in the area are referred to as Westerlies, with the majority originating out of the north/northwest (Alberta Agriculture, no date).	The strong summer winds and warm temperatures may create excessive loss of moisture that can lead to drought stress .
Microclimate	Warmer daytime temperatures tend to be found in river valleys, although these sites tend to be more prone to night time frosts and fog conditions. South and west facing slopes receive more direct radiation and tend to be warmer than east and north facing slopes, thus water tends to evaporate more quickly on these slopes.	This is important for plant selection and for overall site design.

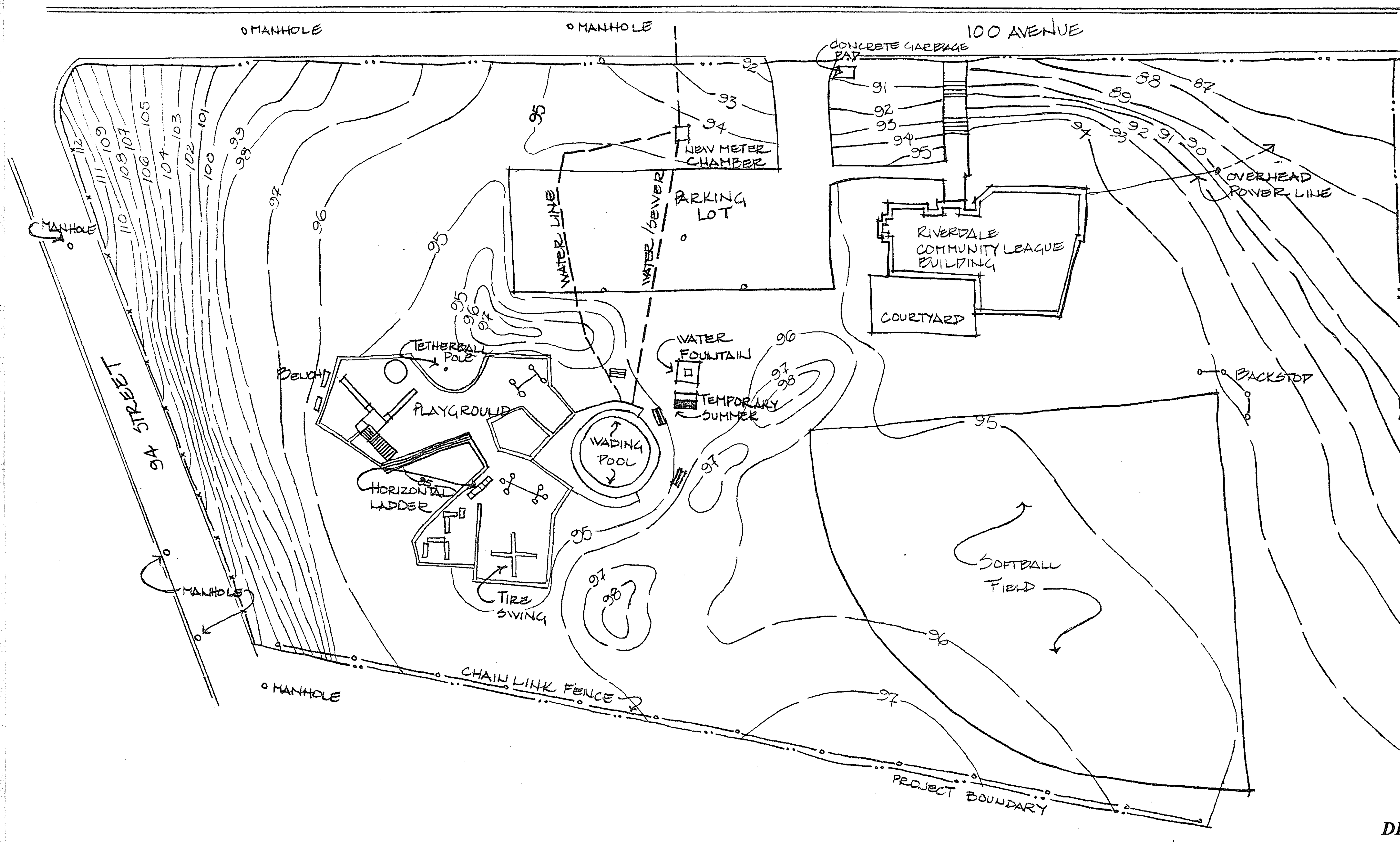
4.4.2 SITE SPECIFIC INVENTORY

The specific inventory information that follows includes key inventory elements the existing built structures, topography, hydrology, site's soils, and vegetation.

i) Built Structures

The existing built structures on site, as shown on the **Built Structures** drawing include the Riverdale community league building and its adjacent fenced-in courtyard. An extensive play area occupies the middle of the site complete with a wading pool, tire swing, junior and senior swings, a multi-deck for climbing, horizontal ladder, and tetherball. A drinking fountain is located centrally in the park near the wading pool. Next to it is a temporary summer shed which provides storage for the games and activities offered in the park through the Edmonton Parks and Recreation Department. A large parking lot accommodates approximately 30 cars and two basketball hoops. A small scale softball field lies in the southeast corner of the site and delineates the eastern boundary of the study site. To the east of the softball field is an outdoor skating rink, which delineates the east boundary of the project site. Drawing 4.1 - Built Structures also shows the location of the new meter chamber, water line, manholes, catch basins, benches and picnic tables.

RIVERDALE PARK



DRAWING 4.1

BUILT STRUCTURES

SCALE 1:250

↑ **NORTH**

NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

ii) Topography

Site topography, as shown on Drawing 4.2 illustrates the 1 foot contours * and numerous spot elevations, ranging from **112** feet on the west side at 94 Street to **87** feet on the east side of the site. This represents the steepest slopes on the site. By knowing site topography and identifying high and low spots, natural drainage may be assessed. Small berms were added near the parking lot and community league building in the past.

iii) Slope Analysis

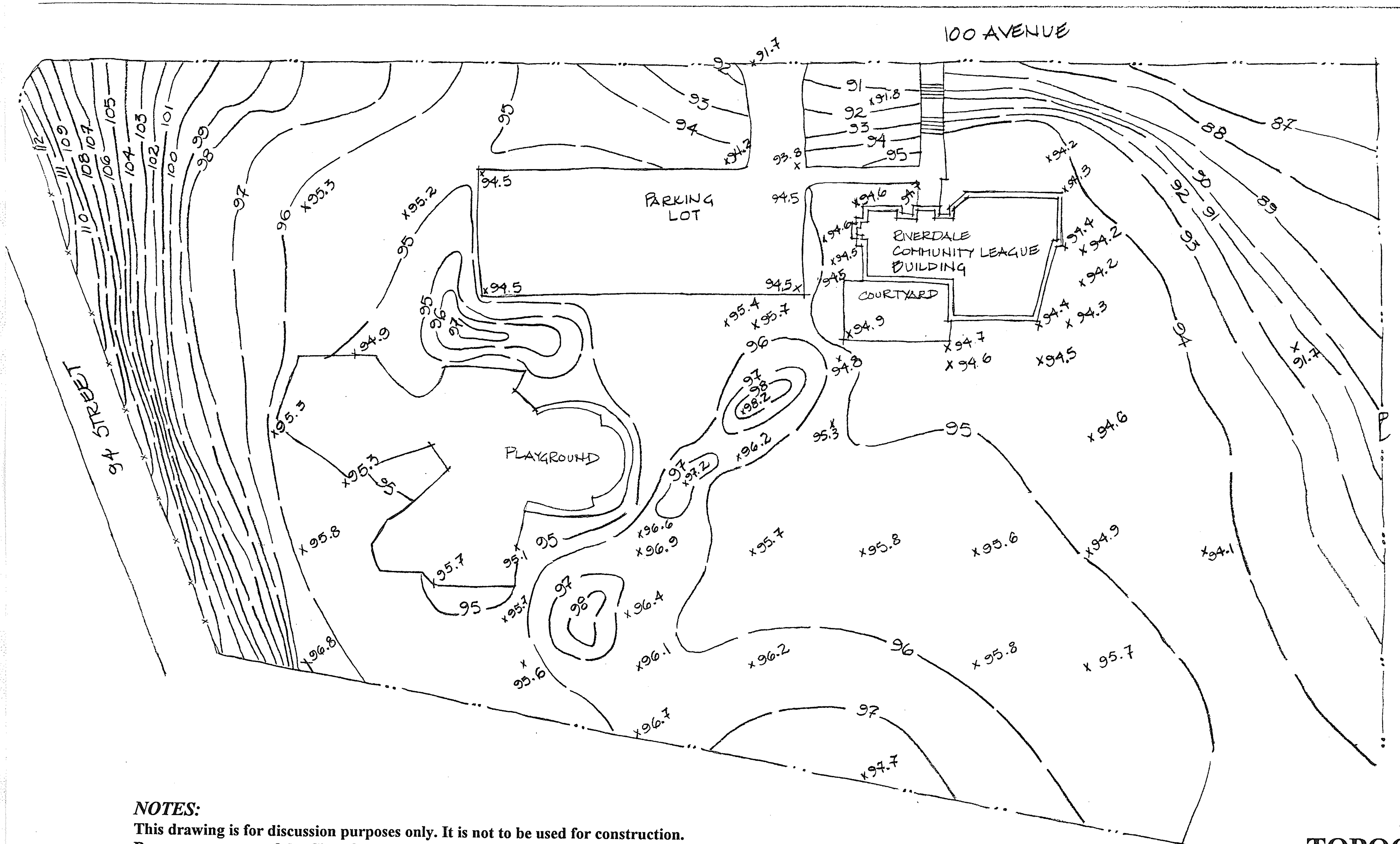
Analyzing the slope provides a detailed account of slope steepness, which is important for site design. Drawing 4.3 - Slope Analysis illustrates the slope analysis of the site showing four slope categories.

iii) Hydrology

Elevation changes provide opportunities for catching and re-directing the naturally falling precipitation. **Drawing 4.4 - Hydrology** illustrates general water flow direction, and low spots where water tends to accumulate. Parking lot draining is accommodated by a centrally located catch basin.

* The base drawings supplied by Parks and Recreation provided the contours in imperial measurement. This standard is used in this project.

RIVERDALE PARK



NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

X SPOT ELEVATION

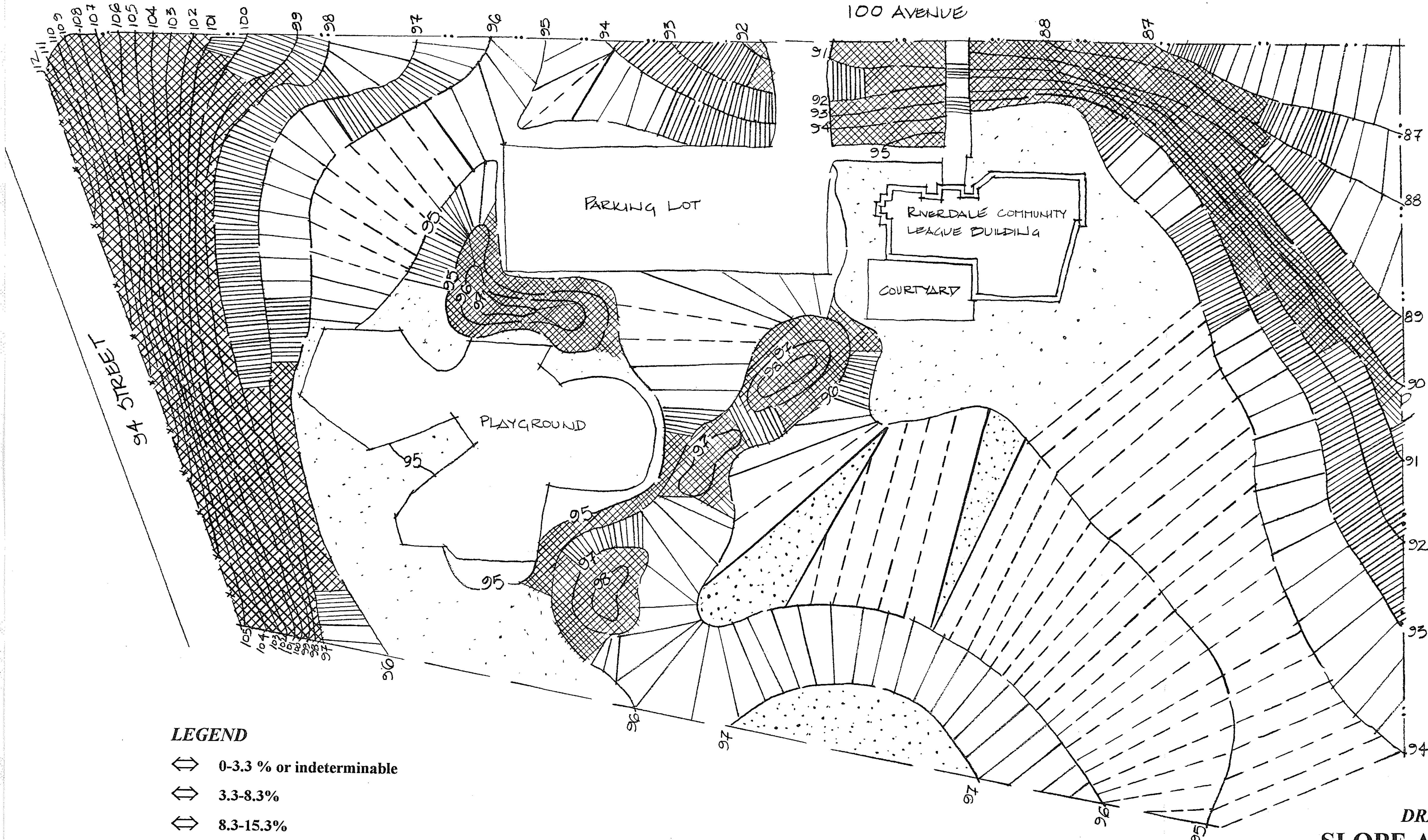
DRAWING 4.2

TOPOGRAPHY

SCALE 1:250

↑ NORTH

RIVERDALE PARK



LEGEND

- 0-3.3 % or indeterminable
- 3.3-8.3%
- 8.3-15.3%
- 15.3-25%
- > 25%

NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department.

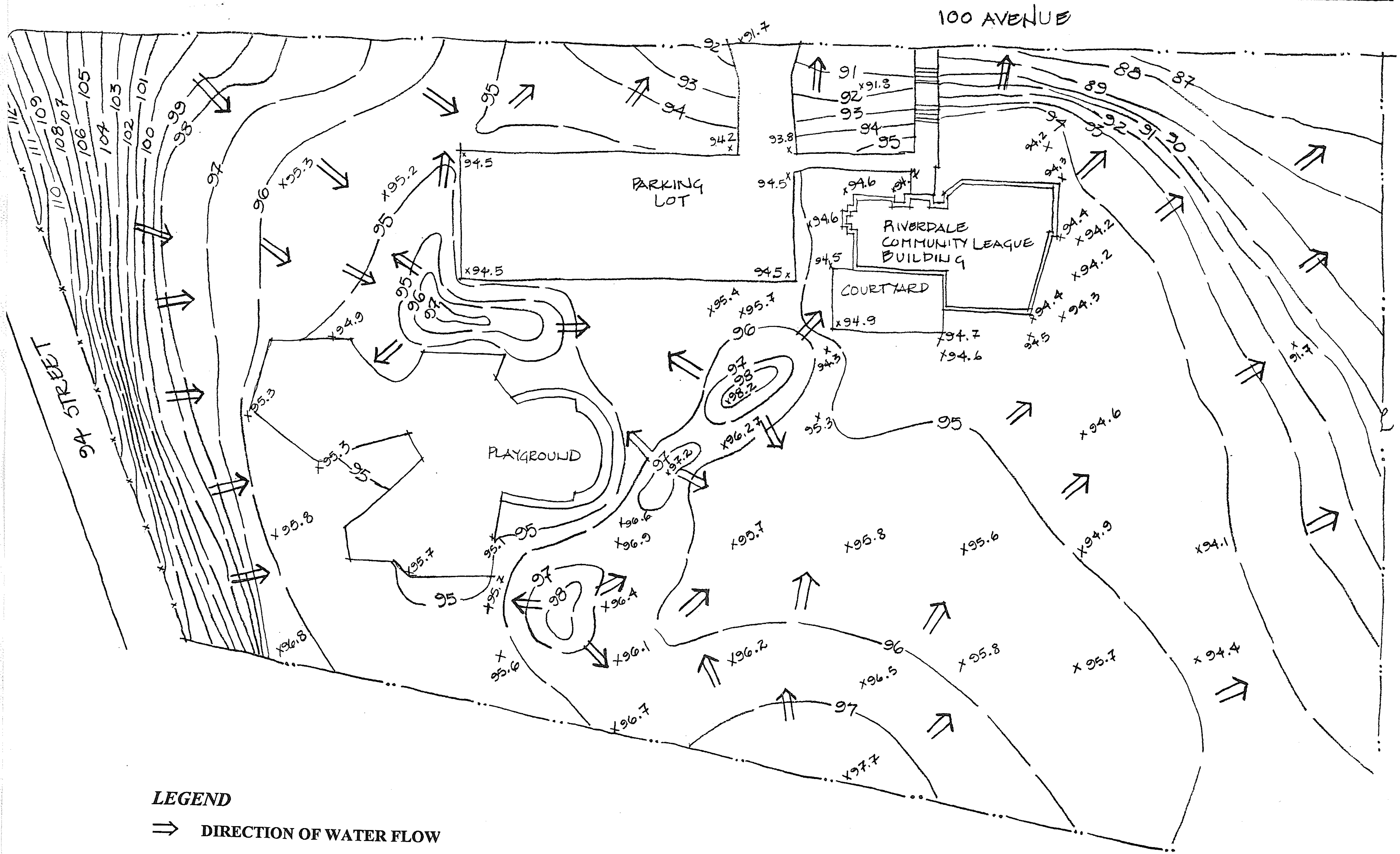
DRAWING 4.3

SLOPE ASPECT

SCALE 1:250

↑ **NORTH**

RIVERDALE PARK



LEGEND

⇒ DIRECTION OF WATER FLOW

DRAWING 4.4

HYDROLOGY

SCALE 1:250

↑ **NORTH**

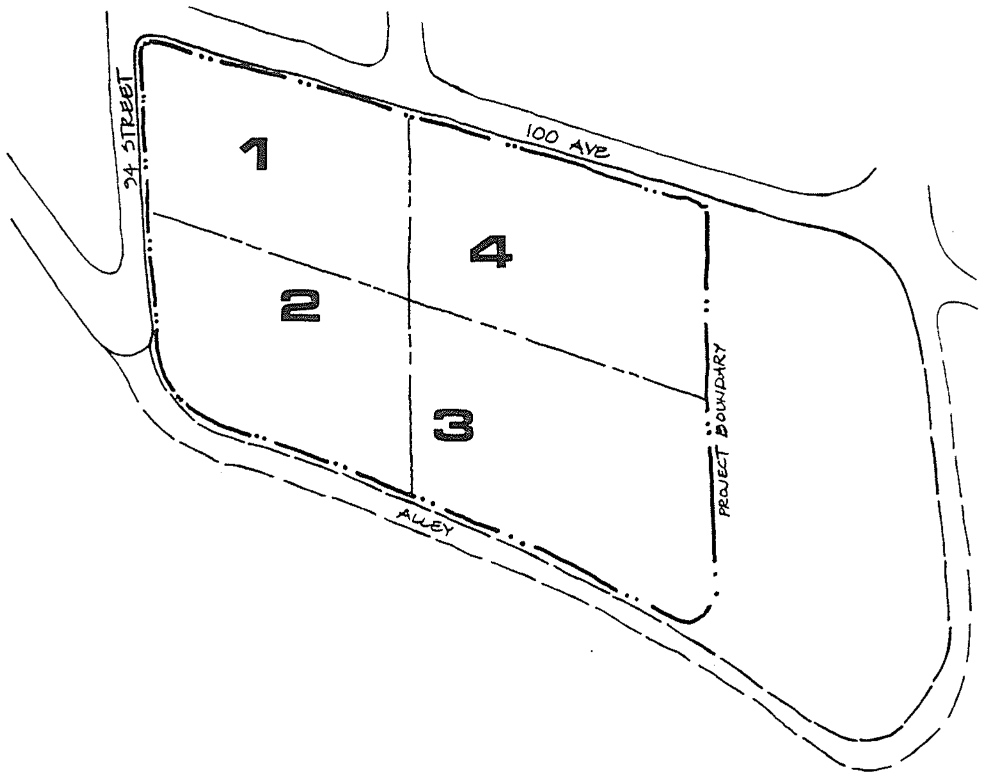
NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

iv) Soils

Soil physically supports plant material and acts as a reservoir for water and nutrient requirements. In assessing a site, knowledge of the physical aspects of soil such as particle size, pH, and electrical conductivity (EC) is important. In the early fall of 1993, the Riverdale Park site was divided into four quadrants, as shown on Figure 4.2, from which a soil sample was taken using a eight inch soil auger.

FIGURE 4.2 - ***LOCATION OF SOIL SAMPLES***



Three soil tests were performed on each sample: 1) electrical conductivity (EC) which measures the amounts of salts in dsm -1 (SI units); 2) soil pH; and 3) particle size to determine the ratio of sand to silt to clay. Test results are shown below in Table 4.2.

TABLE 4.2 -*RESULTS OF SOIL TESTS*

TEST PERFORMED	QUADRANT #1	QUADRANT #2	QUADRANT #3	QUADRANT #4
EC (dsm-1)	0.02	0.43	0.16	0.15
pH	6.81	6.89	7.72	6.92
% SAND	41.00	33.50	78.10	76.70
% SILT	36.50	44.50	14.40	13.60
% CLAY	22.50	22.0	7.50	9.70

Source: Testing Courtesy of the Soil Science Department, University of Alberta, 1994.

The University of Alberta Soils Science Department uses an internal working standard derived from a site near Ellerslie, Alberta. When comparing the findings from the tests performed on the demonstration site's soils to the Ellerslie internal working standard, it was found that the soils on site have very low salts and will not pose a threat to plant growth (personal communication, Konwicki, 1994).

The University of Alberta uses a bench mark standard of 6.0 for comparing soil pH, which is also derived from the Ellerslie test site. The pH of the site is slightly higher than the Ellerslie standard, but represent very neutral readings and will not pose a problem for growing most vegetation on site (personal communication, Konwicki, 1994).

Sample testing determined the ratio of sand, silt and clay. By taking the average of four test sites, the soils at the Riverdale Park site would be roughly classified as sandy loam (Harapiak 1986). Thus, the soil has a coarse texture rating, with potentially 8 cm of available water within 1 metre of moist soil. This type of soil is conducive to plant growth.

v) **Existing Vegetation**

Existing trees and shrubs at the Riverdale Park site were identified (assisted by H. Knowles) with five species each of deciduous and coniferous trees, and three species of shrubs found. The park's plant material was compared to the lists of plants believed to tolerate a greater degree of water stress (see Appendix 1) to ascertain which of the existing site vegetation would be considered to have a greater degree of water stress tolerance. The information gathered for the plant material at the Riverdale Park site is summarized in Tables 4.3, 4.4 and 4.5.

TABLE 4.3 - *CONIFEROUS WITH WATER STRESS TOLERANCE*

BOTANICAL NAME	COMMON NAME	CONSIDERED TO BE WATER STRESS TOLERANT
Picea pungens	Colorado Spruce	Yes
Pinus sylvestris	Scots Pine	Yes
Pinus contorta	Lodgepole Pine	No
Picea glauca	White Spruce	No
Pinus banksiana	Jack Pine	Yes

Table 4.4 shows that two of the five deciduous tree species in the park are considered to have a greater degree of water stress tolerance.

TABLE 4.4 ***DECIDUOUS TREES WITH WATER STRESS TOLERANCE***

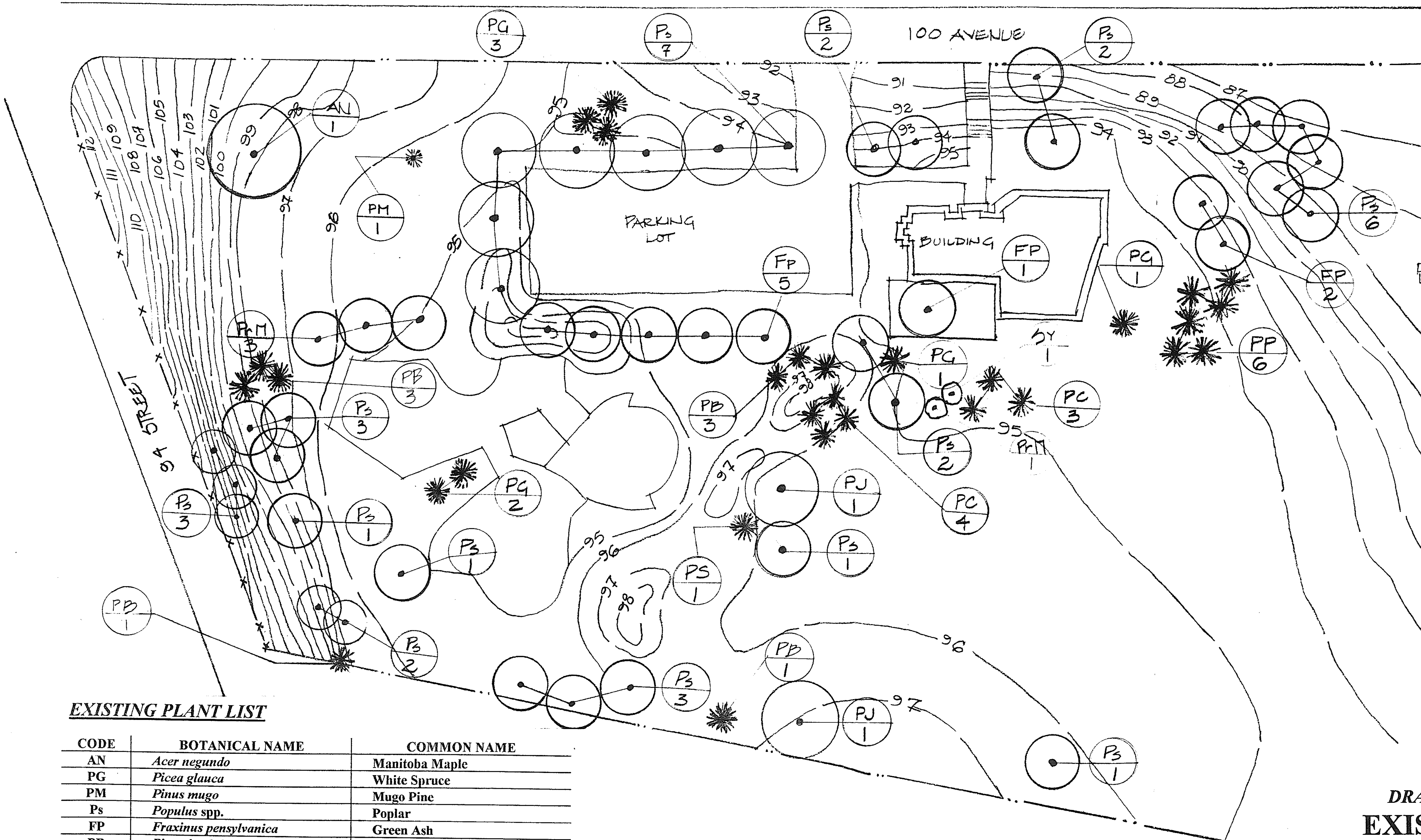
BOTANICAL NAME	COMMON NAME	CONSIDERED TO BE WATER STRESS TOLERANT
Fraxinus pennsylvanica	Green Ash	Yes
Populus x jackii "northwest"	Northwest Poplar	No
Populus spp.	Poplar	No
Prunus maackii	Amur Cherry	No
Acer negundo	Manitoba Maple	Yes

Table 4.5 lists the existing shrubs found at the Riverdale Park site. As indicated, all shrubs identified are considered to have a greater degree of water stress tolerance.

TABLE 4.5 - ***SHRUBS WITH WATER STRESS TOLERANCE***

BOTANICAL NAME	COMMON NAME	CONSIDERED TO BE WATER STRESS TOLERANT
Syringa vulgaris	Common Lilac	Yes
Prunus spp.	Cherry/Plum	Yes
Pinus mugo	Mugo Pine	Yes

RIVERDALE PARK



EXISTING PLANT LIST

CODE	BOTANICAL NAME	COMMON NAME
AN	*Acer negundo*	Manitoba Maple
PG	*Picea glauca*	White Spruce
PM	*Pinus mugo*	Mugo Pine
Ps	*Populus* spp.	Poplar
FP	*Fraxinus pensylvanica*	Green Ash
PB	*Pinus banksiana*	Jack Pine
PC	*Pinus contorta*	Lodgepole Pine
PP	*Picea pungens*	Colorado Spruce
PrM	*Prunus mackii*	Amur Cherry
PS	*Pinus sylvestris*	Scots Pine
Sy	*Syringa* spp.	Lilac
PJ	*Populus x jackii* 'Northwest'	Northwest Poplar

NOTES:

The majority of the site is covered with turf grass.
This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

DRAWING 4.5

EXISTING VEGETATION

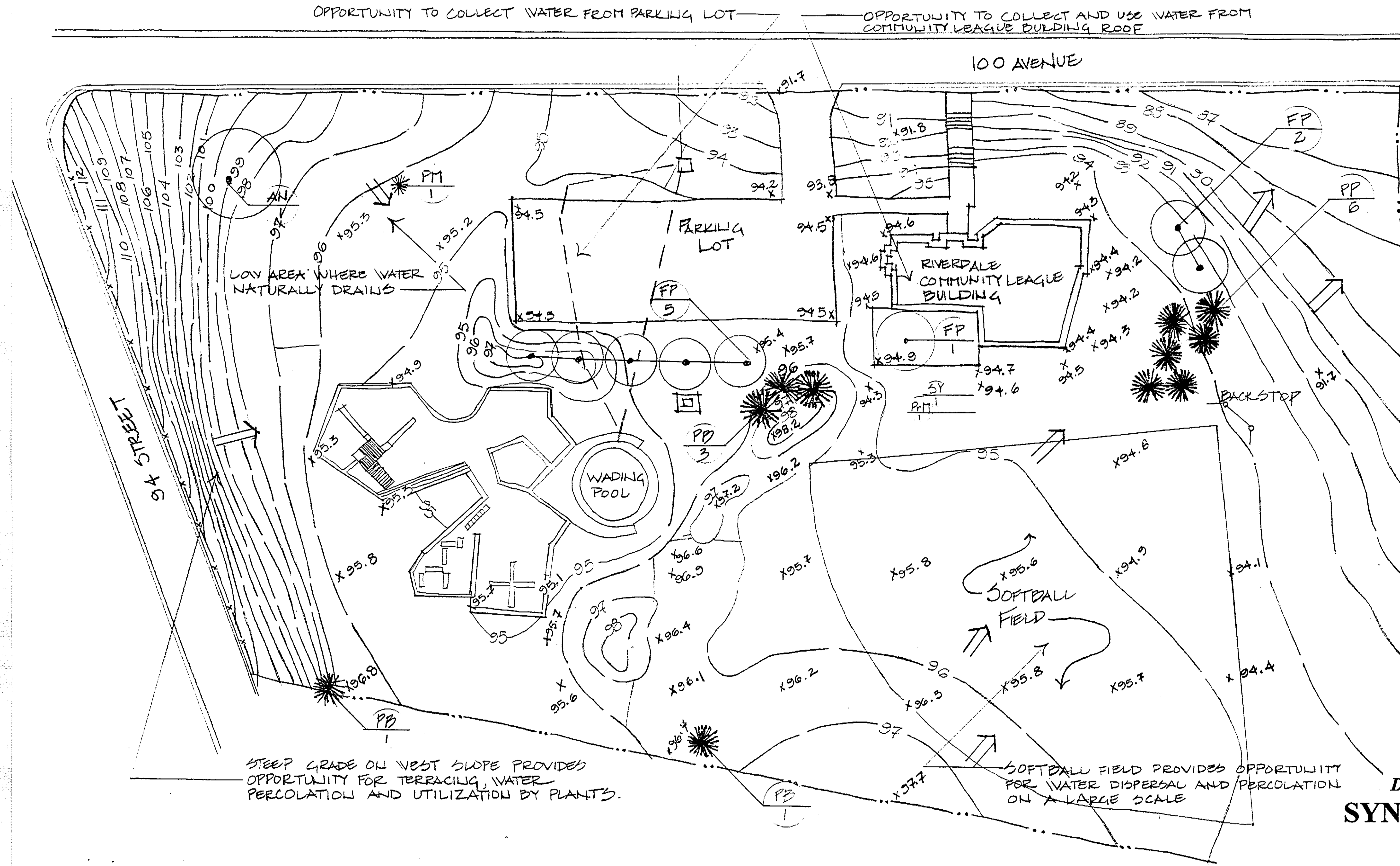
SCALE 1:250

↑ **NORTH**

4.5 SYNTHESIS OF OPPORTUNITIES AND CONSTRAINTS

Generally, with respect to water management, the temperature range in the Edmonton area will limit plant selection, hardiness and growth. As the wind is primarily from the north/northwest moisture loss may result, but not in any amounts that would be above normal or be of concern. As the site is in the river valley, microclimate conditions may result in warmer daytime temperatures and more frequent night time frost, especially in early fall and late spring. The valley location is also more prone to fog, which has a cooling effect on plant material. Due to the site's location on a river terrace, there may be seasonal fluctuations in the water table, which may affect the amount of water in the soil available for plant uptake. As well, this river terrace soil may have silt and clay lenses that may affect percolation rates, and may lack cohesion resulting in potential erosion.

Drawing 4.6 **Synthesis** graphically summarizes the inventory information and identifies areas of potential problems and opportunities for managing on-site water. The drawing shows the direction of water movement over the site and low areas where water naturally drains, elements and structures such as the play structure, community league building, water line, parking lot, softball field, and the chain link fence which defines the site's south boundary. Existing vegetation considered to be able to withstand drought stress is also shown on Drawing 4.6 and includes *Pinus banksiana, Acer negundo, Pinus sylvestris, Picea pungens, Fraxinus pennsylvanica, Syringa* spp. and *Pinus mugo.*



RIVERDALE PARK

DRAWING 4.6

SYNTHESIS

SCALE 1:250

↑ **NORTH**

NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department.

5.0 APPLICATION OF PRINCIPLES TO SITE DESIGN

5.1 DESIGN CONCEPT

From the children who come to play in the playground or softball field, to the people who attend functions at the community league building, or enjoy the river valley with its trails, opportunities exist to educate and demonstrate ways to manage water at the Riverdale Park site. The concept for the park, as detailed in Drawing 5.1 **Concept Plan** (p. 84) hinges on three initiatives - managing water, utilizing water, and educating park visitors. To manage water on site, slope terracing is recommended, a downspout collection system is designed for the Community league building, and water is collected from the parking lot and directed to a dry well. Managing water also includes allowing water to percolate to groundwater, which is accomplished through the choice of materials including shale paving and boardwalk bridges.

To utilize the water falling on site and that which is collected, additional plant material is recommended. Plant material choices, including trees, shrubs and perennials, should include those which are more tolerant of water stress. (See Appendix 1 for lists of plants considered to withstand water stress). To educate visitors and provide reminders of water movement, a dry streambed meanders through the site with its main function being educational. A pergola is added as a focal point at the wading pool's east side in order to draw people into the park where they can learn about water management.

Figures 5.1, 5.2, 5.3 and 5.4 illustrate the design ideas for the park. These ideas are common in most parts of the site and are not specific to one area.

FIGURE 5.1 - ***SECTIONAL DETAIL OF WALKWAY*** (not to scale)

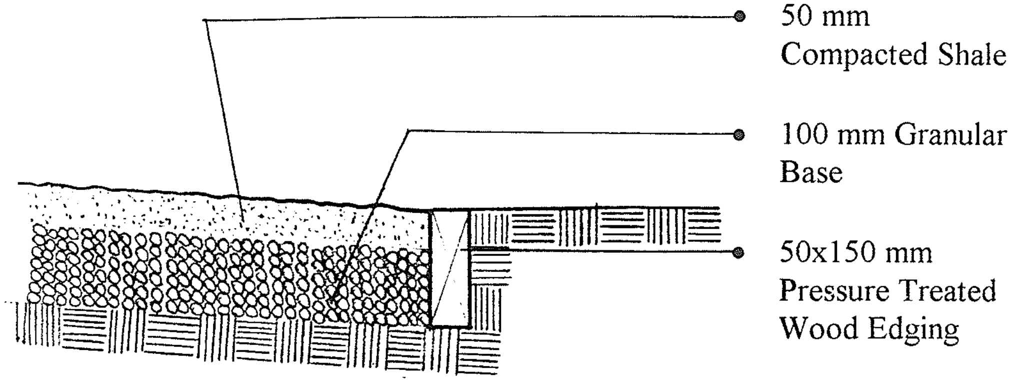


FIGURE 5.2 - ***PLAN DETAIL OF WALKWAY/BOARDWALK BRIDGE***
(not to scale)

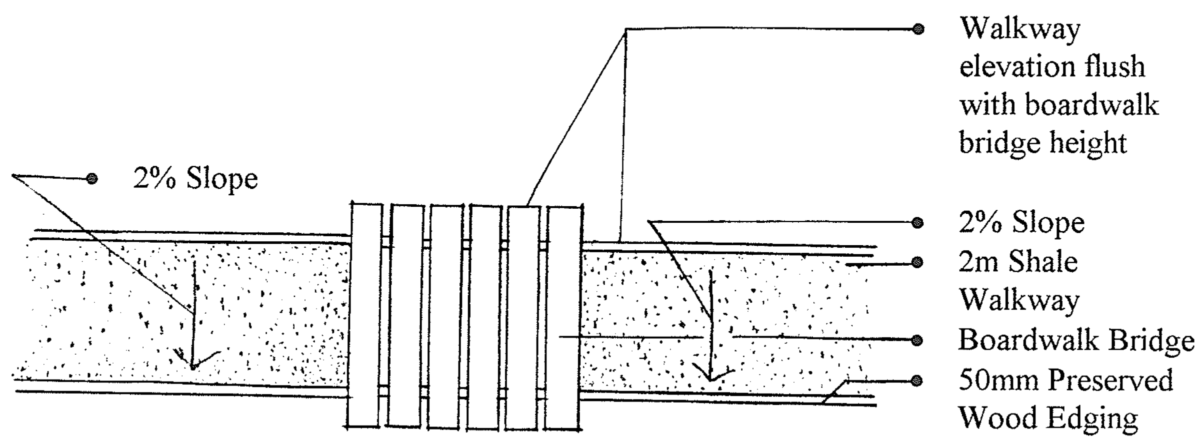


FIGURE 5.3 - ***SECTION SHOWING WALKWAY/BOARDWALK BRIDGE***
(not to scale)

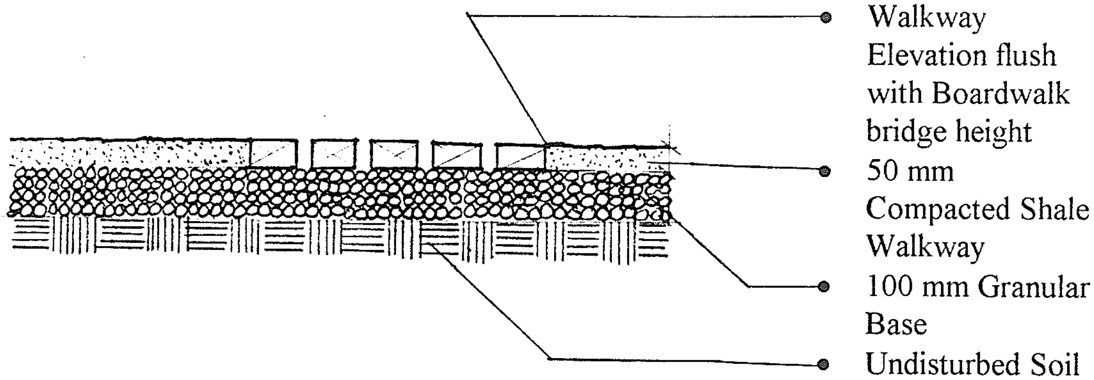
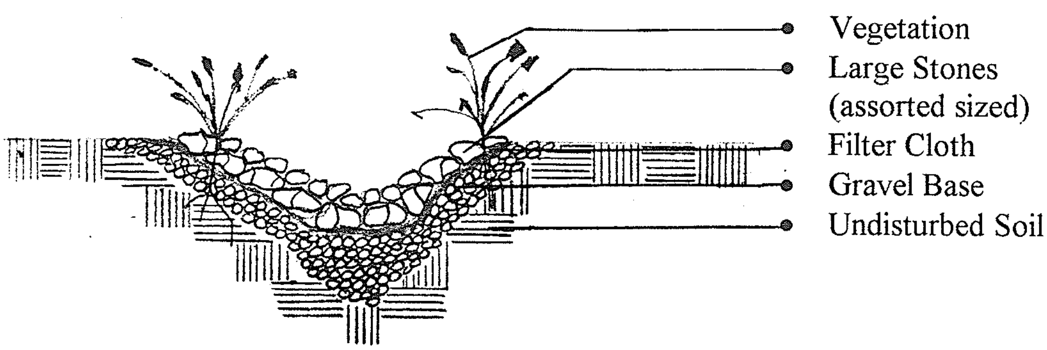
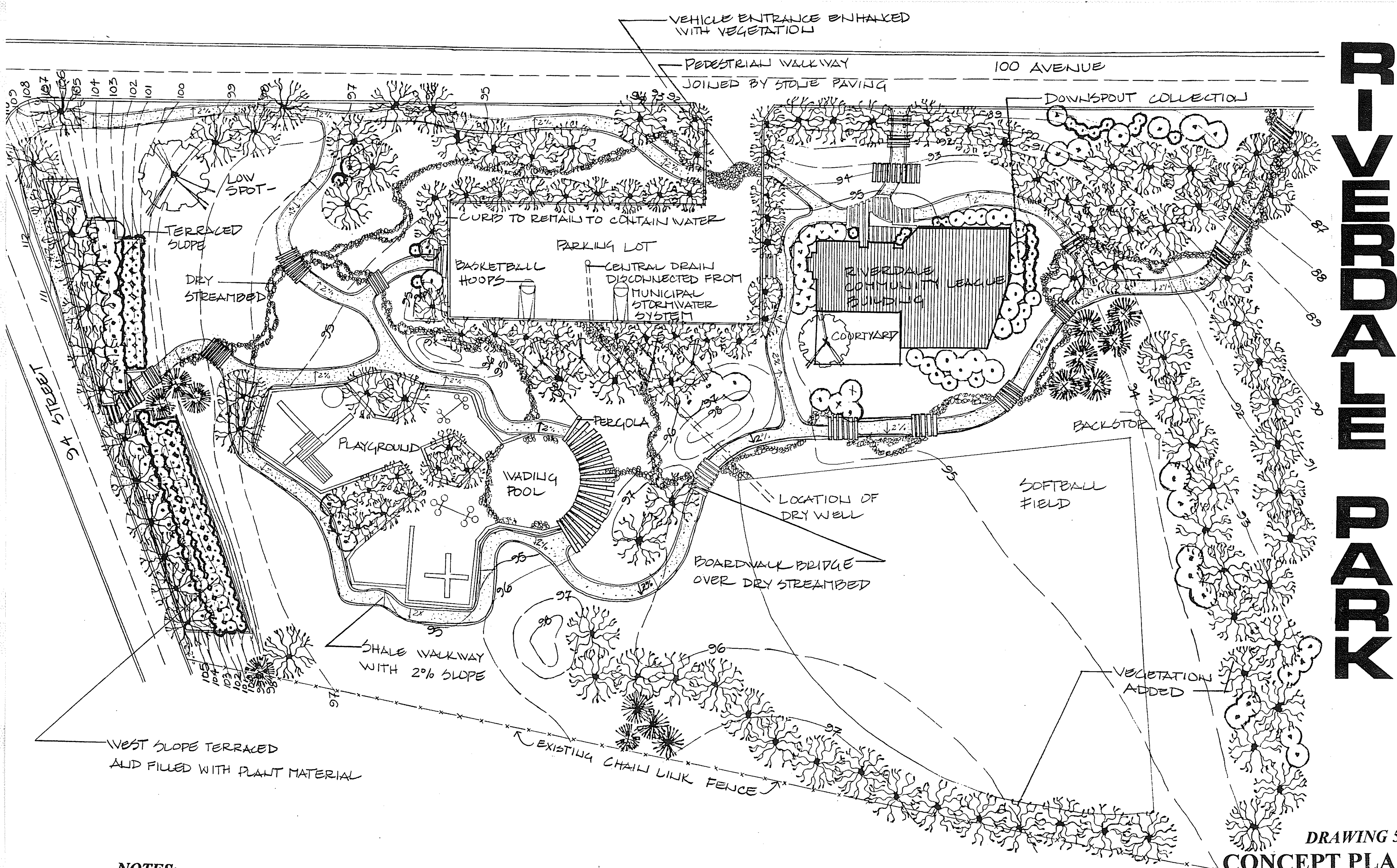


FIGURE 5.4 - ***DRY STREAMBED DETAIL***
(not to scale)



Drawing 5.1 Concept Plan illustrates the main design initiatives for managing water at the Riverdale Park site.



DRAWING 5.1

CONCEPT PLAN

SCALE 1:250

↑ NORTH

NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

5.2 SITE ZONING

The inventory, analysis and synthesis are used in conjunction with the methods and guidelines to demonstrate ways to achieve water management at site design. To demonstrate this, the site is divided or "de-constructed" into nine zones. Drawing 5.2 illustrates the division of the site into the nine zones.

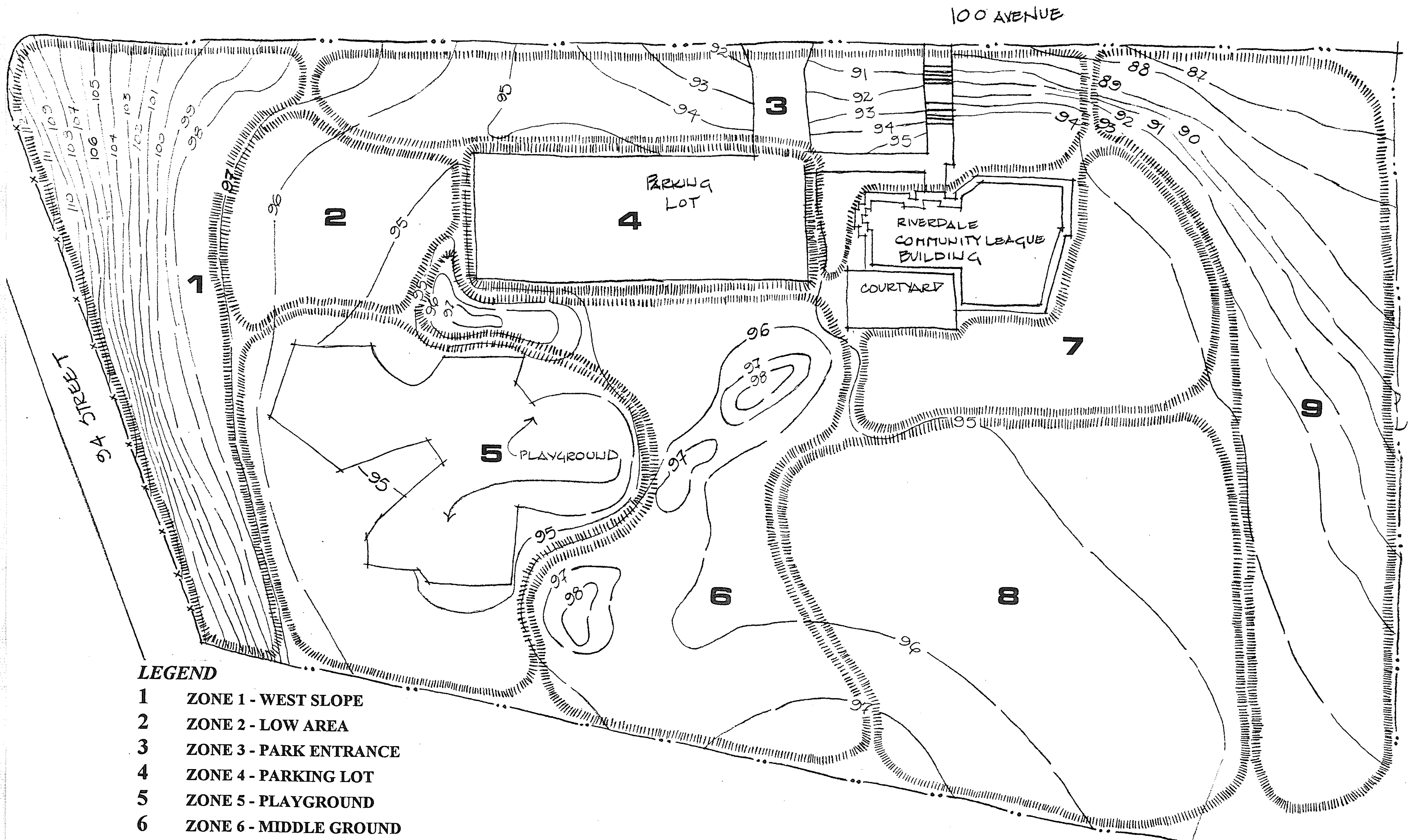
- **Zone 1 - The West Slope**: The west slope is covered with existing vegetation including grass, shrubs and trees, and represents the westerly site boundary. Zone 1 offers management opportunities by terracing the slope and keeping water from moving down slope. Plant material added to the slope will utilize the water.
- **Zone 2 - The Low Area**: The low area is located at base of the west slope and is an area where water naturally drains. This area will naturally manage water as it drains to the low area and seeps into the ground, thus replenishing the ground water system. This area remains in turf grass.
- **Zone 3 - The Park Entrance**: The park entrance spans most of 100 Avenue and welcomes visitors to the site, whether they arrive in cars, on foot or bike. This zone offers opportunities to educate the visitor by use of the dry streambed, the addition of plant material, and by enticing visitors into the site.
- **Zone 4 - The Parking Lot**: The existing asphalt parking lot accommodates about 30 cars and has two basketball baskets incorporated along the south edge. The proposed design plans to contain the water from the parking lot which currently drains to the municipal storm water system. The collected water is managed by directing it from the parking lot to an underground pipe system which is further directed to an on-site dry well.
- **Zone 5 - The Playground**: The playground area has a number of swings, a wading pool, and climbing apparatus set in a sand base. A pergola is added as a focal point, making this zone a key educational tool on the site. As well, water is managed by

allowing it to percolate into the ground by the continued use of the sand base under the play structures.

- **Zone 6 - The Middle Ground:** The middle ground represents the central part of the site. The dry streambed meanders it way through the zone, acting as a reminder and educator of the potential movement of water. Vegetation is added to utilize water falling on the site.
- **Zone 7 - The Community League Building Area**: The existing Riverdale community league building, with its lean-to type sloped roof incorporates offices and a gym. Water is managed in this zone by incorporating a downspout collection system which directs water from the roof to a piped irrigation system. The water can then be utilized by the additional plant material added to this zone.
- **Zone 8 - The Softball Field**: The softball field is a relatively flat, grassy area in the southeast corner of the site. Zone 8 assists in managing site water by including a dry well which accepts water from the parking lot. The dry well allows water to seep into the ground water and also accepts overground runoff during major storm events.
- **Zone 9 - The East Slope**: The east slope represents the most eastern site boundary, sloping towards the adjacent skating rink. Water is utilized and kept on site by the addition of plant material and mulch.

Following Drawing 5.2 **Site Zoning**, each zone is discussed in more detail, starting with the design intent, followed by the management methods for that zone where applicable, and a list of existing plant material and a proposed planting list.

RIVERDALE PARK



LEGEND

1	ZONE 1 - WEST SLOPE
2	ZONE 2 - LOW AREA
3	ZONE 3 - PARK ENTRANCE
4	ZONE 4 - PARKING LOT
5	ZONE 5 - PLAYGROUND
6	ZONE 6 - MIDDLE GROUND
7	ZONE 7 - COMMUNITY LEAGUE BUILDING
8	ZONE 8 - SOFTBALL FIELD
9	ZONE 9 - EAST SLOPE

DRAWING 5.2

SITE ZONING

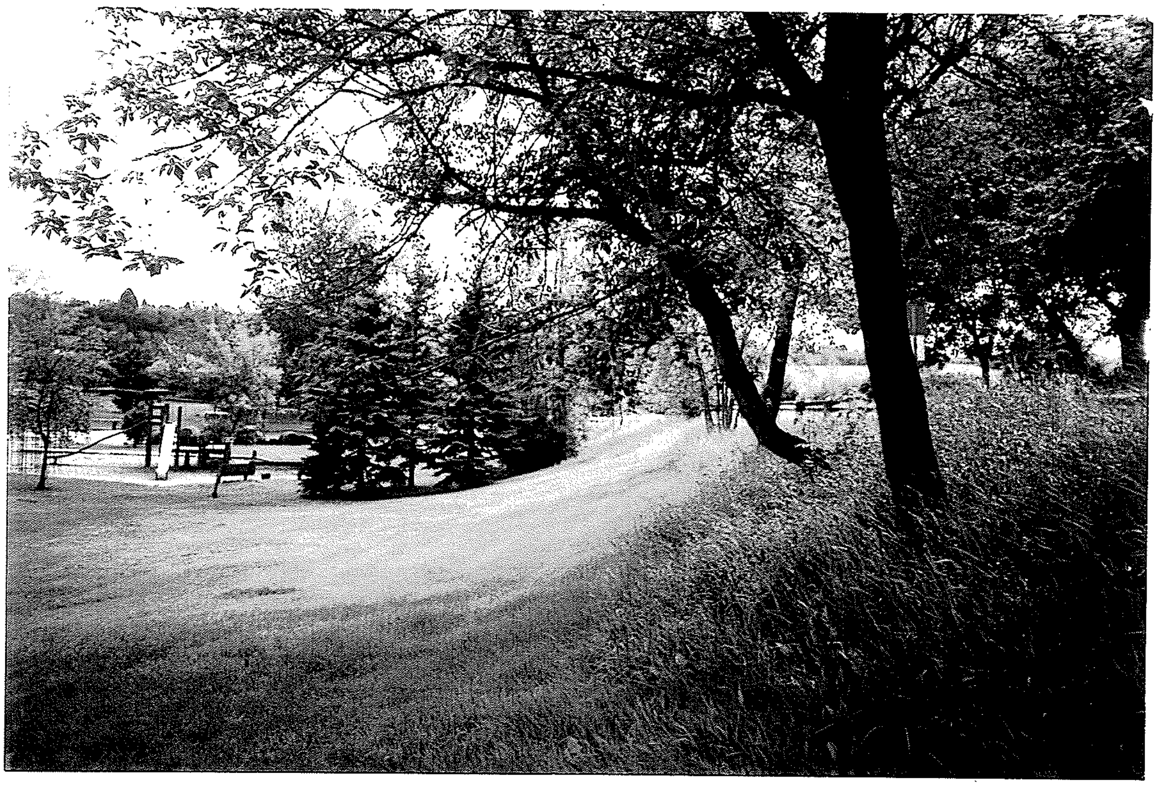
SCALE 1:250

↑ **NORTH**

NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

5.2.1: ZONE 1 - THE WEST SLOPE



Design Intent

The most westerly slope of the site was chosen as Zone 1, and represents a change in elevation of approximately 8 metres at its greatest point. Pedestrian circulation begins from the two entrance points and as it works its way down the slope becomes a series of wooden steps and landings*. Wooden steps allow water to run off and seep into the ground. The west slope offers management opportunities by terracing the slope in order to catch the natural

* It is recommended that handicapped visitors use the parking lot as their entrance.

precipitation falling on site, and assist in replenishing the groundwater system. Additional plant material will utilize and benefit from the water detained on the slope. This additional plant material will require watering for the first two years or until adequately established.

Water Management Methods

The water management methods proposed for this zone is terracing as detailed below. Figure 5.5 shows how the original slope would be schematically cut to incorporate a terrace.

FIGURE 5.5 - ***SECTION SHOWING ORIGINAL SLOPE***
(not to scale)

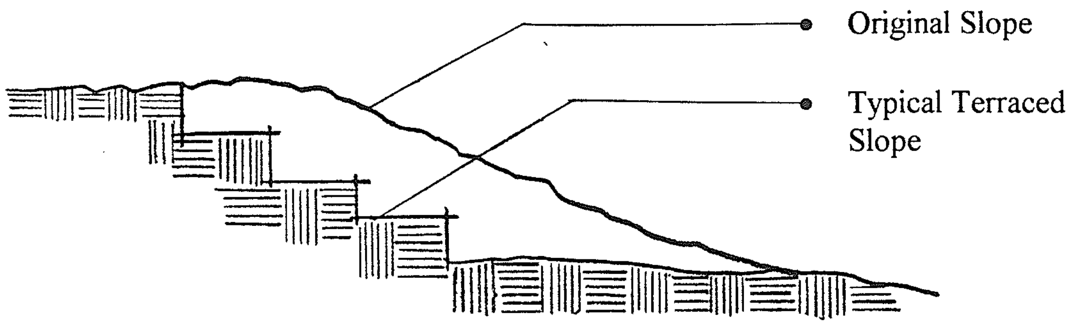
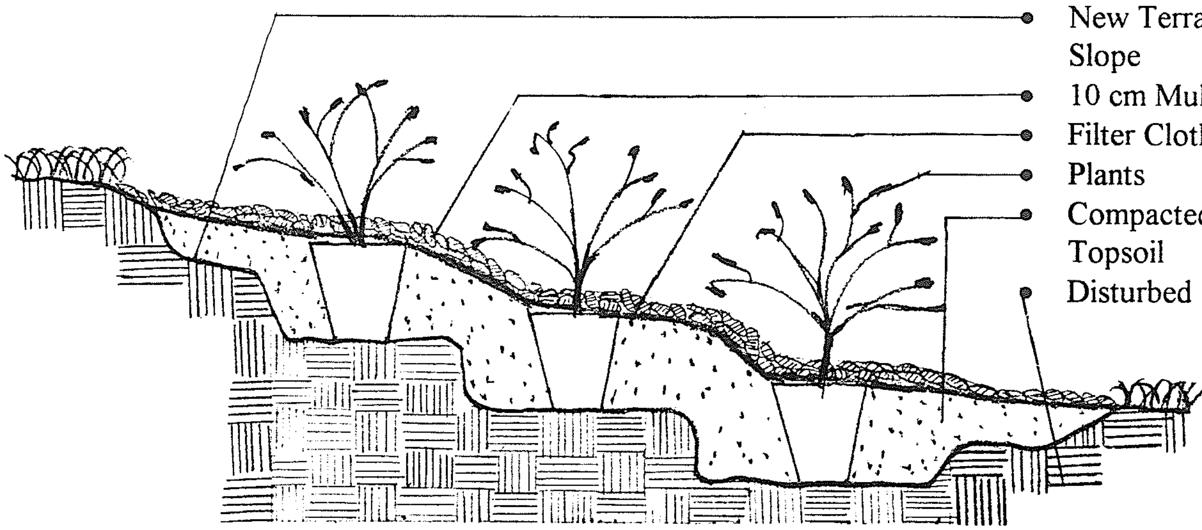


Figure 5.6 shows the incorporation of plants, mulch and top soil into the altered slope. This is the recommendation for the west slope in Riverdale Park.

FIGURE 5.6 - ***SECTION SHOWING SLOPE TERRACE***
(not to scale)



Existing And Proposed Vegetation

The following two tables, Table 5.1 and Table 5.2 list the vegetation existing in the zone, and the proposed vegetation. The proposed vegetation table provides the number and size of each plant recommended.

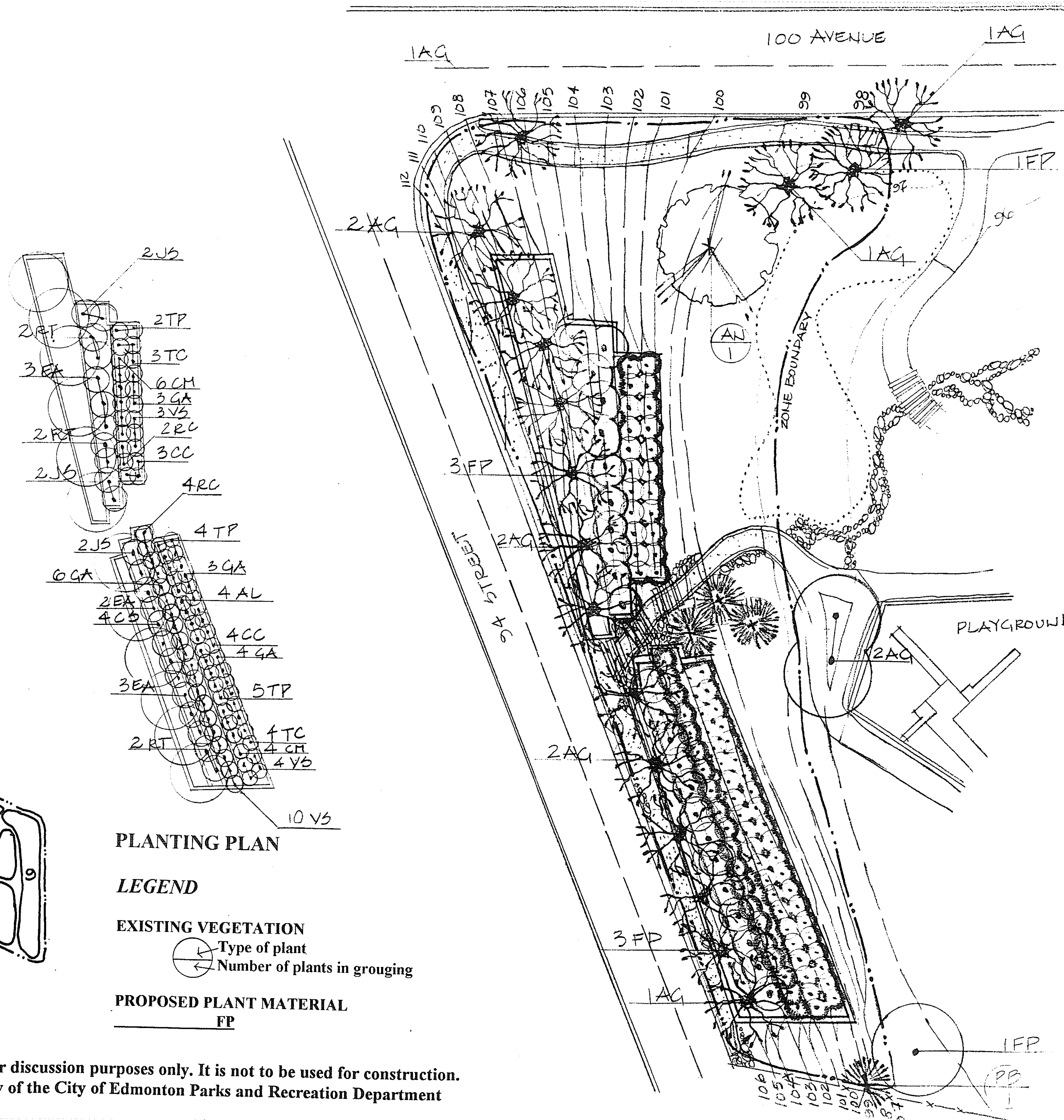
TABLE 5.1 - ***EXISTING VEGETATION***

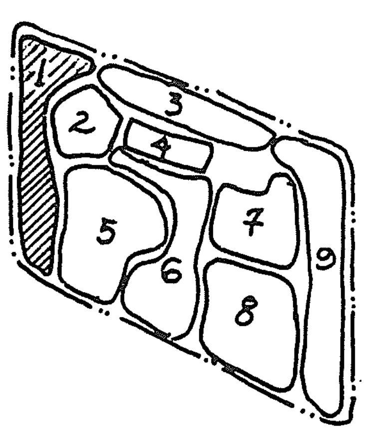
SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER
AN	*Acer negundo*	Manitoba Maple	1
PB	*Pinus banksiana*	Jack Pine	4
Ps	*Populus spp.*	Poplar	9

TABLE 5.2 - *PROPOSED PLANT MATERIAL*

SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER	SIZE
AG	*Acer ginnala*	Amur Maple	10	2.5"caliper
FP	*Fraxinus pennsylvanica*	Green Ash	7	2.5"caliper
JS	*Juniperus sabina*	Savin Juniper	6	1 gal. pot
RT	*Rhus trilobata*	Lemonade Sumac	6	2 gal. pot
EA	*Euonymus alatus*	Burning Bush	8	5 gal. pot
CS	*Cornus sericea*	Red Osier Dogwood	4	2 gal. pot
VS	*Veronica spp.*	Speedwell "Sunny Border Blue"	7	1 gal. pot
GA	*Gaillardia aristata*	Wild Blanket Flower	16	4" pot
AL	*Artemesia ludoviciana*	Silver King Sage	4	4" pot
TC	*Thymus citrodorus*	Thyme	7	4" pot
TP	*Thymus praecox*	Mother-of-thyme	11	4" pot
CC	*Campanula cochlearifolia*	Creeping Bellflower	7	4" pot
RC	*Ratibida columnifera*	Prairie Coneflower	6	1 gal. pot
CM	*Centaurea montana*	Cornflower	10	1 gal. pot

The following drawing, Drawing 5.3 shows the zone and it associated planting. See Drawing 5.12 for complete site planting plan and schedule.





KEY PLAN

PLANTING PLAN

LEGEND

EXISTING VEGETATION

Type of plant
Number of plants in grouging

PROPOSED PLANT MATERIAL

FP

NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

RIVERDALE PARK

DRAWING 5.3

ZONE 1 - WEST SLOPE

SCALE 1:250

↑ **NORTH**

5.2.2: ZONE 2 - THE LOW AREA

Design Intent

The area at the base of the west slope, adjacent to the parking lot and playground represents Zone 2. The key design intent of this zone plays on the natural inclination of the adjacent west slope which will supply this low area with naturally moving overflow water. The opportunity exists for catching this overflow water and replenishing the groundwater. It is recommended that the turf grass remain in this area.

Existing And Proposed Vegetation

The following two tables, Table 5.3 and Table 5.4 list the vegetation existing in the zone and the proposed vegetation. The proposed vegetation table provides the number and size of each plant recommended.

TABLE 5.3 - *EXISTING VEGETATION*

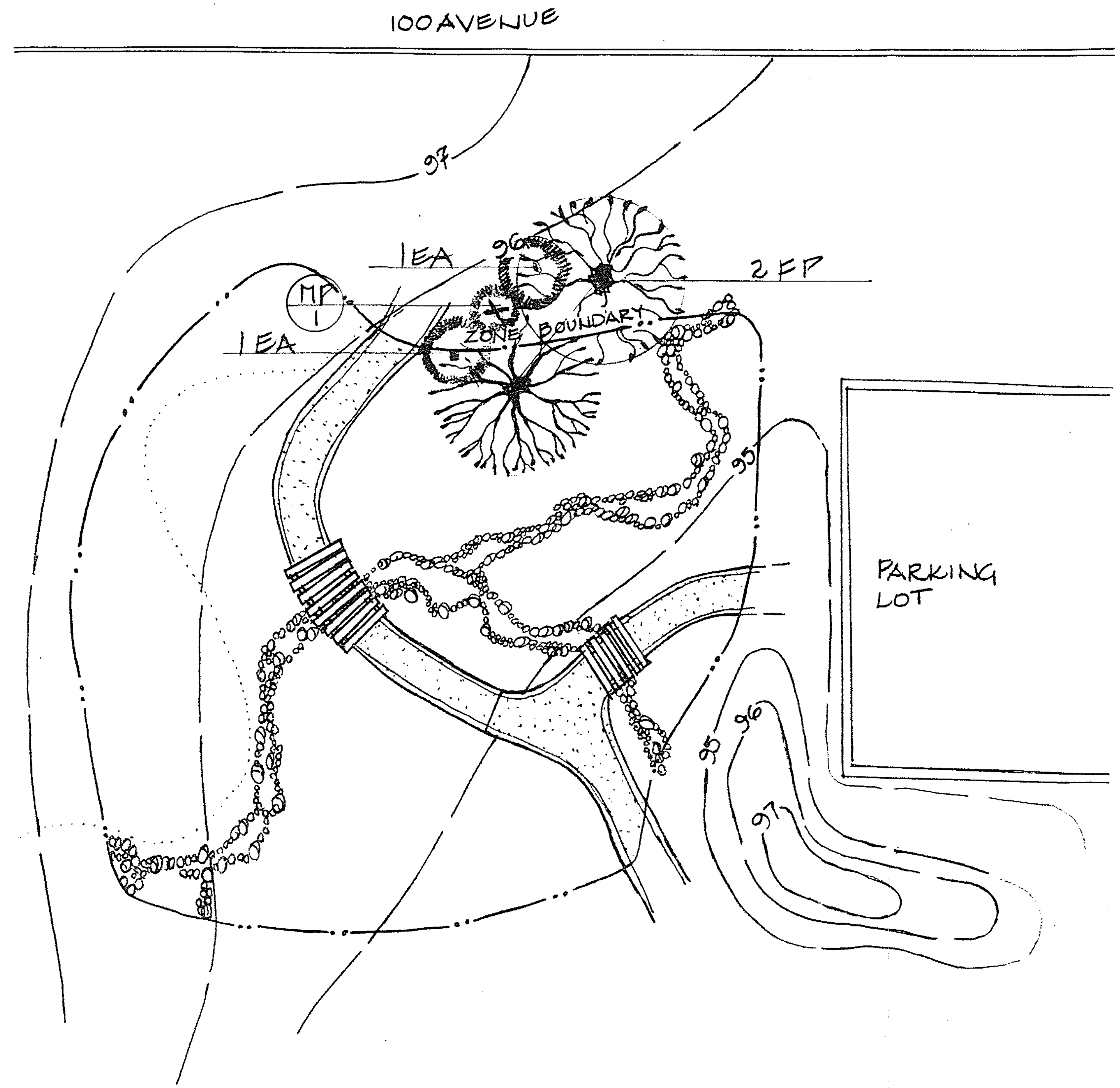
SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER
PM	*Pinus mugo*	Mugo Pine	1

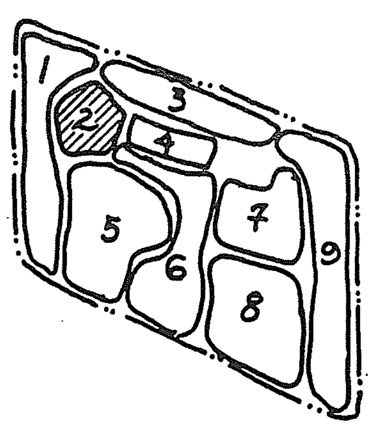
TABLE 5.4 - *PROPOSED PLANT MATERIAL*

SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER	SIZE
FP	*Fraxinus pennsylvanica*	Green Ash	2	2.5"caliper
EA	*Euonymus alatus*	Burning Bush	2	5 gal. pot

The following drawing, Drawing 5.4 shows the zone and it associated planting. See Drawing 5.12 for complete site planting plan and schedule.

RIVERDALE PARK





KEY PLAN

LEGEND

EXISTING VEGETATION

Type of plant
Number of plants in grouging

PROPOSED PLANT MATERIAL

FP

DRAWING 5.4

**ZONE 2 -
LOW AREA**

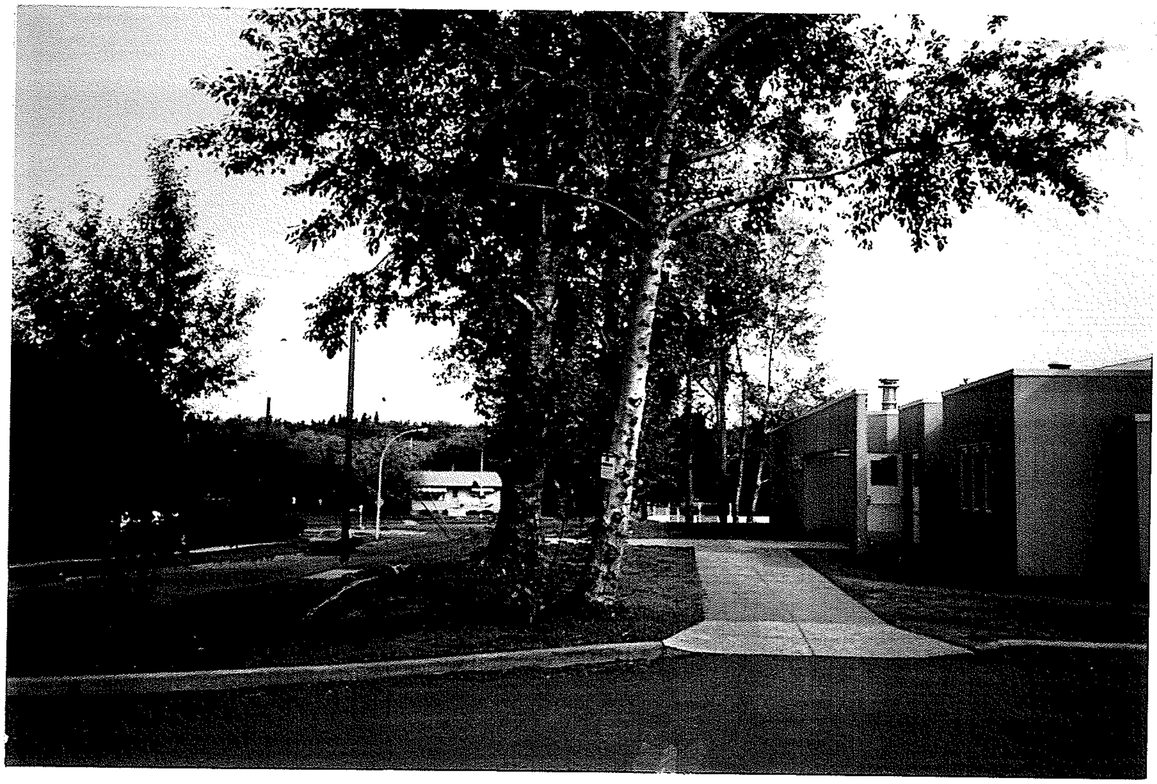
SCALE 1:250

↑ **NORTH**

NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

5.2.3: ZONE 3 - THE PARK ENTRANCE



Design Intent

Zone 3 represents the front door of the park - people's first introduction to the site and its water management messages. This zone spans the majority of 100 Avenue fronting the park, and welcomes everyone to the site including those in cars, on foot or bike. This zone offers opportunities to educate visitors by use of the dry streambed and addition of plant material able to withstand drought stress. The driveway into the parking lot, which dissects this zone in two, is enhanced with flowering trees creating a dynamic effect as one enters the site. A stone path joins the shale walkway on either side of the driveway, denoting pedestrian domain.

Existing And Proposed Vegetation

The following two tables, Table 5.5 and Table 5.6 list the vegetation existing in the zone and the proposed vegetation. The proposed vegetation table provides the number and size of each plant recommended.

TABLE 5.5 - *EXISTING VEGETATION*

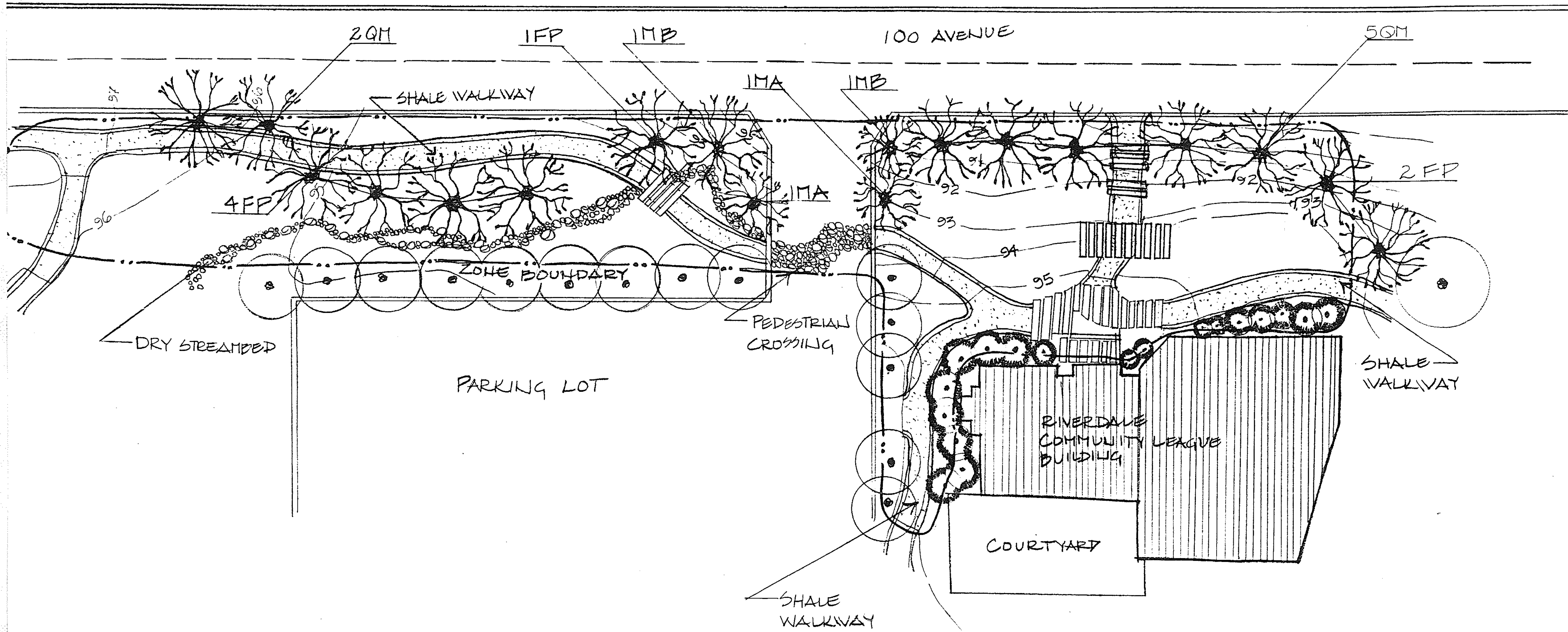
SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER
Ps	*Populus spp.*	Poplar	4

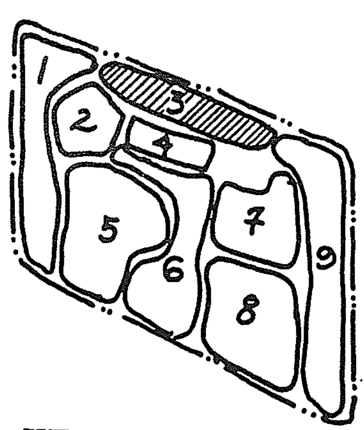
TABLE 5.6 - *PROPOSED PLANT MATERIAL*

SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER	SIZE
QM	*Quercus macrocarpa*	Bur Oak	7	2.5"caliper
FP	*Fraxinus pennsylvanica*	Green Ash	7	2.5"caliper
MA	*Malus* x *adstringens* "Almey"	Rosybloom Crabapple	1	5-6' height
MB	*Malus baccata*	Siberian Crabapple	2	5-6'height

The following drawing, Drawing 5.5, shows the zone and its associated planting. See Drawing 5.12 for complete site planting plan and schedule.

RIVERDALE PARK





KEY PLAN

LEGEND

PROPOSED PLANT MATERIAL

FP

DRAWING 5.5

ZONE 3 - PARK ENTRANCE

SCALE 1:250

↑ **NORTH**

NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

5.2.4: ZONE 4 - THE PARKING LOT

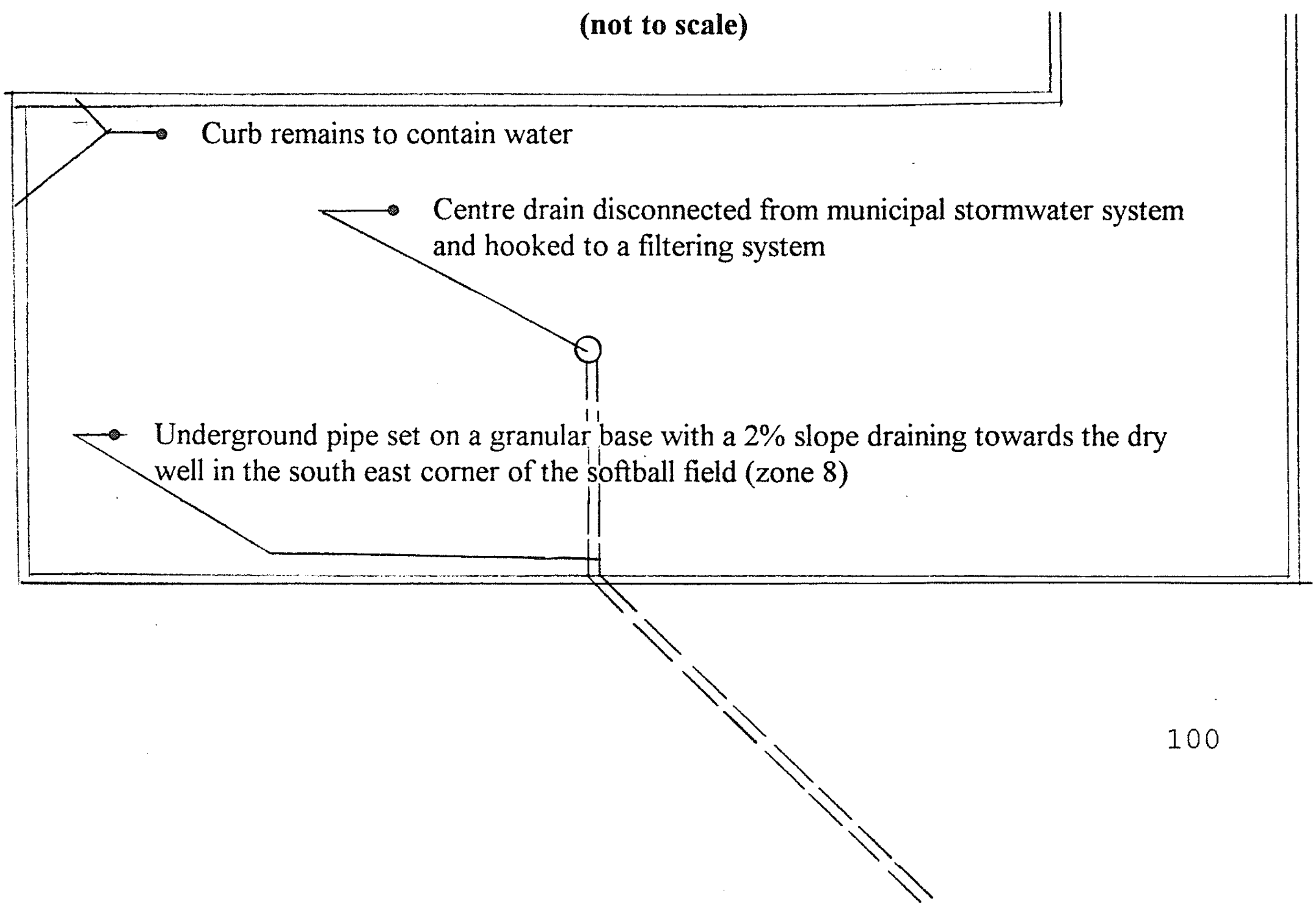
Design Intent

The parking lot zone offers interesting and unique opportunities for managing water. As it is the largest paved surface on site, the potential for water harvesting and redirection may be taken advantage of. The design recommends containing the water falling within the parking lot. This water currently drains to the municipal storm water system. As the parking lot is used by vehicles, potential contamination by oil and gas by-products in runoff water needs to be dealt with. The inclusion of a filtering system is recommended to deal with this potential. As the parking lot is in fairly adequate condition, repairs or overall changes are not required at this time. When resurfacing is required, it is recommended that the parking lot continue to have a curb system to detain water and control potential water contamination. The continued use of the parking lot as a basketball court is also recommended and encouraged. Although this does not directly manage on-site water, the potential for enticing visitors to the site, and thus the opportunity for introducing and educating court users to the many water management lessons validates the basketball court as an important auxiliary use.

Water Management Method

As Figure 5.7 illustrates, water is to be contained in the parking lot and drained through a filtering system to the pipe system which leads to the dry well (as detailed in Zone 8).

FIGURE 5.7 - ***PLAN SHOWING PIPE SYSTEM FROM PARKING LOT***
(not to scale)



Existing And Proposed Vegetation

The following two tables, Table 5.7 and Table 5.8 list the vegetation existing in the zone and the proposed vegetation. The proposed vegetation table provides the number and size of each plant recommended.

TABLE 5.7 - *EXISTING VEGETATION*

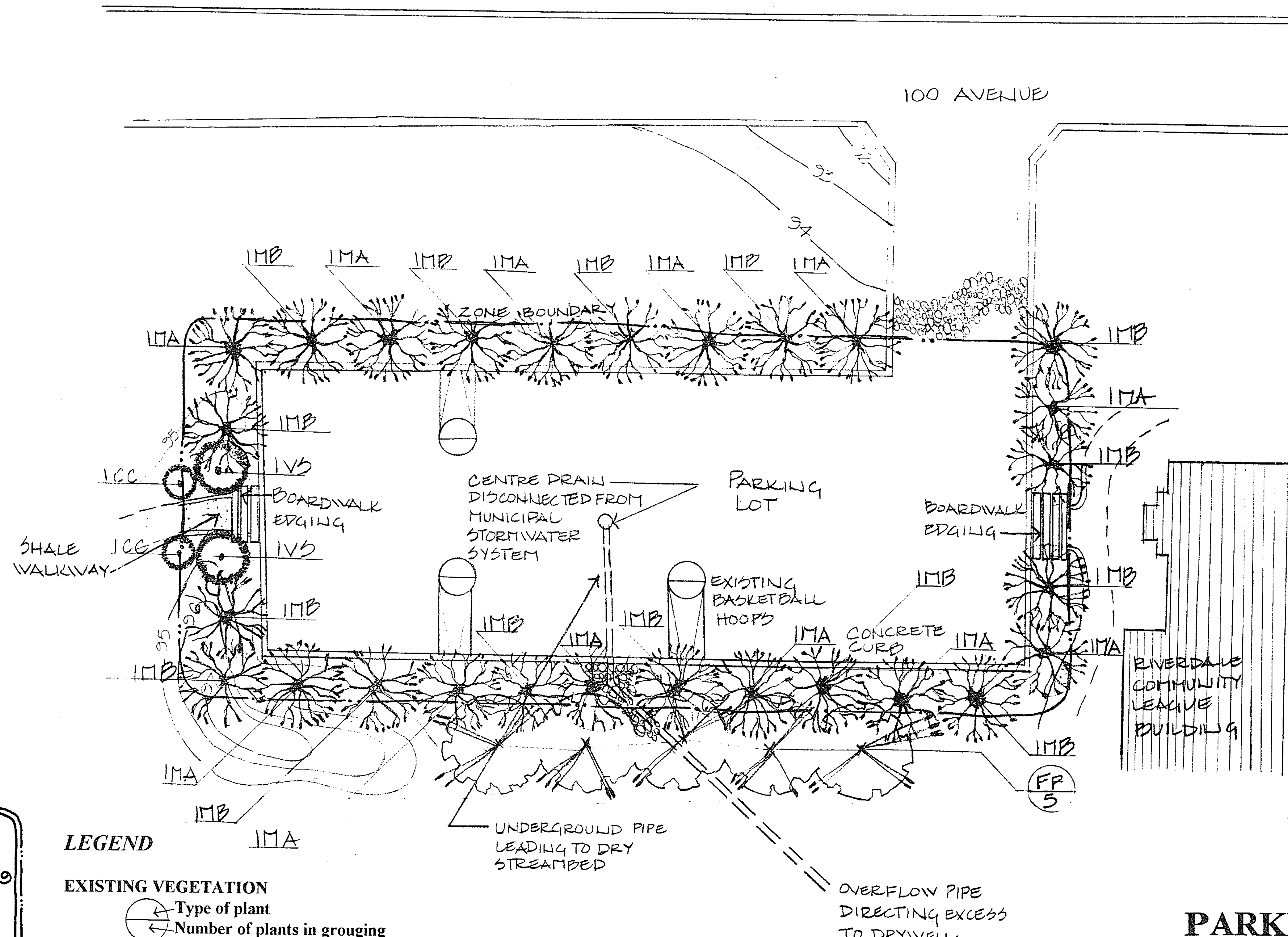
SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER
Ps	*Poplus* spp.	Poplar	7
FP	*Fraxinus pennsylvanica*	Green Ash	5
PG	*Picea glauca*	White Spruce	3

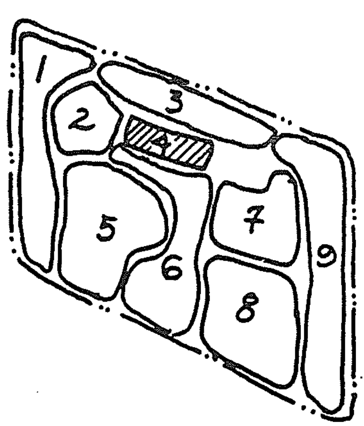
TABLE 5.8 - *PROPOSED PLANT MATERIAL*

SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER	SIZE
MA	*Malus* x *adstringens* "Almey"	Rosybloom Crabapple	11	5-6'height
MB	*Malus baccata*	Siberian Crabapple	13	5-6'height
CC	*Campanula cochlearifolia*	Creeping Bellflower	2	4" pot
VS	*Veronica* spp.	Speedwell "Sunny Border Blue"	2	1 gal. pot

The following drawing, Drawing 5.6, shows the zone and its associated planting. See Drawing 5.12 for complete site planting plan and schedule.

RIVERDALE PARK





KEY PLAN

LEGEND

EXISTING VEGETATION

Type of plant
Number of plants in grouging

PROPOSED PLANT MATERIAL

FP

DRAWING 5.6

ZONE 4 - PARKING LOT

SCALE 1:250

↑ **NORTH**

NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

5.2.5: ZONE 5 - THE PLAYGROUND

Design Intent

Zone 5, encompassing the existing playground, offers many opportunities to have fun with water and educate visitors to the importance of managing water. One of the most exciting additions to Zone 5 is the dry streambed which borders both the north and south ends of the zone. A pergola is added at the east end of the wading pool. Water is pumped up the structure and trickles down like a soft rainfall into the wading pool. The design intent is to play in the water and watch it move, with water becoming an integral part of the playground experience.

The sand base of the playground is recommended to remain and augmented with drains to ensure sufficient drainage, thus keeping the sand base relatively dry and more useable as a play surface.

Seating areas are provided near the wading pool. The drinking fountain is relocated closer to the pool. The existing central patch of grass is replanted with drought tolerant vegetation to add shady places for informal sitting opportunities.

Existing And Proposed Vegetation

The following two tables, Table 5.9 and Table 5.10 list the vegetation existing in the zone and the proposed vegetation. The proposed vegetation table provides the number and size of each plant recommended.

TABLE 5.9 - *PROPOSED PLANT MATERIAL*

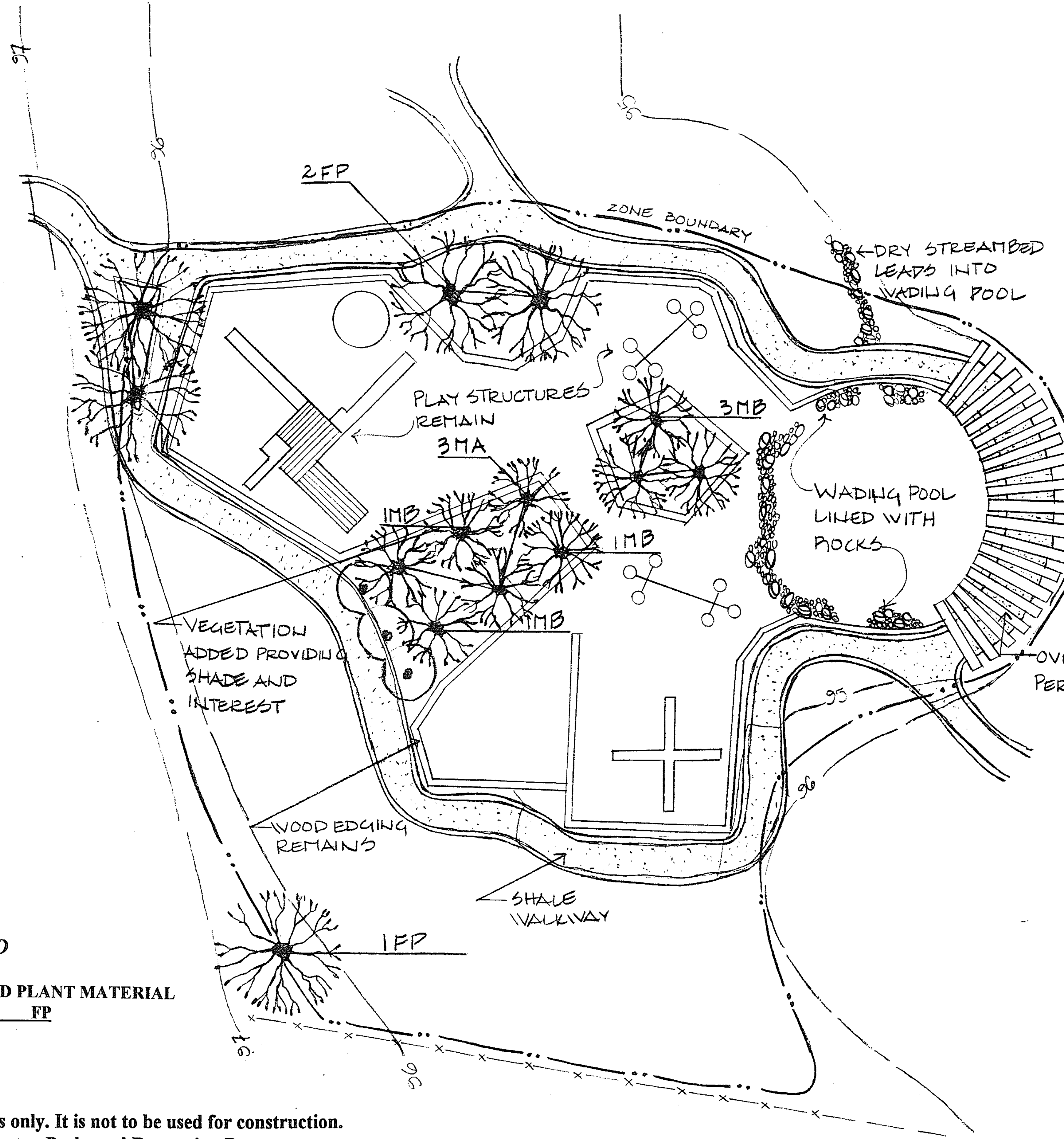
SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER
PrM	*Prunus maackii*	Amur Cherry	3
PG	*Picea glauca*	White Spruce	2
Ps	*Populus* spp.	Poplar	4

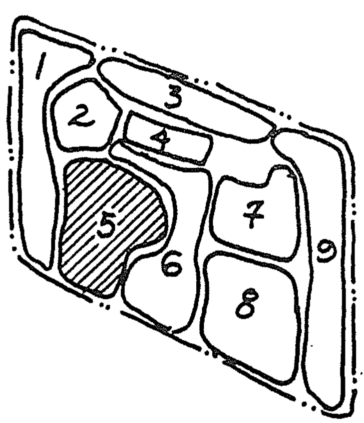
TABLE 5.10 - *PROPOSED PLANT MATERIAL*

SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER	SIZE
FP	*Fraxinus pennsylvanica*	Green Ash	2	2.5"caliper
AT	*Achillea tomentosum*	Yarrow	3	4" pot
MA	*Malus* x *adstringens* "Almey"	Rosybloom Crabapple	3	5-6' height
MB	*Malus baccata*	Siberian Crabapple	6	5-6' height

The following drawing, Drawing 5.7, shows the zone and its associated planting. See Drawing 5.12 for complete site planting plan and schedule.

RIVERDALE PARK





KEY PLAN

LEGEND

PROPOSED PLANT MATERIAL
FP

DRAWING 5.7

ZONE 5 - PLAYGROUND

SCALE 1:250

↑ **NORTH**

NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

5.2.6: ZONE 6 - THE MIDDLE GROUND

Design Intent

The middle ground zone, lying between the playground (Zone 5) and the softball field (Zone 7), offers opportunities for replenishing groundwater. The dry streambed meanders its way through the zone, acting as a reminder and educator of the potential movement of water. Vegetation is added to utilize water falling on the site.

Existing And Proposed Vegetation

The following two tables, Table 5.11 and Table 5.12 list the vegetation existing in the zone and the proposed vegetation. The proposed vegetation table provides the number and size of each plant recommended.

TABLE 5.11 - *EXISTING VEGETATION*

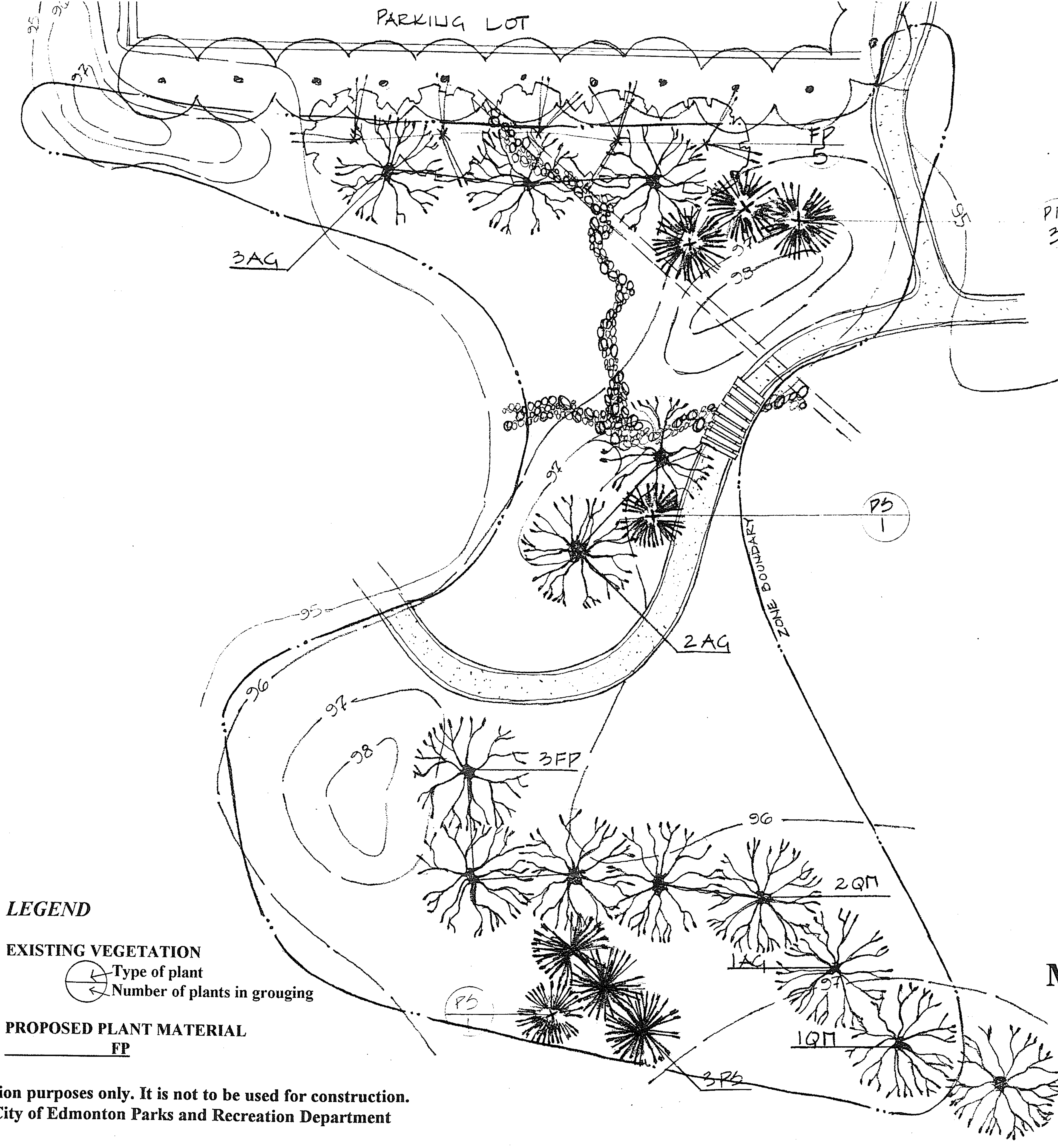
SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER
PB	*Pinus banksiana*	Jack Pine	4
PS	*Pinus sylvestris*	Scots Pine	1
PJ	*Populus x jackii* "Northwest"	Northwestern Poplar	2
Ps	*Populus* spp.	Poplar	3
PG	*Picea glauca*	White Spruce	1
PC	*Pinus contorta*	Lodgepole pine	4

TABLE 5.12 - *PROPOSED PLANT MATERIAL*

SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER	SIZE
AG	*Acer ginnala*	Amur Maple	6	2.5"caliper
QM	*Quercus macrocarpa*	Bur Oak	3	2.5"caliper
PS	*Pinus sylvestris*	Scots Pine	3	8-10' height
FP	*Fraxinus pennsylvanica*	Green Ash	3	2.5"caliper

The following drawing, Drawing 5.8, shows the zone and its associated planting. See Drawing 5.12 for complete site planting plan and schedule.

RIVERDALE PARK

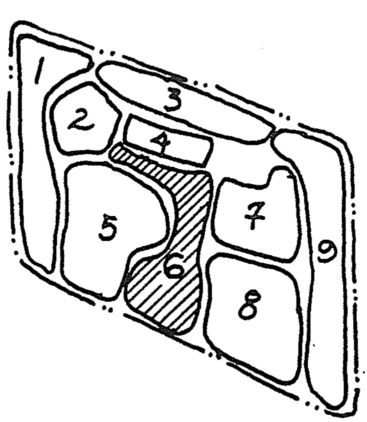


DRAWING 5.8

ZONE 6 - MIDDLE GROUND

SCALE 1:250

↑ **NORTH**



KEY PLAN

LEGEND

EXISTING VEGETATION

Type of plant

Number of plants in grouging

PROPOSED PLANT MATERIAL

FP

NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

5.2.7: ZONE 7 - THE COMMUNITY LEAGUE BUILDING AREA

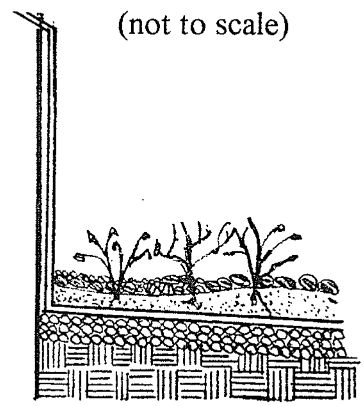
Design Intent

A great opportunity exists to utilize the Riverdale community league building and the area immediately surrounding it for water harvesting and managing. And given the building's use, the potential exists to educate a wide spectrum of visitors. Water is managed in this zone by the incorporation of a downspout collection system which directs water from the roof of the building to an irrigation system. The water can then be utilized by the additional plant material which are added in the zone. The area immediately around the building is planned to be subdivided into specific hydrozones, thus taking advantage of available water in concert with specific plant water requirements.

Water Management Methods

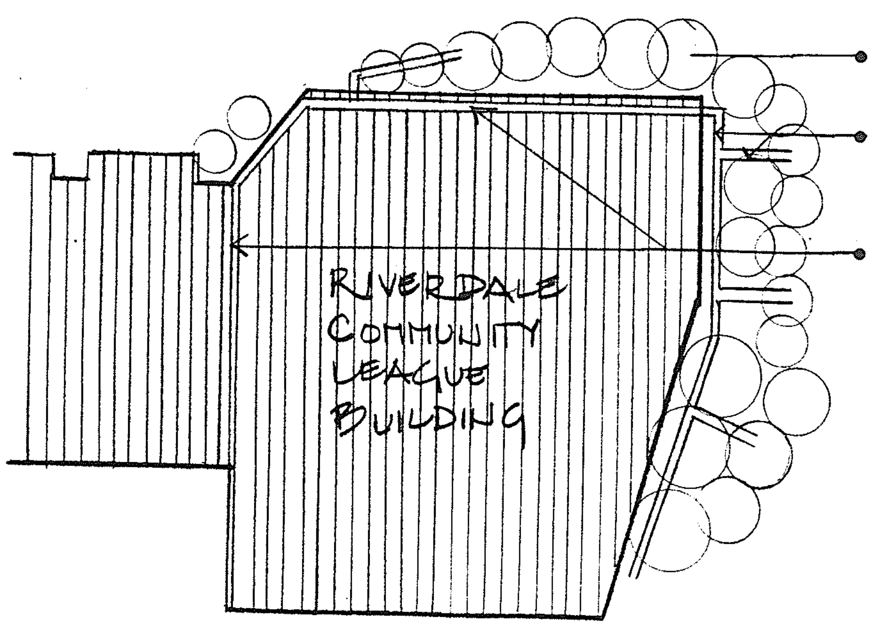
Zone 7 uses downspout collection of water from the community league building roof. The water travels down the downspout to an underground storage area of crushed stones, as detailed in Figure 5.8. The water is then directed through a perforated pipe to the planting beds planned around the outside of the building, as detailed in Figure 5.9 below.

FIGURE 5.8 - ***SECTION SHOWING DOWNSPOUT COLLECTION***
(not to scale)



- Downspout from roof
- Mulch
- Ground Pipe at 2% slope
- Granular Base

FIGURE 5.9 - ***WATER DIRECTED TO PLANTING BEDS***
(not to scale)



- Proposed Planting
- Irrigation Pipe System
- Roof Divider and Eavestrough

Existing And Proposed Vegetation

The following two tables, Table 5.13 and Table 5.14 list the vegetation existing in the zone and the proposed vegetation for Zone 7. The proposed vegetation table provides the number and size of each plant recommended.

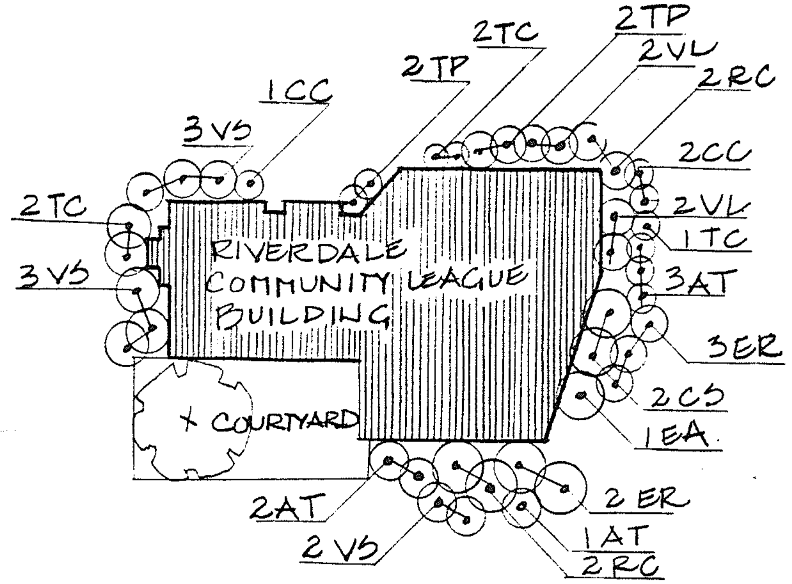
TABLE 5.13 - *EXISTING VEGETATION*

SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER
PG	*Picea glauca*	White Spruce	1
FP	*Fraxinus pennsylvanica*	Green Ash	1
PP	*Picea pungens*	Colorado Spruce	4
PC	*Pinus contorta*	Lodgepole Pine	3
PrM	*Prunus maackii*	Amur Cherry	1
Sy	*Syringa spp.*	Lilac	1

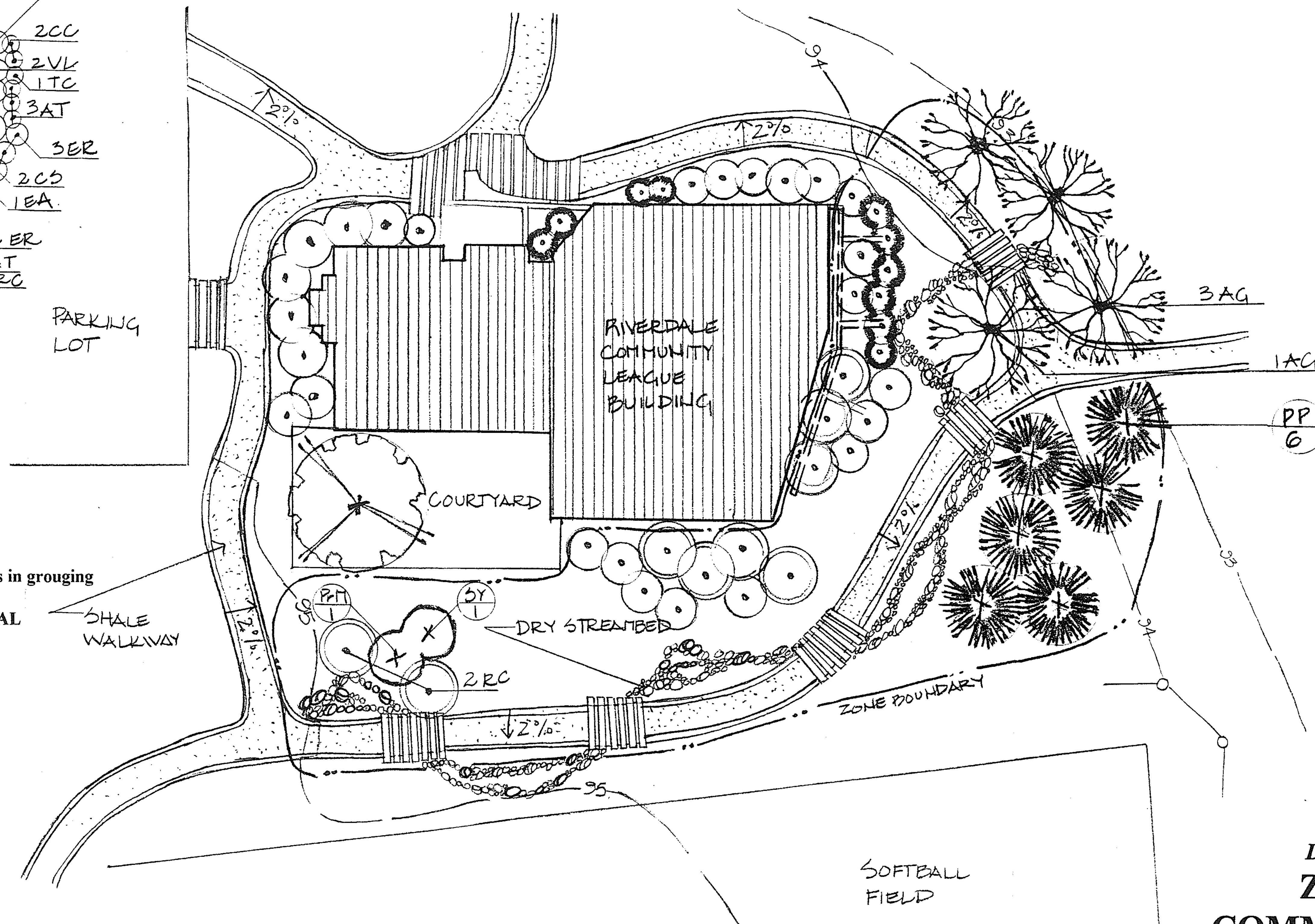
TABLE 5.14 - *PROPOSED PLANT MATERIAL*

SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER	SIZE
AG	*Acer ginnala*	Amur Maple	3	2.5"caliper
FP	*Fraxinus pennsylvanica*	Green Ash	4	2.5"caliper
RC	*Ratibida columnifera*	Prairie Coneflower	5	1 gal. pot
AT	*Achillea tomentosum*	Yarrow	6	4 " pot
VS	*Veronica* spp.	Speedwell "Sunny Border Blue"	8	1 gal. pot
VL	*Viburnum lantana*	Wayfaring Tree	5	3 gal. pot
ER	*Echinops ritro*	Globe Thistle	5	1 gal. pot
CS	*Cornus sericea*	Red Osier Dogwood	2	2 gal. pot
EA	*Euonymus alatus*	Burning Bush	1	5 gal. pot
TC	*Thymus citrodorus*	Thyme	5	4 " pot
CC	*Campanula cochlearifolia*	Creeping Bellflower	4	4 " pot

The following drawing, Drawing 5.9, shows the zone and its associated planting. See Drawing 5.12 for complete site planting plan and schedule.



PLANTING PLAN



LEGEND

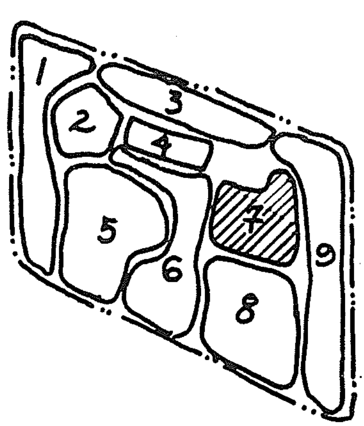
EXISTING VEGETATION

Type of plant

Number of plants in grouging

PROPOSED PLANT MATERIAL

FP



KEY PLAN

RIVERDALE PARK

DRAWING 5.9

ZONE 7 - COMMUNITY LEAGUE BUILDING

SCALE 1:250

↑ **NORTH**

NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

5.2.8: ZONE 8 - THE SOFTBALL FIELD

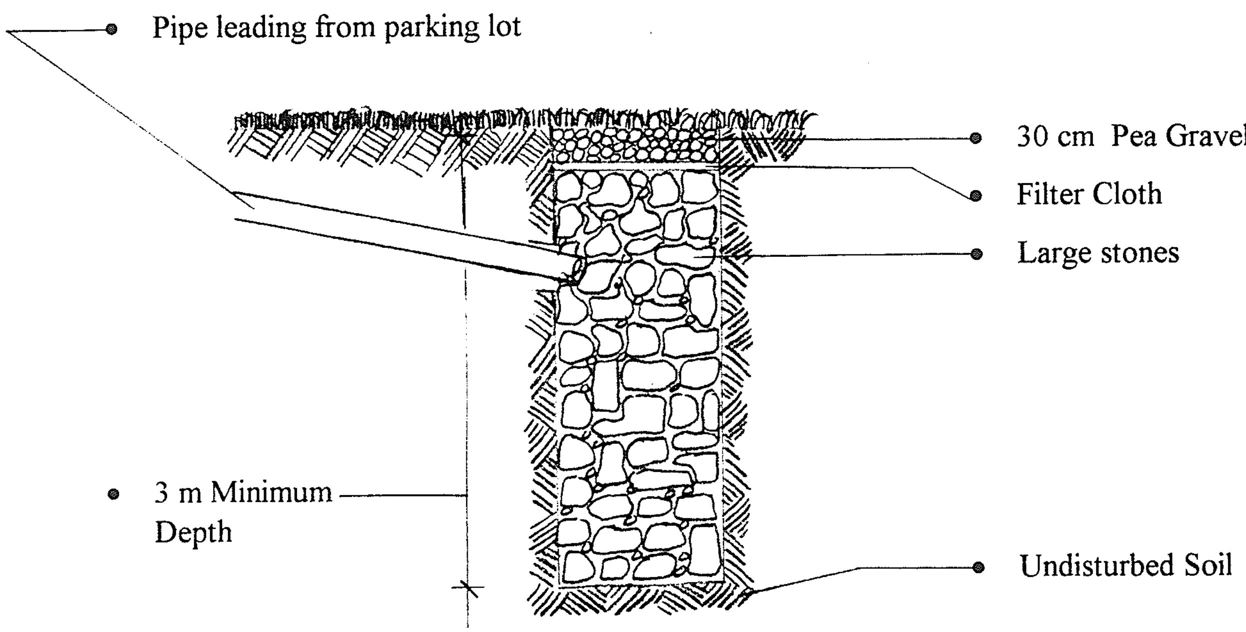
Design Intent

The softball field is a relatively flat, grassy area in the southeast corner of the site. Zone 8 assists in managing site water by including a dry well into the northeast corner of the softball field which accepts water from the parking lot. It also accepts excessive overground runoff in times of major storm events, allowing water to seep into the groundwater. The design intent of Zone 8 also recommends continued use of the softball field. Although not a water management initiative, the softball field remains in its present location and orientation in order to continue to draw visitors to the site, enabling them the opportunity to learn more about water management.

Water Management Methods

The main water management method proposed for Zone 8 is the use of a dry well in the north west corner of the zone, as detailed below in Figure 5.10.

FIGURE 5.10 - ***DETAIL OF A DRY WELL***
(not to scale)



Existing And Proposed Vegetation

The following two tables, Table 5.15 and 5.16 list the vegetation existing in the zone and the proposed vegetation for Zone 8. The proposed vegetation table provides the number and size of each plant recommended.

TABLE 5.15 - *EXISTING VEGETATION*

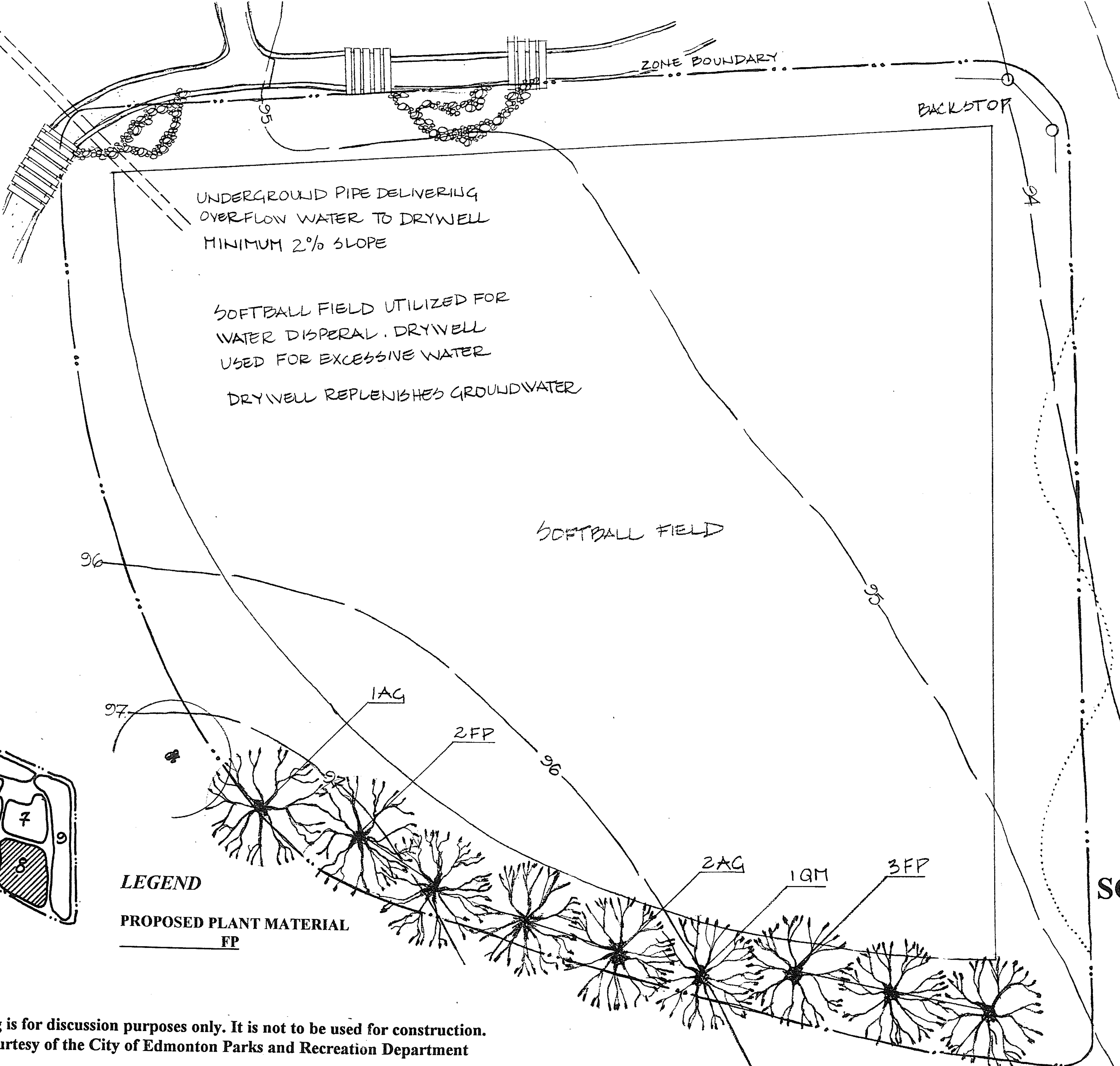
SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER
Ps	*Populus* spp.	Poplar	1

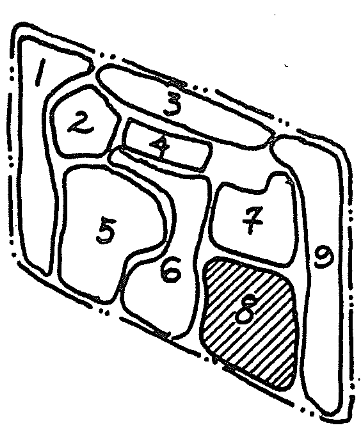
TABLE 5.16 - *PROPOSED PLANT MATERIAL*

SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER	SIZE
AG	*Acer ginnala*	Amur Maple	3	2.5"caliper
FP	*Fraxinus pennsylvanica*	Green Ash	5	2.5"caliper
QM	*Quercus macrocarpa*	Bur Oak	1	2.5"caliper

The following drawing, Drawing 5.10, shows the zone and its associated planting. See Drawing 5.12 for complete site planting plan and schedule.

RIVERDALE PARK





KEY PLAN

LEGEND

PROPOSED PLANT MATERIAL
FP

DRAWING 5.10

ZONE 8 - SOFTBALL FIELD

SCALE 1:250

↑ NORTH

NOTES:
This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

5.2.9: ZONE 9 - THE EAST SLOPE

Design Intent

The east slope represents the most eastern site boundary and slopes towards an adjacent skating rink. The design intent for Zone 9 is to use the water falling on-site as efficiently as possible within the zone and not allow potential runoff onto adjacent properties where it may cause flooding or erosion problems. Further, the intent of this zone is to provide an adequate water supply to the added plants on the slope, and potentially recharge groundwater. The planting beds are to be covered with a 10 cm (4 inch) layer of organic mulch to help retain moisture.

Existing And Proposed Vegetation

The following two tables, Tables 5.17 and Table 5.18 list the vegetation existing in the zone and the proposed vegetation. The proposed vegetation table provides the number and size of each plant recommended.

TABLE 5.17 - *EXISTING VEGETATION*

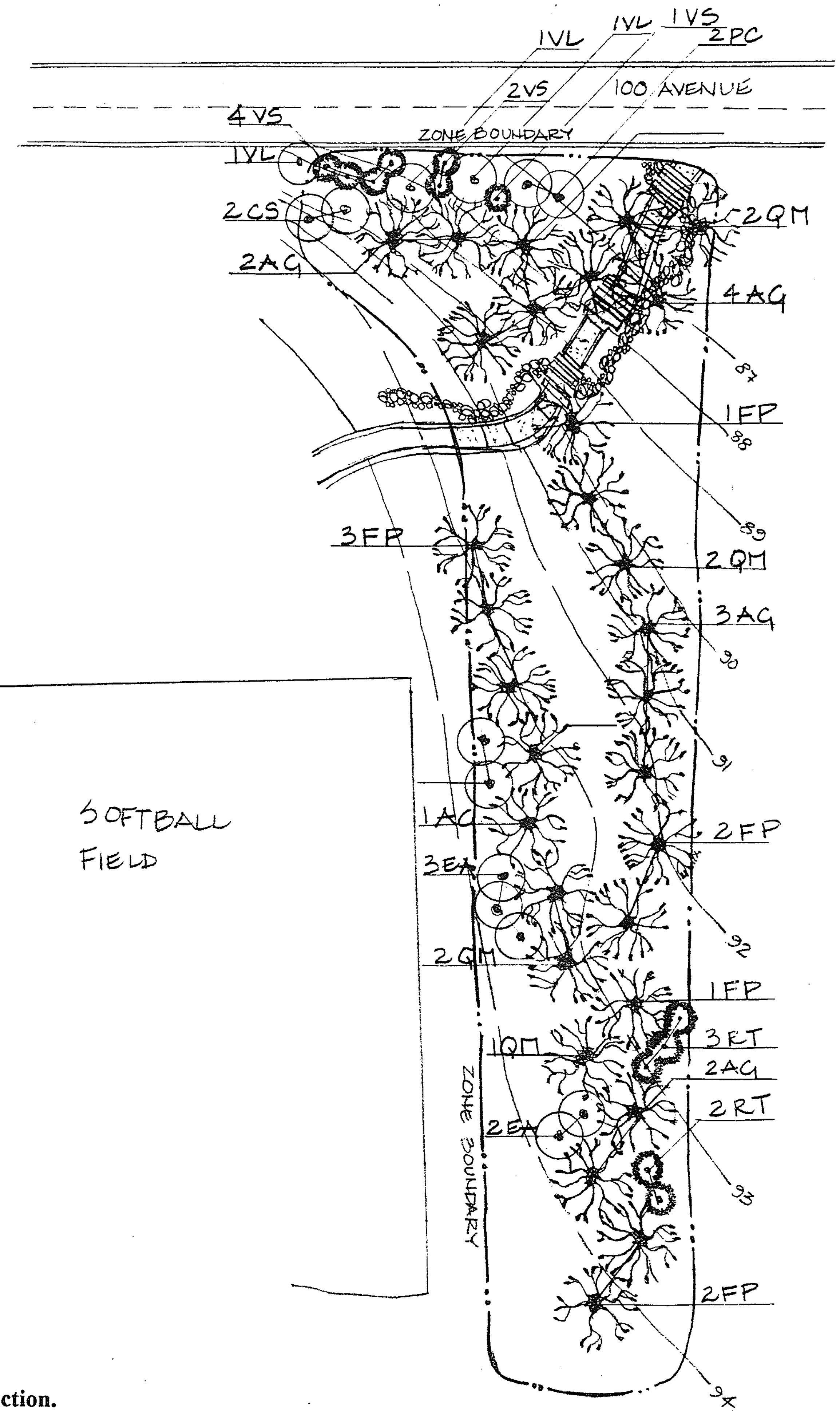
SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER
FP	*Fraxinus pennsylvanica*	Green Ash	2
Ps	*Populus* spp.	Poplar	6
PP	*Picea pungens*	Colorado Spruce	2

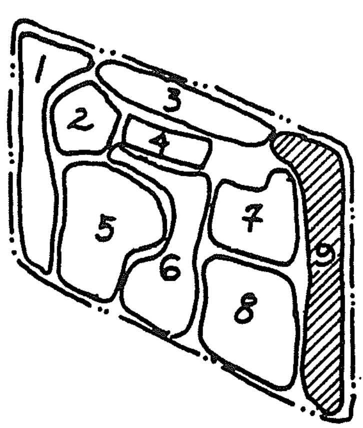
TABLE 5.18 - *PROPOSED PLANT MATERIAL*

SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER	SIZE
AG	*Acer ginnala*	Amur Maple	13	2.5"caliper
FP	*Fraxinus pennsylvanica*	Green Ash	9	2.5"caliper
QM	*Quercus macrocarpa*	Bur Oak	8	2.5"caliper
RT	*Rhus trilobata*	Lemonade Sumac	2	2 gal. pot
EA	*Euonymus alatus*	Burning Bush	5	5 gal. pot
VL	*Viburnum lantana*	Wayfaring Tree	5	3 gal. pot
VS	*Veronica spp.*	Speedwell "Sunny Border Blue"	7	1 gal. pot
PC	*Philadelphus coronarius*	Sweet Mock Orange	2	3 gal. pot

The following drawing, Drawing 5.9, shows the zone and its associated planting. See Drawing 5.12 for complete site planting plan and schedule.

RIVERDALE PARK





KEY PLAN

LEGEND

PROPOSED PLANT MATERIAL

FP

NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

DRAWING 5.11

ZONE 9 - EAST SLOPE

SCALE 1:250

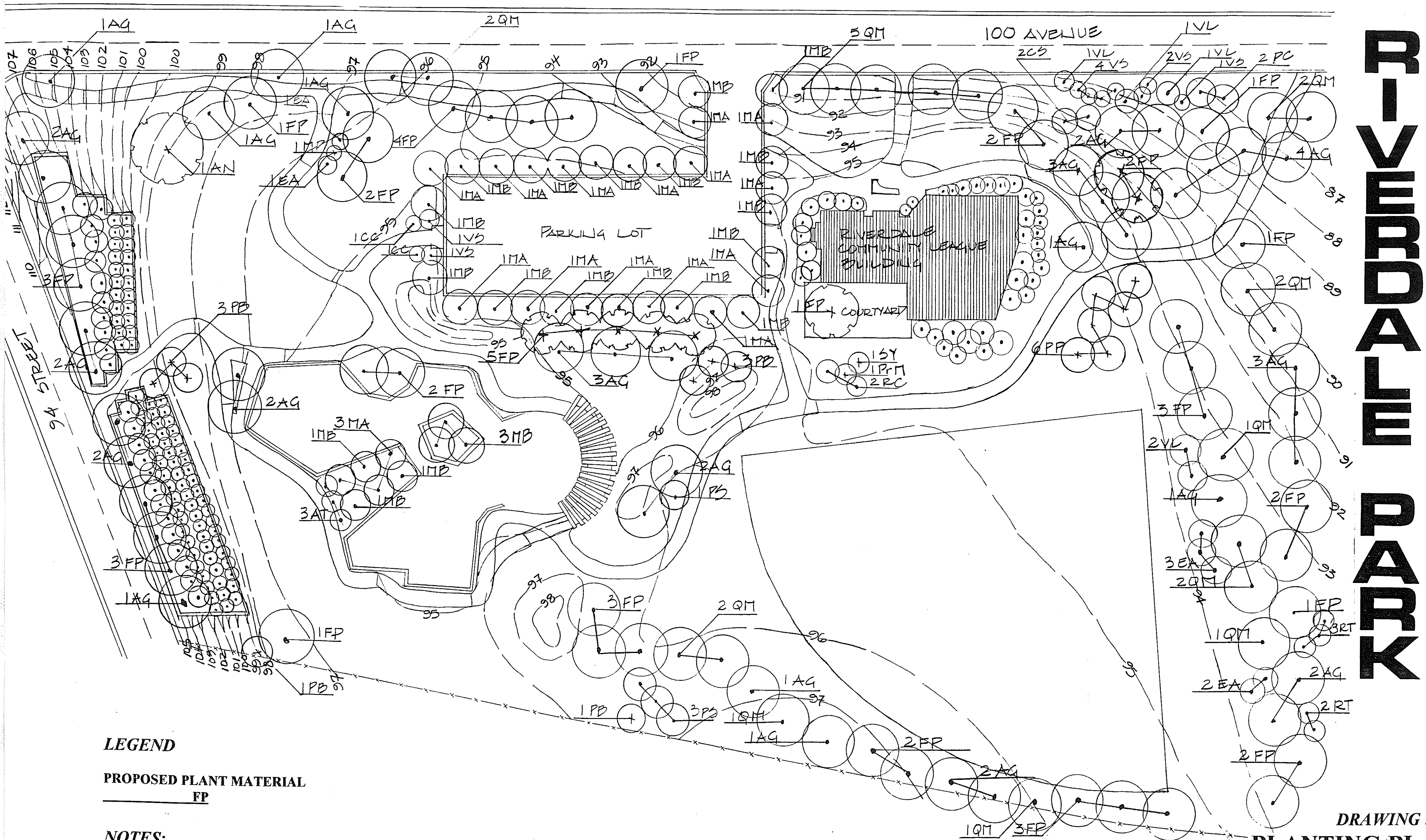
↑ NORTH

5.3 PLANTING SUMMARY

The following schedule and drawing summarize the planting scheme for the Riverdale Park site. The planting schedule is complete with the number and size of plants recommended. Drawing 5.12 summarizes the location of the plant material.

TABLE 5.19 - *PROPOSED PLANTING SCHEDULE*

SYMBOL	BOTANICAL NAME	COMMON NAME	NUMBER	SIZE
JS	*Juniperus sabina*	Savin Juniper	6	1 gal. pot
TP	*Thymus praecox*	Thyme	15	4" pot
TC	*Thymus citriodorus*	Mother of Thyme	12	4" pot
CM	*Centaurea montana*	Cornflower	10	1 gal.pot
GA	*Gaillardia aristata*	Wild Blanket Flower	16	4" pot
VS	*Veronica* spp.	Speedwell "Sunny Border Blue"	23	1 gal. pot
RC	*Ratibida columnifera*	Prairie Coneflower	10	1 gal. pot
CC	*Campanula cochlearifolia*	Creeping Bellflower	12	4" pot
AL	*Artemesia ludoviciana*	Silver King Sage	4	4" pot
RT	*Rhus trilobata*	Lemonade Sumac	8	2 gal. pot
EA	*Euonymus alatus*	Burning Bush	15	5 gal. pot
CS	*Cornus sericea*	Red Osier Dogwood	8	2 gal.pot
AG	*Acer ginnala*	Amur Maple	35	2.5"caliper
FP	*Fraxinus pennsylvanica*	Green Ash	38	2.5"caliper
QM	*Quercus macrocarpa*	Bur Oak	19	2.5"caliper
MB	*Malus baccata*	Siberian Crabapple	21	5-6' height
MA	*Malus adstringens "Almey"*	Rosybloom Crabapple	15	5-6' height
AT	*Achillea tomentosum*	Yarrow	9	4" pot
PS	*Pinus sylvestris*	Scots Pine	4	8-10' height
VL	*Viburnum lantana*	Wayfaring Tree	9	3 gal. pot
ER	*Echinops ritro*	Globe Thistle	5	1 gal. pot
PC	*Philadelphus coronarius*	Sweet Mock Orange	2	3 gal. pot



LEGEND

PROPOSED PLANT MATERIAL

FP

NOTES:

This drawing is for discussion purposes only. It is not to be used for construction.
Base map courtesy of the City of Edmonton Parks and Recreation Department

DRAWING 5.12

PLANTING PLAN

SCALE 1:250

↑ NORTH

6.0 ANALYSIS AND CONCLUSIONS

6.1 ANALYSIS

Measuring the success of applying water management methods and guidelines in the landscape is a difficult task. To assist in measuring, the maintenance regime of the City of Edmonton Parks and Recreation Department is useful. One of the main priorities of the City of Edmonton in the last few years has been to control costs while maintaining maximum productivity. In 1985-86, the City's Parks and Recreation Department developed and began implementing a system to control, measure, and evaluate all park maintenance activities, as they are applied to the Parks and Recreation facilities. The system initiated is called the Parks Maintenance Management System (PMM System) and is structured to improve the planning of work programs, to define and document budget allocations, and to measure productivity (See Appendix 3). The PMM System is important for this study as it gives reference points from which to compare the existing design and maintenance of the site with the proposed conceptual design.

As discussed earlier, turf watering accounts for approximately 50% of summer water usage and costs, and is one of the highest water users in the landscape. The conceptual design has worked at reducing the amount of turf and replacing it with plant material that can withstand water stress and numerous water management methods, as described throughout the project. The project uses cost reduction estimates for maintaining the substantially decreased amount of turf grass. It does not add in initial capital costs for the installation of the boardwalks and streambed, nor the preparation of planting beds and the person hours required to plant, weed, fertilize and water in plants until established.

For the purpose of comparing existing maintenance with the conceptual design, the site was measured and was found to cover 15,643.39 square meters. To estimate the existing square meterage currently not requiring turf maintenance, the building (including the courtyard), parking lot and vehicle entrance, and the playground and wading pool were measured equaling a total of 2,214.15 square metres. By subtracting this number from the total site coverage, it was estimated that approximately 13,429.24 square metres will require turf maintenance.

In the conceptual design proposed by the project, approximately two thirds of the remaining total (13,429.24 square metres) accommodates pedestrian circulation, the enhanced wading pool/playground area and planting beds and boxes with plant material that can withstand water stress. The material chosen includes a variety of trees, shrubs, and perennials. The area no longer requiring turf maintenance, as proposed in the conceptual design, is approximately 9,093.74 square metres, leaving 4335.50 square meters in turf.

To compare the existing maintenance and the proposed maintenance that may result from the conceptual design, two sets of data were compiled and compared given the PMM System data. Table 6.1 provides information on the existing maintenance costs, as outlined and followed by the City of Edmonton Parks and Recreation Department for Riverdale Park. Table 6.2 outlines costs based on the conceptual design.

TABLE 6.1 - *EXISTING YEARLY COSTS FOR MAINTAINING RIVERDALE PARK*

MAINTENANCE TASK*	TOTAL UNIT COST (1.34 ha or 8 man hours)*	TIMES PER YEAR*	TOTAL COSTS
1. Power Mowing	89.59/ha	7	$840.35
2. Machine Trimming	31.14/mh	4	$996.48
3. Turf Repair (minor)	42.30/mh	1	$338.40
4. Turf Fertilizing	160.58/ha	1	$215.18
5. Turf Herbiciding	122.82/ha	Once ever 2 years	$82.29
6. Misc. Turf Maintenance	39.46/mh	1	$315.68
7. Verti-drain Aerating	441.86/ha	1	$592.09
8. Hard Surface Repair	58.99/mh	4 times a year	$1887.68
TOTALS	-	-	$5268.15

* As determined by the City of Edmonton Parks and Recreation Department

TABLE 6.2 - *MAINTENANCE COSTS BASED ON CONCEPTUAL DESIGN*

MAINTENANCE TASK*	TOTAL UNIT COST (0.43 ha or 8 man hours)*	TIMES PER YEAR*	TOTAL COSTS
1. Power Mowing	89.59/ha	7	$269.66
2. Machine Trimming	31.14/mh	4	$996.48
3. Turf Repair (minor)	42.30/mh	1	$338.40
4. Turf Fertilizing	160.58/ha	1	$69.04
5. Turf Herbiciding	122.82/ha	Once ever 2 years	$26.40
6. Misc. Turf Maintenance	39.46/mh	1	$315.68
7. Verti-drain Aerating	441.86/ha	1	$189.99
8. Hard Surface Repair	58.99/mh	4 times a year	$1887.68
9. Shrub bed Maintenance	0.66 sq. m**.	3 times a year	$79.86
10. Park Furniture Maintenance	41.83/mh	Once every 3 years	$111.55
11. Gravel Surface Maintenance	81.34/mh	4 times a year	$2602.88
TOTALS	-	-	$6887.62

* As determined by the City of Edmonton Parks and Recreation Department
** Based on 121 square meters of Shrub beds

6.2 CONCLUSIONS

The conceptual design represents a meshing together of traditional design elements with water management methods such as turf reduction, water stress tolerant vegetation, and water redirection in order to demonstrate a complete design concept that works toward managing the water resource. In analyzing the numbers, the conceptual design would cost approximately $1,619.47 more per annum to maintain the park*. Thus, the design initiatives would be more costly to maintain than the existing design. However, in analyzing the numbers, it is apparent that one of the largest cost differences is maintaining the gravel pathways 4 times annually. To bring the costs of maintaining the conceptual design more in line with existing costs, the gravel pathways could be maintained one or two times per year which, given the potential use, would be appropriate, or another surfacing material less costly to maintain could be chosen in its place or used in conjunction to reduce overall costs.

The conceptual design attempts to balance any additional costs by providing a place which is pleasant to be in; a park that works at managing and utilizing water more efficiently while providing education potential. Use of products such as stone (i.e., dry streambed), gravel, and boardwalk bridges allow water to percolate into the groundwater. Specifying plant material able to withstand water stress and reducing the

* The analysis does not include installation costs calculations of the main elements such as shale walkways, boardwalk bridges, dry streambed, terracing, or additional planting, but compares existing maintenance with estimated maintenance costs. It should be noted that when retrofitting or changing a landscape, capital improvement costs must be taken into account and longer amortization periods will be required for the installation expenses.

amount of turf will result in less watering required. Use of dry wells and irrigation systems direct water to where it can be most useful, whether that is a planting bed or the groundwater system.

7.0 SUMMARY

> **Water demand up here is not at a critical stage yet, so people are not concerned about saving water,...it's just going to take some time to educate them...[11].**

Due to the lack of a definable water crisis, designers tend not to emphasize their design towards water management, though, by virtue of their profession have a direct role to play in working towards and achieving the goal of managing landscape water. The project's water management methods and guidelines demonstrate ways to work with landscape water and meet the goal of managing the resource. With design choices, such as gravel walkways that allow water to percolate through, and with appropriate yearly maintenance regimes applied to sites, water management designs can be close to or as cost effective as existing maintenance regimes while managing the resource and providing an attractive landscape.

The ideas and guidelines presented here represent a response to the many challenges of managing water which are becoming increasingly more important in the field of landscape architecture and design. Responsible management of water requires an understanding of the reasons for managing water and then implementing water management strategies to create

---

[11] Malmgrem, (No Date) "Cut the Grass". St. Petersburg Times.

designs that are more than aesthetically pleasing while meeting the goals of more efficient water management and reasonable costs. Water management designs should work at meeting existing and future challenges of managing the resource as water amounts change or decrease, as well as educating the landscape architecture profession and the public about water management.

This study will have accomplished its objectives if the reader is persuaded that the premise of water management is more than an academic or professional debate. It is hoped that the reader sees the variety of opportunities and challenges for working with on-site water. Hopefully the ideas presented here are useful as a catalyst for incorporating more efficient water management at the design level. It is hoped that this study helps the debate on the validity of water management and designing landscaping with a sensitivity to water use similar to the ones advocated by *Xeriscape Gardening*. The insights into the diverse meanings of water management gained in conducting this study only begin to tap the rich vein of material generated in the course of the research. Undoubtedly, the researched material could provide the basis for a much more in-depth analysis into any of the issues discussed in this report. As an example, it would be useful to research underground irrigation systems in more depth to be able to better incorporate these systems into water management designs. As well, exploration of the relationship of site grading and water redirection potential may be most useful. The use of plant material that can withstand the stress of less water has been paramount in this study and is very important in water management design. A broader knowledge base of plants able to survive and thrive in varying water conditions, including temporary wet conditions, would round out the potential design possibilities involved in hydrozoning.

Certainly, there are still numerous hypotheses to explore, relationships to establish, and patterns to discover within the realm of water management. It is hoped that the research presented here in this practicum and the appended compendium of other research sources will provide the stimulus for further research, new layers of interpretation, analysis, and other conclusions on the topic of managing landscape water.

REFERENCES

Addkison, R. and **D. Sellick.** 1983. Running Dry - How to Conserve Water Indoors and Out. New York, NY. Stein and Day.

Alberta Agriculture (no date available). **"Agroclimate Atlas of Alberta".** Adgex 071-1: Conservation and Development Branch.

Alex, J. F. and **J. C. Hall**, 1990. "**Weed Control in Lawns and Gardens**". Ontario Agricultural College. University of Guelph, Guelph. Ontario and the Ontario Ministry of Agriculture and Food.

Beaty, K. (no date available) **"Xeriscape - A Sensible Approach".** The Prairie Garden. pp. 52-55.

Bennett, R., E. Michael, and **S. Hazinski**. June 17, 1992. **"Second Draft - Water Efficient Landscape Guidelines".** American Water Works Association Xeriscape Subcommittee. East Bay Municipal Utility District. Oakland, California.

Carson, R. L. 1962. Silent Spring. Houghton Mifflin Company. Boston, Massachusetts.

City of Edmonton Land Use Bylaw, No 5996. 1980.

City of Edmonton, Public Works Department. 1994. **"Ecoscape Residential Landscapes"**.

City of Regina, Municipal Engineering Department. (no date available). **"Xeriscape - Water Conservation through Creative Landscaping"** (pamphlet).

Costello, L. R., N. P. Manthany, and **J. R. Clark**. 7/91. **"Estimating Water Requirements of Landscape Plantings"** Leaflet 21493. Cooperative Extension. University of California Division of Agriculture and National Resources.

Costello, L. R and **K. S. Jones**. February 1992. **"WUCOLS PROJECT - Water Use Classification of Landscape Species".** University of California. Cooperative Extension.

Cundiff, B. August/September, 1988. **"Let Nature do the Landscaping - Bits of Wilderness in the Heart of Town".** Canadian Geographic. Volume 108. No. 4.

Currah, R., A. Smreciu, and **M. Van Dyk**, 1983. **Prairie Wildflowers - An Illustrative Manual of Species Suitable for Cultivation and Grassland Restoration**. University of Alberta, Edmonton, Alberta.: Published by the Friends of the Devonian Botanic Garden.

Dirr, M. A. 1978. **Manual of Woody Landscape Plants - Their identification, Ornamental Characteristics, Culture, Propagation and Uses**. Stipes Publishing Company, Champaign, Illinois.

Dirr. M. A. 1978. **Photographic Manual of Woody Landscape Plants - Form and Function in the Landscape.** Stipes Publishing Company, Champaign, Illinois.

Ellefson, C., T. Stephens and **D. Welsh**. 1992. **Xeriscape Gardening - Water Conservation for the American Landscape.** New York, NY. MacMillan Publishing Company.

Godfrey, J. 1993. **Edmonton Beneath Our Feet - A Guide to the Geology of the Edmonton Region**. Edmonton Geological Society. The University of Alberta.

Gordon. D. 1990. **Green Cities - Ecologically Sound Approaches to Urban Space**. Black Rose Books. Quebec, Canada.

Greenburg. C. September, 1992. **"Xeriscaping - It means youcan have a lush colorful garden that doesn't drink the earth dry"**. House Beautiful. pp. 32-34.

Harapiak, J. 1986. **"Horticulture Soils" University of Alberta Home Gardening Course.** Edmonton, Alberta. University of Alberta Faculty of Extension.

Hilderman Witty Crosby Hanna and Associates. 1993. **"Efficient Irrigation"** Every Drop Counts Conference.

Hilderman Witty Crosby Hanna and Associates. 1993. **"Practical Turf"**. Every Drop Counts Conference.

Hitchmough, J. 2/90. **"The Selection of Ground Covers for the Urban Landscape"**. in Landscape Australia. pp. 150-153.

Hosie, R. C. 1979. **Native Trees of Canada**. Fitzhenry and Whiteside Ltd. Canadian Government Publishing Centre. Suppy and Services. Canada. Don Mill, Ontario.

Hough, M. 1989. **City Form and Natural Process**. Routledge. London.

Hough, M. October 1990. **"Formed by Natural Process"**. Landscape Architectural Review.

Jarmusch, A. "Natives to the Rescue". in Organic Gardening. pp. 68-70.

Jones, H. G. 1992. **Plants and Microclimate - A Quantitative Approach to Environmental Plant Physiology**. (Second Edition) Cambridge University Press. Great Britain.

Karlik, J. July 15, 1992. **"A Study in Xeriscaping"**. American Nurserymen. pp. 72-77,

Kathol. C. P. and R. A. McPherson. 1975. **Urban Geology of Edmonton**. Alberta Research Council. Bulletin 32.

Knowles, H. 1989. **University of Alberta - Woody Ornamentals for the Prairies**. Edmonton, Alberta: University of Alberta Faculty of Extension.

Knox, G. W. December 1989. **"Water Use and Average Growth Index of Five Species of Container Grown Woody Landscape Plants"**. Journal of Environmental Horticulture. pp. 136-139.

Kourik, R. 1995. **"Graywater for Residential Irrigation"**. Landscape Architecture. Volume 85. No.1. pp. 30-33.

Latta, M. April 1988. **"Xeriscape Design: Principles in Sound Horticulture Practices"**. The Landscape Architect and Specifier News. pp. 34-36.

Lawson, S. October 1992. **"Under Stress"**. Landscape Architecture. Vol. 81 No. 10. pp. 76-78.

LeMontre, S. November 1988. **"California Greening"**. Organic Gardening. pp. 62-67.

Logan, B. September 1989. **"Drought Tolerant Landscapes and Water Conservation Techniques"**. The Landscape Architect and Specifier News. pp. 14-15.

MacDonald, J. January 1993. **"Return of the Native".** in Canadian Gardening.

Malmgren, J. (no date available). **"Cut the Grass".** St. Petersburg Times.

Mather, J. R. 1985. **Drought Indices for Water Management**. University of Delaware Centre for Climatic Research. Newark, De. Volume XXXVIII Number 1.

McHarg, I. L. 1971. **Design with Nature**. Doubleday/Natural History Press, Doubleday and Company Inc. Garden City, New York.

McPherson, E. G. Fall 1990. **"Modelling Residential Landscape Water and Energy Uses to Evaluate Water Conservation Policies".** in Landscape Journal. Vol. 9 No. 2. pp. 127-134.

Morrow, B. H. 1987. **A Dictionary of Landscape Architecture**. Albequerque, N. M. University of New Mexico Press.

Moss, E. H. 1983. **Flora of Alberta - A Manual of Flowering Plants, Conifers, and Fern Allies found growing without cultivation in the Province of Alberta.** University of Toronto Press. Toronto.

Mullany, S. 1/90. **"Xeriscape - Water Conservation through Creative Landscaping".** in Landscape Australia. pp. 55-57.

Nehrling, A. and **I. Nehrling.** 1968. **Easy Gardening with Drought-Resistant Plants**. New York,NY. Hearthside Press Inc. Publishers.

Quin, C. W. June 1991. **"Pest Control Before Modern Chemicals".** Friends of Devonian Botanic Garden. Publication No. 14A.

Rankin, G. 1986. **"Botany" University of Alberta Home Gardening Course.** Edmonton, Alberta. University of Alberta Faculty of Extension.

Roseland, M. 1992. **Toward Sustainable Communities - National Roundtable on the Environment and the Economy**. Ottawa, Ontario.

Rosenburg, N. J. 1980. **Drought in the Great Plains - Research on Impacts and Strategies.** Littleton, Colorado. Water Resources Publications.

Russell, C. S., D. G. Arey, and **R. W. Kates**, 1970. **Drought and Water Supply - Implications of the Massachusetts Experience for Municipal Planning**. The John Hopkins Press.

Schubsole, D. and **D. Tate.** 1994. **"Every Drop Counts".** Cambridge, Ontario. Canadian Water Resources Association.

Simpson, G. M. 1981. **Water Stress on Plants**. New York. NY. Praeger Publishers.

Smith, G. (no date available).**"Water and the Sustainable Home Landscape".** Prairie Garden. pp. 74-80.

Smittle, D. May/June1992. **"Synthetic Insecticides".** Taunton's Fine Gardening, No. 25.

Soto, H. C. March 1989. **"Water Conservation Garden - A Volunteer Project".** The Landscape Architect and Specifier News. pp. 68-71.

Steffens, C. 1990 **"The Texas Highways Department Wildflower Program".** **Green Cities - Ecologically Sound Approaches to Urban Space.** Black Rose Books Ltd. Montreal Quebec. pp. 133-143.

Stroud, T. April, 1987. **"Xeriscaping...xeri what?"** Grounds Maintenance. pp. 74-82.

Stushnoff, C. and **J Stushnoff**. 1988. **Prairie Garden Notebook, A Record Keeping Guide to Fruit and Vegetable Gardening**. Saskatoon, Saskatchewan. Western Producer Prairie Book.

Sunset Books. 1989. **Waterwise Gardening**. Lane Publishing Co. Menlo Park. California.

Taylor's Guide. 1990. **Water-Saving Gardening**. Boston Massachusetts. Houghton Mifflin Company.

The World Commission on Environmental Development. 1987. **Our Common Future.** Oxford University Press. Oxford.

Thomsen, C. 1993. **"Design and Maintenance of the Water Efficient Landscape".** Every Drop Counts: Canada's First National Conference on Water Conservation. Winnipeg, Manitoba.

Thomsen, C. 1993. **"Water Conservation and the Prairie Landscape".** The Prairie Garden.

Tourbier, J. T. and **R. Westmacott**. 1981. **Water Resources Protection Technology - A Handbook of Measures to Protect Water Resources in Land Development**. Washington, D.C. The Urban Land Institute.

Trulsson, N. B. October, 1991. **"Planning Sonoran Landscapes".** Landscape Architecture. Vol. 81. No. 10. pp. 114-116.

University of Saskatchewan. 1992. **"The Seven Principles of Xeriscape - Planning and Design, Soil Analysis, Efficient Irrigation, Practical Turf Areas, Plant Selection Mulches, and Maintenance".** The University of Saskatchewan Extension Division.

Vink. A. P. A. 1983. **Landscape Ecology and Land Use**. Longman Group Limited. Essex, England.

Wallace, Dr. A. November/December 1988. **"Landscaping the Xeriscape Way - Soil Improvements".** National Xeriscape News. p. 3.

Wallace, G. A. and **A Wallace**. April 5-7, 1989. **"Using Polymers to Enhance Shrub Transplant Survival and Seed Germination for Revegetation of Desert Lands".** Paper presented at the Symposium on Cheatgrass Invasion, Shrub Die-off and Other Aspects of Shrub Biology Mangement. Las Vegas, N. V.

Walker, R. E. and **G. F. Kah**. June 1990. **"Landscape Irrigation Auditor Handbook".** Irrigation Training and Research Centre. California Polytechnic State University.

Wilkinson, K. 1990. **Trees and Shrubs of Alberta - A Habitat Field Guide**. Edmonton, Alberta. Lone Pine Publishing.

Williams, S. 1993. **"List of Drought Tolerant Plants".** University of Saskatchewan Extension Division.

GLOSSARY

Drought A period in which the scarity of soil moisutre is limiting the growth of plants (Rankin, 1986).

Drought Avoiders Plants that maintain a high water potential when exposed to extended water stress. These plants possess physiological mechanisms that aid in the retention of a favourable water status by either conserving water or by supplying wate to the above-ground parts during time of drought stress (Simpson, 1981).

Drought Resistant Plants Plants that either avoid drought or tolerate it (Simpson, 1981).

Drought Physiology The study of the activities and life processes which occur in plants during periods of drought (Rankin, 1986).

Dry Stream bed A simulation of the bed of a creek, used when the effect of a water course is wanted but flowing water is not available or desirable (Morrow, 1987).

Gray Water The waste water from non-toilet facilities including sinks, tubs, washing machines and dishwashers. This water usually does not require biological or chemical treatment before use as a landscape irrigation source.

Hydrophytes Those plants which grow in water or wet conditions. They ususally have low oxygen requirements and usually have poorly developed root systems (Rankin, 1986).

Life Processes The life processes of plants includes transpiration, photosynthesis, and respiration (Rankin, 1986).

Mesophytes Those plant with intermediate water requirements. They usually have well-developed root systems and are commonly found growing in good soil. In these circumstances, water is not a limiting to factor to growth or survival (Rankin, 1986).

Monoculture Monoculture refers to only one type of plant growing in a specific area (Ellefson, Stephens and Welsh, 1992 1992).

Osmosis The movement of water or solvent through a semi-permeable cell membrane from a region of high free energy to a region of low free energy (Rankin, 1986).

pH pH is a measure of relative acidity or alkalinity of soil. The pH scale ranges from 0-14 with neutral soil having a pH of 7.0, which represents equal amount of hydrogen and hydroxyl ions. A pH below 7.0 is considered acidic and has a surplus of hydrogen ions. A pH above 7.0 is considered to be basic or alkaline and has a surplus of hydroxyl ions. Each pH unit represents a ten-fold increase or decrease in relative acidity or alkalinity (Harapiak, 1986).

Phloem Cells The food conduction cells of plants (Rankin, 1986).

Photosynthesis The process by which plants produce food (Rankin, 1986).

Plants with Water Stress-Tolerance — Plants that can withstand a certain amount of water stress resulting from dry or droughty conditions. These plants are sometimes referred to as drought tolerant plants. (No testing was conducted as part of this project in order to assess the stress tolerance of plants. Written sources were utilized to compile plant lists).

Plant Metabolism — The sum of the life processes including transpiration, photosynthesis, and respiration (Rankin, 1986).

Potable Water — Water that is fit for drinking.

Respiration — A process which can be defined as the opposite of photosynthesis that uses oxygen to break down carbohydrates to supply food for the plant (Rankin, 1986).

Sluice — A structure having a gate for holding back or controlling the flow of water.

Soaker System — A system of pipes or hoses that have a series of small holes through which small amounts of water are released (Addkison and Sellick, 1983).

Stomata — Tiny pores in the green stem and leaves of plants (Rankin, 1986).

Water Management — The act or manner of managing, handling, directing or controlling the water that falls on the landscape or water which is added through irrigation methods. Managing water in the landscape requires skills in managing or directing the water using the best judgement possible.

Xerophytes — Those plants growing in dry habitats that have various adaptations which enable them to grow and reproduce. These plants usually have either deep tap roots or extensive fibrous root sytems (Rankin, 1986).

Xylem Cells — The water conducting cells of plants (Rankin, 1986).

APPENDIX 1: PLANT LISTS

Seven sources were used to compile the following lists of plants able to withstand a certain level of water stress. The numbers at the beginning of each source is used as the reference numbers in the following tables.

(1) **R. Currah, A. Smreciu, and M. Van Dyk. 1983.** Prairie Wildflowers - An illustrative manual of species suitable for cultivation and grassland restoration.

(2) **H. Knowles. 1989.** University of Alberta - Woody Ornamentals for the Prairies

(3) **A. Nehrling and I. Nehrling. 1968.** Easy Gardening with Drought-Resistant Plants.

(4) **S. Williams. 1991. " *Drought Tolerant Plant Material for the Prairies*".**

(5) **D. McKernan. 1994., *"Practical Turf Areas"*. Xeriscaping - Landscaping for the Future,** Conference Proceedings, February 17 and 18, 1994.

(6) **E. Toop. 1994. *"Drought Tolerant Annuals"* Landscaping for the Future,** Conference Proceedings,

(7) **Taylor's Guide to Water Saving Gardening. 1990.**

TABLE 1 - *DECIDUOUS TREES*

BOTANICAL NAME	COMMON NAME
Acer ginnala	**Amur Maple (4)**
Acer negundo	**Manitoba Maple (4)**
Elaeagnus angustifolia	**Russian Olive (4)**
Fraxinus pennsylvanica	**Green Ash (3; 4)**
Malus spp.	**Flowering Crabapple (4)**
Prunus pennsylvanica	**Pincherry (2)**
Prunus tomentosa	**Nanking Cherry (4)**
Quercus macrocarpa	**Bur Oak (4)**

TABLE 2 - *CONIFEROUS TREES*

BOTANICAL NAME	COMMON NAME
Picea abies	Norway Spruce (3)
Pinus banksiana	Jack Pine (3)
Picea glauca 'Densata'	Black Hills Spruce (3)
Picea pungens	Colorado Blue Spruce (3)
Pinus cembra	Swiss Stone Pine (3)
Pinus sylvestris	Scots Pine (3)

TABLE 3 - *SHRUBS*

BOTANICAL NAME	COMMON NAME
Amelanchier alnifolia	Serviceberry, Saskatoon (3; 4)
Amorpha fruticosa	False Indigo (2; 3; 4)
Arctostaphylos uva-ursi	Bearberry (3) Kinnikinnick (2)
Berberis thunbergii	Japanese Barberry (3; 7)
Caragana pygmaea	Pygmy Caragana (2; 3)
Cotoneaster spp.	Cotoneaster (3; 4)
Elaeagnus commutata	Silverberry (3)
Erica carnea	Spring Heath (3)
Euonymus alata	Burning Bush (3)
Euonymus obovatus	Running Euonymus (3)
Forsythia ovata	Korean Golden Bell (3)
Juniperus spp.	Juniper (3;4)
Lonicera maackii	Amur Honeysuckle (3; 4)
Lonicera spinosa 'Albertii'	Albert Regal Honeysuckle (2)
Lonicera tartarica	Tartarian Honeysuckle (3; 4)
Philadelphus coronarius	Sweet Mock-Orange (2; 3)
Physocarpus opulifolius	Eastern Ninebark (3)

SHRUBS CONTINUED	
Pinus mugo	**Mugo Pine (3)**
Potentilla fruticosa	**Bush Cinquefoil (3; 4)**
Prinsepia sinensis	**Cherry Prinsepia (3; 4)**
Prunus pumila	**Sandcherry (2)**
Prunus virginiana var. *melanocarpa*	**Chokecherry (2; 3)**
Rhus trilobata	**Lemonade Sumac (2; 3)**
Rhus typhina	**Staghorn Sumac (2; 3)**
Ribes aureum	**Golden Flowering Current (2)**
Rosa arkansana	**Sunshine Rose (2)**
Rosa rugosa	**Rugosa Rose (3; 4)**
Rosa virginiana	**Virginia Rose (3; 4)**
Rosa wichuraiana	**Memorial Rose (3; 4)**
Shepherdia argentea	**Silver Buffaloberry (2)**
Spiraea x *vanhouttei*	**Bridal Wreath Spirea (3)**
Symphoricarpos orbiculatus	**Coralberry (3;7)**
Syringa vulgaris	**Common Lilac (2; 3; 4)**
Tamarix pentandra	**Amur Tamarisk (2)**
Viburnum lantana	**Wayfaring Tree (3)**
Viburnum lentago	**Nannyberry (3)**

TABLE 4 - *PERENNIALS*

BOTANICAL NAME	COMMON NAME
Achillea millefolium	Common Yarrow (4; 7)
Achillea ptarmica	Sneezewort (4)
Achillea tomentosa	Dwarf Woolly Yarrow (4; 7)
Antennaria nitada *Antennaria plantaginifolia* var. *ambigens* *Antennaria rose/*	Pussy Toes (1; 2; 4; 7)
Anthemis tinctoria	Golden Marguerite or Chamomile (4; 7)
Arabis spp.	Rockcress (4)
Arenaria congesta var. *lithphila*	Sandwort (1)
Artemisia ludoviciana var. *'Silver King'*	Ghost Plant (4)
Artemisia schmidtiana	Silver Mound or Wormwood (4; 7)
Astragalus bisulcatus	Two-grooved Milk Vetch (1)
Astragalus crassicarpus	Ground Plum (1)
Astragalus drummondii	Drummond's Milk Vetch (1)
Astragalus missouriensis	Missouri Milk Vetch (1)
Astragalus pectinatus	Narrow-leaved Milk Vetch (1)
Aurinia saxatilis	Perennial Alyssum (4; 7)
Campanula cochleariifolia	Creeping Bellflower (4)
Centaurea montana	Mountain Bluet (3)
Cerastium tomentosum	Snow-in-Summer (4; 7)
Chysopsis villosa	Golden Aster (1)
Coreopsis verticillata	Threadleaf Coreopsis (4; 7)
Dianthus deltoides	Maiden Pinks (4)
Echinops ritro	Globe Thistle (4)
Euphorbia cyparissias	Cypress Spurge (4)
Gaillardia aristata	Blanket Flower (1; 4; 7)
Gaura coccinea	Scarlet Butterfly-Weed (1)
Gypsophila paniculata	Babysbreath (4; 7)
Gypsophila repens	Creeping Babysbreath (4)

PERENNIALS CONTINUED	
Heuchera spp.	**Coralbells (4; 7)**
Iris germanica	**Bearded Iris (4; 7)**
Limonium spp.	**Sea Lavender (4; 7)**
Lithospermum incisum	**Yellow Stoneseed (1)**
Oenothera missourensis	**Missouri Evening Primrose (4; 7)**
Oxytropis viscida	**Viscid Locoweed (1)**
Paeonia spp.	**Peony (4)**
Papaver nudicaule	**Iceland Poppy (4; 7)**
Penstemon albidus	**White Beard-Tongue (1)**
Petalostemon purpureum	**Purple Prairie Clover (1)**
Phlox hoodii	**Moss Phlox (1)**
Psoralea argophylla	**Silver-leaved Psoralea (1)**
Ratibida columnifera	**Prairie Coneflower (1)**
Rosa acicularis	**Prickly Rose (1)**
Sempervivum spp.	**Hens and Chicks (4)**
Senecio canus	**Prairie Groundsel (1)**
Silene vulgaris maritima	**Sea Campion (4)**
Solidago missouriensis	**Low Goldenrod (1)**
Thymus spp.	**Thyme (4)**
Veronica spp.	**Speedwell (4)**
Vicia sparsifolia	**Narrow-leaved Vetch (1)**

TABLE 5 - *ANNUALS*

BOTANICAL NAME	COMMON NAME
Ageratum houstonianum	Ageratum or Flossflower (4)
Amaranthus caudatus	Love-lies-bleeding (4)
Calendula officinalis	Calendula or Pot Marigold (4)
Catharanthus roseus x *tricophyllus*	Vince or Periwinkle (4; 7
Celosia cristata	Cockscomb (4)
Centaurea cineraria	Dusty Miller (4)
Centaurea cyanus	Bachelor's Button (4)
Chrysanthemum parthenium	Feverfew or Marticaria (4)
Cleome hasslerana	Cleome or Spider Flower (4; 6; 7)
Cleome serrulata	Bee Plant, Pink Cleome (1)
Coreopsis tinctoria	Calliopsis (4; 7)
Cosmos bipinnatus	Cosmos (4; 7)
Dianthus chinensis	China Pink or Dianthus (4)
Dimorphoteca sinuata	African Daisy (4; 6; 7)
Dorotheanus bellidiformis	Livingstone Daisy (4; 6)
Eschscholzia californica	California Poppy (4)
Euphorbia marginata	Snow-on-the-Mountain (4)
Gaillardia puchella	Annual Gaillardia (4; 6)
Gomphrena globosa	Globe Amaranth (4; 7)
Gypsohpila elegans	Annual Babysbreath (4; 7)
Helichrysum bracteatum	Strawflower (4; 7)
Kochia scoparia	Burning Bush or Summer Cypress (4; 6;7)
Petunia x *hybrida*	Petunia (4; 7)
Portulaca grandiflora	Portulaca (4; 6; 7)
Rudbeckia hirta	Black -eyed Susan (4; 7)
Sanvitalia procumbens	Creeping Zinnia (4)
Tagetes spp.	Marigold (4)
Zinnia spp.	Zinnia (4)

TABLE 6 - *WILDFLOWERS*

BOTANICAL NAME	COMMON NAME
Allium textile	Prairie Onion, Wild Onion (1)
Antennaria spp.	Dwarf Pussy Toes (1; 7)
Artemisia campestris	Field Sage, Plains Wormwort (1; 7)
Artemisia cana	Sagebrush, Silvery Sagebrush (1)
Astragalus striatus	Purple Milk Vetch (1)
Atrixplex nuttallii	Salt Sage (1)
Crysothamnus mauseosus	Rabbit-brush (1)
Elaeagnus commutata	Wolfwillow, Silverberry (1)
Erigeron caespitosus	Fleabane (1; 7)
Eriogonum flavum	Yellow Umbrella Plant (1)
Eurotia lanata	Winter Sage, White Sage (1)
Gutierrezia sarothrae	Broomweed (1)
Happlopapppus nuttallii	Toothed Ironplant (1)
Hymenoxys acaulis	Butte Marigold (1)
Lappula redowskii var. *occidentalis*	Stick-tights, Burweed (1)
Liatris punctata	Dotted Blazing Star (1; 7)
Linum lewisii	Wild Blue Flax (1)
Lomatium foeniculaceum	White Prairie Parsley (1)
Lygodesmia juncea	Skeleton-weed, Prairie Pink (1)
Mamillaria vivipara	Cushion Cactus, Ball Cactus (1)
Opuntia polyacantha	Prickly Pear Cactus (1)
Oxytropis sericea var. *spicata*	Early Yellow Locoweed (1)
Penstemon nitidus	Smooth Blue Beard-tongue (1)
Petalostemon candidum	White Prairie Clover (1)
Potentilla concinna	Early Cinquefoil (1)
Sedum stenopetalum	Common Stonecrop, Sedum (1)
Townsendia sericea	Prairie Townsendia (1)
Yucca glauca	Soapweed, Yucca (1; 7)

TABLE 7 - TURF GRASSES

BOTANICAL NAME	COMMON NAME
FESCUES	
Festuca arundinaceae	**Tall Fescue (5)**
Festuca ovina (var. saximontana)	**Hard Fescue (5)**
Festuca ovina var. *duriuscula*	**Sheep Fescue (5)**
BLUEGRASSES	
Poa compressa	**Canada Bluegrass (5)**
WHEATGRASSES	
Agropyron dasystachyum	**Northern Wheatgrass (5)**
Agropyron cristatum	**Crested Wheatgrass (5)**

APPENDIX 2: TASKS DEFINITIONS - PARKS MAINTENANCE MANAGEMENT SYSTEM (PMM SYSTEM)

The following are the definitions as specified by the Edmonton Parks and Recreation Department for the Parks Maintenance Management System.

Accomplishment Units - A measure of output that can be quantified.

Activity - Groups the maintenance tasks into 12 activity groups. Each activity is assigned a specific number.

Field Costs - Calculated based on the actual work and materials used in the execution of the task.

Inventory - The physical assets which the Maintenance Branch are responsible for.

Methods and Procedures - The standard equipment, tools and materials required to perform the maintenance task.

Productivity Standards - The level of accomplishment expected in a standard 8 hour day on a specific task.

Quality Standards - Specific goals for the quality of maintenance of the inventory

Service Levels - Established for inventory and delegates the amount of maintenance service that will be provided.

Site Rating - The Parks and Recreation Department rate parks according to a three tier system. Level A refers to sites which require continual maintenance such as watering, mowing, weeding etc. An example of a Level A site would be the grounds around the City Hall. Level B refers to parks which are mowed seven times a year and watered only in dry times. Level C parks or open space are not maintained, including the river valley.

Standard Crew Complement - Includes the manpower, vehicles, and equipment needed to perform a certain task.

Tasks - The basic maintenance activity, which is measured in terms of units of output. Each task is assigned a unique number.

Total Unit Costs - Include the field cost estimates and the overhead costs.

The following information describes the Parks Maintenance Management System as applied by Edmonton Parks and Recreation. The method of estimating required maintenance and associated costs was applied to the Riverdale Park demonstration site.

POWER MOWING (#100): Power mowing entails the cutting of turf areas by use of ride-on mowing equipment of various types. This task also includes sanitation(e.g. litter pickup in advance of mowing) and servicing of equipment (not to exceed 30 minutes).

Service Level Description: Level B - 7 cuts per year.
Quality Standard: Level B - Turf height 5 to cm. Developed Turf to be cut even, litter free and no damage to plant material.
Field Unit Cost: $48.37/hectare
Total Unit Cost: $89.59/hectare
Productivity Standard: 5.2 manhours

MACHINE TRIMMING (#101): This task involves machine trimming around all obstacles in the turf area by walk behind mower, weedeater, flymo, scythe etc. This task also includes all related sanitation prior to trimming and servicing of equipment (not exceeding 30 minutes).

Service Level Description: Level B - 4 times per year.
Quality Standard: Level B - Turf height to 5 cm. Developed turf to be cut even and free of damage and litter.Obstacles/edges free of tufts of grass.
Field Unit Cost: $20.03/Manhours
Total Unit Cost: $31.14/Manhours
Productivity Standard: 32.0 hours

TURF REPAIR-MINOR (#104): This task involves all turf repairs of depressions, ruts, bare spots, diseased or damaged areas not larger than 1000 m2 per location. The repairs may include floating, filling and levelling overseeding or sodding, rolling and related fertilizing and watering (if necessary).

Service Level Description: Once per year as required.
Quality Standards: Repair turf area at grade and flush with surrounding turf area. Even germination. Seed evenly and at recommended rates.
Field Unit Cost: $26.86/Manhours
Total Unit Cost: $42.30/Manhours
Productivity Standard: 16.0 manhours

TURF FERTILIZING (#105): This task involves the application of fertilizers (liquid or granular) to established turf areas.

Service Level Description: Level B - once per year.
Quality Standard: Application is even and uniform throughout. Turf is free of burn spots.
Field Unit Cost: $111.77/hectare
Total Unit Cost: $160.58/hectare
Productivity Standard: 18.0 manhours

TURF HERBICIDING (#106): This task includes the application of herbicides to control broad leaf weeds in turf areas using large boom sprayers, tanks, or small walk-behind sprayers for applying approved chemicals. This task does NOT include the application of RoundUp around obstacles and along fenceline as outlined in the Chemical Trimming Task #102.

Service Level Description: Level B - 55% of inventory (once every two years).
Quality Standard: Level B- Turf Height 5 cm. Non target areas are to be kept free of overspray or drift. Trees and shrubs are not to be damaged. Targeted areas are to be kept free of broadleaf weeds.
Field Unit Cost: $82.87/hectare
Total Unit Cost: $122.82/hectare
Productivity Standard: 10.0 manhours.

MISCELLANEOUS TURF (#108): This task includes dethatching, topdressing, edging, irrigation, removal of clippings, (eg. turf sweeping and/or raking). It also includes tine slicing and core aerating.

Service Level Description: As required.
Quality Standard: De-thatching: uniform throughout, thatch removed. Top dressing: uniform application not to exceed 10 mm thickness. Edging: curbs free of overgrowth, edgings removed. Irrigation: thorough soaking to the depth of root zone. Clippings removed to prevent killing of grass.
Field Unit Cost: $25.15/manhour
Total Unit Cost: $39.46/manhour
Productivity Standard: 8.0 manhours

VERTI-DRAIN AERATING (#110): This task involves the use of tractor drawn aerating equipment to punch holes in soil to relieve soil compaction.

Service Level Description: Once per year.
Quality Standard: Uniform coverage, depth at 20-30 cm (8-12") for Verti-drain. Turf free of rips and tears.
Field Unit Cost: $251.94/hectare
Total Unit Cost: $441.86/hectare
Productivity Standard: 0.9 manhours