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CFB East Redevelopment: An Ecological Planning Perspective

by

Robert Pierce

A MASTERS DEGREE PROJECT

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Abstract

CFB East Redevelopment: An Ecological Planning Perspective

Robert Pierce

May, 1998

Prepared in partial fulfillment of the requirements of the degree of Master of Environmental Design (Planning) in the Faculty of Environmental Design, The University of Calgary

Supervisor: Dr. Richard Levy

The realization that the practice of contemporary suburban development runs counter to the concept of sustainability is gaining prominence in North American communities. Yet, there are still growth pressures and suburbs continue to expand outward. One alternative to alleviate some of this outward sprawl is infill development both within cities and existing suburbs. If infill sites are to be exploited to their greatest potential, they must be developed in a manner which promotes sustainability. Ecological planning is one tool that can help communities accomplish this and contribute to sustainability.

The closure of Canadian Forces Base Calgary presents an infill opportunity for Calgary, which is currently experiencing tremendous growth. The first portion of the site to be developed is the former military residential community known as CFB East.

This Master's Degree Project examines if it is possible to achieve the City of Calgary's stated planning objectives for CFB East through an environmentally sensitive design approach that utilizes ecological planning. This approach attempts to lessen the impact of development on the environment and promote re-integration with natural systems.

Key Words: Ecological Planning, Sustainability, Infill Redevelopment, CFB Calgary, Ecological Community.

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Finally, my heartfelt thanks to my wife Barb, for her encouragement, assistance, and willingness to live with a shadow of a husband for the last two years.

Dedication

To Barb for her support, patience, and love.

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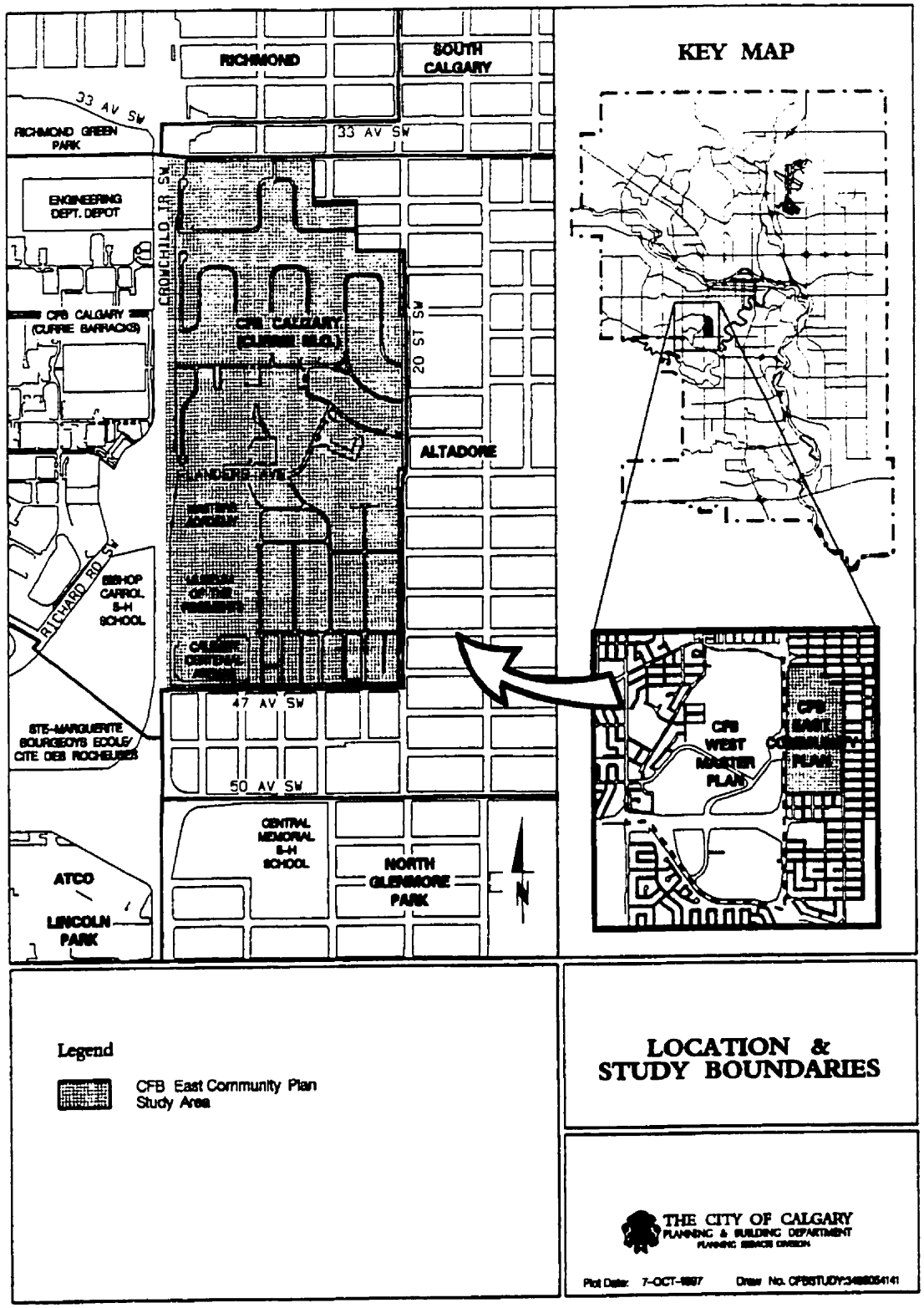
1 Background

Closures of military bases and stations in Canada and many other countries have become more frequent with the end of the cold war and shrinking defence budgets. A base closure is defined as:

> Terminating military activity at the base, and transferring personnel and equipment. The property may be used by another federal agency, sold to the province or municipality, sold in the marketplace at fair market value, or turned over to the community (Bruce 1995).

In February of 1995, the Government of Canada announced that Canadian Forces Base (CFB) Calgary was to be closed by the end of 1998. Only 8 kilometres from Calgary's downtown core and well within its older suburbs, the soon to be closed 184 hectare (455 acre) military base offers unique re-development potential. The City of Calgary published a proposed CFB East Community Plan in February of 1998. The City of Calgary planning process for the reuse of the base lands calls for the former military residential area to be redeveloped first. This area, known as CFB East, is located east of Crowchild Trail and is approximately 70 hectares (174 acres) in size (see Map 1-1).

Calgary is under great pressure to continue its pattern of outward suburban sprawl. CFB East offers the possibility of alleviating some of this pressure. The site's location, existing physical layout with ample green space and the absence of environmental contamination from previous military activity lend credence to its potential to be developed as a model of innovative and sensitive design.



Map 1-1 - Key Map CFB East (City of Calgary Planning and Building Department)

In addition to the opportunity presented by the fact that CFB East is being redeveloped, it was chosen because such sites, which are well within the urban fabric, offer the opportunity for moving toward sustainability "so that a new pattern of activities and of energy and resources can emerge and infiltrate into the existing pattern" (Van der Ryn and Calthorpe 1986).

1.1 Goal of MDP

The goal of this MDP is to determine if it is possible to achieve The City of Calgary's stated planning objectives for CFB East (see Appendix 1) through an environmentally sensitive design approach that utilizes ecological planning. This approach attempts to lessen the impact of development on the environment and promote re-integration with natural systems.

1.2 Objectives

The following secondary objectives will also be attempted to be satisfied:

1. Establish an understanding of ecological planning and its relationship to sustainability; and
2. Determine a method and design tools of environmentally sensitive design, which could be used on other redevelopment sites in Calgary, such as the redevelopment of the Bow Valley Centre (General Hospital) and CFB West.

1.3 Organization of MDP

This document first presents a literature review of ecological planning and design. Second, it establishes a methodology to produce a conceptual design (hereafter referred

to as CFB East II) to re-integrate CFB East into Calgary's urban fabric in an environmentally sensitive manner. CFB East II is assessed comparatively against the City of Calgary's proposed CFB East Community Plan (1998). Finally, the MDP concludes with recommendations for future use of the ecological planning approach in redevelopment projects within urban settings and for further development of CFB East.

1.4 Scope of MDP and Assumptions

Scope

This MDP only addresses the redevelopment of CFB East, which accounts for about 20% of the entire CFB Calgary redevelopment planning area. Since its initial development in the early 1950s, the site has been residential. An expressway (Crowchild Trail) separates it from the operational portion of the former military base. There is no environmental contamination from military activities on site. Due to these characteristics, the larger issues surrounding the redevelopment of former military sites are not be explicitly examined.

Within this MDP where there is a conflict between the achievement of the City's planning objectives and environmentally sensitive design, in CFB East II, the principles of environmentally sensitive design prevail.

CFB East II is a conceptual planning study and details land use, massing, open spaces, movement systems and, where necessary, crucial details are illustrated at a larger scale. This MDP does not address design details or guidelines at the architectural level, except where illustration is necessary. The concept for CFB East II is being approached

as a case study to examine the feasibility of the goal of this project and to provide a starting point for further ecological design of the site.

Assumptions

The main assumptions of this project are:

- some latitude was assumed to be inherent in City policies and standards;[1]
- the larger redevelopment of the entire CFB Calgary planning area was assumed to eventually include a range of uses (including employment);
- the City of Calgary's Proposed CFB East Community Plan has successfully met all of its planning objectives and goals (see Appendix 1); and
- by meeting the following criteria,[2] it was assumed that the MDP conceptual plan would be able to meet the planning goals and objectives as described in The City of Calgary's proposed CFB East Community Plan (1998):
  - achieving, as a minimum, a density of 27 units per hectare (11 units per acre);
  - providing, as a minimum, 1600 housing units;
  - providing a mix of housing types; and
  - providing, as a minimum, 4.45 hectares (11 acres) of open space.
- in the comparative assessment both financial and ecological costs are used, and are considered of equal importance.

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[1] Existing City of Calgary development standards and planning policies were assumed to have a degree of flexibility, which in the development process allows negotiation over such engineering requirements as street standards and infrastructure. This is necessary to allow for innovation beyond the existing prescriptive standards.

[2] All figures are based on meeting the same amounts as achieved in the CFB East Community Plan. This assumption is necessary to facilitate an accurate comparison of the ecological performance of each design by limiting the variables. The design features of CFB East II are largely based upon the proposed CFB East Community Plan.

2 Literature Review

2.1 Introduction

The purpose of this literature review is to: gain an understanding of ecological planning and its relationship to sustainability; explore the application of ecological planning in urban settings; and to derive a method for ecological planning in this project's design. Sources include books, professional journals (*Journal of the American Planning Association, Journal of Planning Literature, Environment and Planning B: Planning and Design, Plan Canada, Annals of Earth*, and *Urban Land*), electronic databases and the Internet. The Canadian Research Index and the Avery Index to Architectural Periodicals were particularly useful electronic databases.

2.2 Contemporary Urban Development

Human development activity has widely affected the natural environment, leaving few, if any landscapes on the earth untouched (Grant 1996). There is a consensus in the literature that the majority of urban development in the last century, and particularly suburbanization, has had little regard for natural systems or the future sustainability of suburbs (Newman 1997; Saunders 1997; Van der Ryn and Cowan 1996; Hough 1984). Present day cities have been planned in many cases with a separation of nature and humans and are the manifestation of humans' attempted dominance of nature (Walker and Rees 1997). Van der Ryn and Cowan (1996) argue that cities have separated people, both spatially and psychologically, from nature. Furthermore, Guerstein (1994) argues that societal and ecological problems have often been considered mutually exclusive. Cities can be seen as the ultimate attempt at denial of nature by humans (Hough 1984;

Manning 1979). It could then be inferred, when considering an ecologically sound method of urban development, that the most ecologically desirable process could be to forego development (Saunders 1997). Yet, there are solutions to this dilemma. There have been attempts throughout history to better incorporate nature into the city environment (Girling and Helphand, 1994). Nature often determined the form of many historical cities:

> great care was taken as far as relief, soil differences and water courses are concerned. Decisions about the location, the street pattern, squares and parks in these cities have been strongly influenced by the natural differentiation in the pre-urban landscape (Tjallingi 1994, p. 38).

Today, ecological planning is one method that attempts to maintain "landscape functions wherever possible.... Ecosystem mechanisms often prove more efficient in energy and cost than do human systems" (Grant 1996, p. 334).

2.3 Definition of ecological planning

Today, two trends that characterize traditional urban development are, firstly, the lack of basic infrastructure funding by government and, secondly, the "conflict between growth and quality of life" (Sackett 1997, p. 23). In concert with the emphasis on the concept of sustainable development, the process of ecological planning is now receiving more attention in North America (Hygeia and Reic 1995; Sackett 1997). Ecological planning has been defined by Steiner as **"the use of biophysical and sociocultural information to suggest opportunities and constraints for decision making about the use of the landscape"** (1991, p.9). Steiner adopts a holistic approach which integrates the consideration of the environment with other planning considerations (i.e.,

sociocultural), in fact, calling for the environment to form part of the basis of the decision making process.

Van der Ryn and Cowan define ecological design as **"any form of design that minimizes environmentally destructive impacts by integrating itself with living process"** (1996, p.*x*). Van der Ryn and Cowan's definition is similar to Steiner's but is intended for application beyond community design to any form of design.[3] In addition, they write that ecological design can act as the integrating body for "scattered efforts in green architecture, sustainable agriculture, ecological engineering, and other fields" (Van der Ryn and Cowan 1996, p. *x*). Both definitions emphasize consideration of the natural environment first when planning urban development.

Regardless of our perceptions, the rules of abiotic and biotic nature continue to be applicable in cities (Tjallingi 1994). Hough (1984) contends that the form of the urban landscape should be determined with an awareness of energy, the environment, and natural resource conservation. There are design methods and technologies that can "integrate with natural systems instead of obliterating or radically converting them" (Van Vliet 1994). Both Perks and Van Vliet (1993) and Van Vliet (1994) provide examples of successful ecological community design in Scandinavia. However, with the pattern of existing development in many North American cities the question then arises: is it possible to repair the damage done and allow natural systems to re-surface? A number of sources indicate that it is (Beer 1994; Hersperger 1994; Hough 1984; Guerstein 1994; Grant 1996). Natural systems are still at work in the city, "albeit in a damaged

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[3] Van der Ryn and Cowan (1996) define design as: *the intentional shaping of matter, energy, and process to meet a perceived need or desire.*

manner... we can reverse some of the damage a city has done to its local environment by applying more ecologically sustainable urban development systems to the workings of the city" (Beer 1994, p. 73).

2.4 Implications of the acceptance of ecological planning

To implement ecological planning, which is considered a fundamental building block of sustainability (Van der Ryn and Cowan 1996), it has been argued that a shift is required in North American values. Currently we trade off detrimental effects on the natural environment for economic benefit. Grant emphasizes that our value system must adapt to recognize nature's intrinsic value (Grant 1996). One step towards this shift in values is to educate the public on the correlation between the health of the environment and the health of society. The necessity of education on the methods and benefits of ecological design is a common theme expressed in the literature (Hygeia and Reic 1995; Beer 1994; Hough 1985; Van Vliet 1994; Guerstein 1994). The value of educational programs in promoting sustainability and ecological design has been proven in places such as Cerro Gordo, Oregon. Initially, over two-thirds of future residents of this new community wanted to live in low-density single family homes. After an education program, two thirds wanted to live in attached housing near the village centre (Canfield 1996). Regardless of the extent of normative adjustment required, to approach development in Canada from the point of view of considering the environment first is a fundamental departure from the status quo and has several major implications.

The adoption of ecological planning signals the acceptance of the link between the natural and urban world, and that urban development must take its form in response

to natural systems. It also implies the acceptance that the existing development system is not working (Gibson 1997; Van der Ryn and Cowan 1996). Ecological planning calls for the modification of development to enable the continued functioning (or even rehabilitation) of natural systems (Gibson 1997). This could result in a shift in societal values as suggested by Grant (1996) towards the recognition of nature's intrinsic value. In a study of sustainable development in Nova Scotia, Grant (1996) proposes that a value shift is necessary to allow communities to begin practicing sustainable development as opposed to merely adopting policies which are then not implemented. Unlike Van der Ryn and Cowan (1996), Grant (1996) proposes that the recognition of the correlation between the health of the environment and the health of humans will be a beneficial side effect of the value shift, rather than the catalyst for the adoption of ecological planning. Grant (1996) concedes that such a transition will not be easy. There is agreement among several sources that communities in North America are accepting the validity of sustainability (Hygeia and Reic 1995; Sackett 1997; City of Calgary 1995a, 1995b). The degree of success in implementation, however, is questionable (Van Vliet 1994; Grant 1996). The adoption of an ecological planning approach will necessitate a new method of urban development, which accepts limitations on development in order to preserve and, if possible, revitalize natural systems – moving communities closer to a goal of sustainability (Van der Ryn and Cowan 1997).

A further related implication is the need to implement site specific planning. This can be facilitated with the adoption of performance criteria in conjunction with a form of land use zoning. Site-specific thinking is crucial to help implement the ecological planning method of approaching design that considers the existing natural systems first

(Beer 1994; Van Vliet 1994; Guerstein 1994). Performance criteria have been adopted as the basis of community design in numerous sustainable communities in Scandinavia (Perks and Van Vliet 1993).

2.5 Relationship to Sustainability

Sustainable development has been defined by the 1987 World Commission on Environment and Development (Brundtland Commission) Report as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Roseland 1997).[4] Canadian municipalities are beginning to realize that many traditional patterns of development are economically, socially, and environmentally unsustainable and there is a need to foster healthy sustainable communities (Hygeia and Reic 1995). In Calgary, for example, the Sustainable Suburbs Study has been adopted to "create communities that are capable of being sustained far into the future" (City of Calgary 1995). The basis of the City of Calgary study was:

- to help implement Calgary Transportation Plan (City of Calgary 1995b) policies;
- to control the costs of growth;
- to better meet people's needs within their own communities; and
- to encourage more sustainable lifestyles in addressing "the causes of the problems, not just the symptoms" (City of Calgary 1995a).

[4] It is recognized that the term sustainable development is contested and has been called ambiguous. This debate will not be reviewed in this project. Van der Ryn and Cowan (1996) provide a good summary.

Similar initiatives are found in the USA. Sackett (1997) sees the primary challenge for the development industry as meeting "the demand for growth in a manner that preserves the quality of life and the environment" (p. 23). Development regulatory agencies in the USA have put many new regulations in place that make traditional development either prohibitively costly or unworkable. Some regulations include:

- long and costly environmental reviews and mitigation strategies to ensure that new development meets environmental standards;
- passing infrastructure costs for improving environmental standards of water and sewer on to customers; and
- deregulation of the electrical utility industry (currently 27 states) to eliminate subsidization by "more profitable industrial and commercial customers" and adopting a "pay--as-you-go proposition" for new developments (Sackett 1997).

The acceptance and implementation of ecological planning and design has been made more likely in North America by the growing acceptance of sustainability. It is generally accepted that some form of development is necessary to meet the needs of an ever-expanding world population (Lyle 1994). Ecological design is the basis for the effective implementation of sustainability as it deals with the real every-day problems of sustainable development policy implementation: "[p]olicies and pronouncements have their place, but ultimately we must address specific design problems" (Van der Ryn and Cowan 1996). Sustainability cannot be achieved through a single approach (Van der Ryn and Cowan 1996), nor is it linked to any single design concept (Tjallingi 1994). It must be emphasized that ecological design is only one piece of the solutions toward creating

communities that are sustainable, however, it is a crucial piece (Roseland 1997; Van der Ryn and Cowan 1996).

2.6 Principles of Ecological Planning

In the literature reviewed, Saunders (1997), Van der Ryn and Cowan (1996), Grant (1994), and Lyle (1994) provide compilations of principles necessary to achieve ecological or sustainable communities.[5] This section categorizes and summarizes these principles. All of the principles are related and reinforce each other. All are incorporated into either this project's conceptual design or recommendations in accordance with the principle's respective emphasis.

	Saunders	Van der Ryn and Cowan	Grant	Lyle
1. Establish circular flows of resources and ensure their monitoring	X	X	X	X
2. Ensure community involvement in the practice of inter-disciplinary design	X	X	X	
3. Incorporate innovative site specific design features informed by natural processes	X	X	X	X
4. Incorporate nature	X	X	X	X
5. Consider all elements of community design: economic, social, environment	X	X	X	

Table 2-1 Principles of Ecological Planning

Establish circular flows of resources and ensure monitoring

This principle corresponds to the theory of circular flows for ecological communities that are modeled after the flows of natural ecosystems. By maintaining

[5] See Appendix 2 for principles.

circular flows, communities can reduce or eliminate the necessity to draw upon outside external resources; thereby performing more like a natural ecological system (Van der Ryn and Cowan 1996). An essential tenet of this principle is to ensure that community members can measure flows. In the community of Vallersund Gård, Norway, residents monitor the amount of energy consumed in the community as compared to the amount of energy produced by their windmill (Saunders 1997). This principle is not explicitly stated in all four lists studied, but it addresses a key issue of ecological design as defined by Van der Ryn and Cowan (1996) -- specifically, integrating with natural systems.

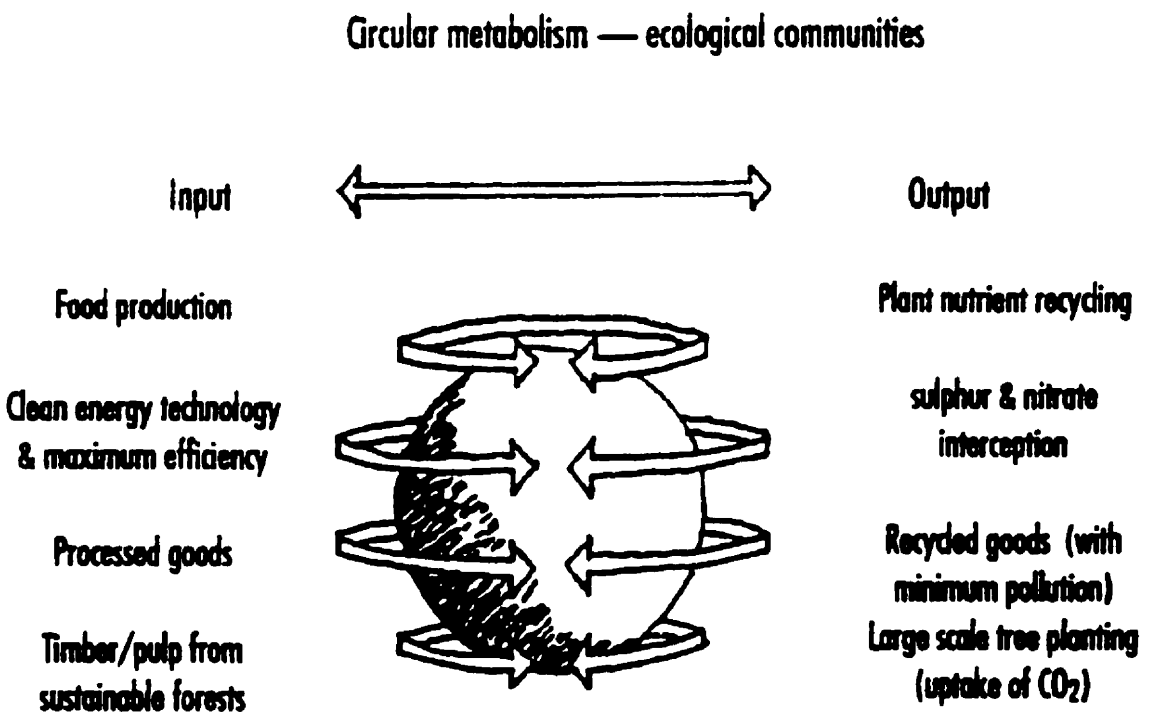


Figure 2-1 Circular metabolism of ecological communities (Saunders 1997)

Ensure community involvement in the practice of inter-disciplinary design

As in community planning, the success of ecological planning is dependent upon community involvement. This helps to ensure the inclusion of local knowledge about both ecological and social opportunities and constraints. It also provides residents with an additional sense of ownership of the final community plan (Saunders 1997). The role of designers in producing ecological community plans is, by necessity, more general and as part of an inter-disciplinary team. Saunders (1997) suggests that design problems should be approached with an integrated team approach to allow the proper consideration and treatment of the wide range of issues in ecological planning. Tyler (1994) and Grant (1996) express similar viewpoints.

Incorporate innovative site specific design features informed by natural processes

The need to approach community design in a new way is fundamental to ecological design. Contemporary Canadian and American urban development largely runs counter to and is destructive of ecological systems. Lyle (1994) places great emphasis on "regenerative design" that replaces the present linear system of throughput flows with cyclical flows at sources, consumption centers, and sinks. Innovative design, modeled after natural processes, allows the replacement of natural functions it displaces, such as the hydrological cycle. Alternative housing arrangements (i.e., other than single family detached) at higher densities reduce "urban sprawl as well as car dependency," which reduces infrastructure costs, and allows more land to be left as green space (Saunders 1997, p. 117). Innovative design features can include such varied elements as both site design and building technology.

Incorporate nature

Instead of using natural areas as buffers between perceived incompatible uses, communities should be designed to include natural areas as their focus. This helps to maintain nature's visibility within the community and allows "people to experience, observe, and understand the cyclic processes of nature. In turn, this understanding can foster a greater appreciation of natural areas that is not possible in the biologically sterile landscapes of conventional communities" (Saunders 1997, p. 119). Residents can develop a greater awareness of how their actions affect nature (Van der Ryn and Cowan 1996). Incorporating nature can include allowing nature to provide the visual context for the site (Lyle 1994).

Consider all elements of community design: economic, social, environment

When designing an ecological community, aspects of community planning beyond ecological concerns cannot be ignored. Designers should not exclude other vital elements of community design, such as economics and lifestyle, in the attempt to achieve singular ecological design objectives such as alternative energy systems. Saunders emphasizes that while "ecological factors are crucial, so is the human aspect, which was the reason why the community was constructed in the first place" (Saunders 1997). Lyle (1994) does not explicitly include such considerations in his design strategies for regenerative communities, however, he does put forth that operational integration with natural processes, by extension, should include integration with social processes. This principle can contribute greatly to the acceptance of sustainable communities and ecological design practices in the creation of healthier communities. Such a link is made by Grant (1996), who writes that many "of the individual and collective problems of

modern societies arise from unsustainable environmental and cultural practices....We can deal better with our social problems as we develop positive new relationships with the landscapes that sustain society" (Grant 1996, 342).

2.7 A Method of Ecological Planning

Ecological planning can largely be summarized as the adoption of a different viewpoint or focus, or as has been suggested, a different normative model that recognizes nature's intrinsic value (Perks and Tyler 1997; Grant 1996). Ecological planning strives to integrate urban development within natural system flows such as the existing hydrological cycle (Van Vliet 1994; Tjallingi 1994). In effect, it modifies the current decision making process and "provides a sufficient rationale on which to base good land-use planning decisions" (Van Vliet 1994) that are based upon the consideration of the environment first.

Ecological planning demands an understanding of the site's natural landscape. Ian McHarg, author of Design by Nature (1969), developed an ecological planning approach that maps the natural features of the landscape and determines optimal locations for development through a method of suitability analysis. A similar method developed by Steiner attempts to be more comprehensive and looks beyond the natural features of the site to also consider goals, implementation, administration, and public participation (Hersperger 1994). His method is a combination of conventional planning processes "as well as those suggested specifically for landscape planning" (Steiner 1991, p. 10). Steiner proposes an 11 step ecological planning method. Throughout the process he emphasizes understanding "the interrelationship between people and nature" (1991, p. 11). Steiner's method is not necessarily linear and the steps may be taking place

simultaneously (See Appendix 3). Steiner's method of ecological planning is one of several, however, it is selected for use in this MDP due to its flexibility and holistic attributes, which are exemplified by its goal of serving "as a common language among those concerned about social equity and ecological parity" (Hersperger 1994, p. 23).

2.8 Performance Objectives and Design Tools

A distinction of more recent ecological communities reviewed by Van Vliet (1994), is the use of community performance objectives. A previous compilation of five case studies of ecologically planned communities by Perks and Van Vliet (1993) similarly found that communities were planned to meet community performance objectives rather than prescriptive guidelines such as land use bylaws. This approach is much more sensitive to site context. One example of a performance objective is:

> *Land uses and built-forms are planned, designed, and developed integrally such as to support and or regenerate vegetation and to nurture wildlife (Perks and Van Vliet 1993).*

Performance objectives generally address energy, water, the nutrient cycle, and food, and can be viewed as a visioning exercise (Van Vliet 1994). It must be emphasized that the entire process of ecological planning is site specific and the fulfillment of a site's performance objectives must be generated in response to the site's natural systems (Van Vliet 1994). The inclusion of performance objectives corresponds both to Steiner's (1991) second step of establishing planning goals and is crucial in step ten – plan design and implementation. It should be recognized that community planning with performance objectives often requires a level of community stewardship (Perks and Van Vliet 1993).

The performance objectives used in this project have been generated in response to the information studied in the literature search. The ecological community performance objectives are categorized to address **energy, water, nutrient cycle and food.** Their aim is to help the community integrate with the natural environment, primarily through creating a circular rather than a linear flow of inputs and outputs (see Figure 2-1). The main sources used in generating this project's performance objectives include City of Calgary (1998), Saunders (1997), Van der Ryn and Cowan (1996), Lyle (1994), Van Vliet (1994), Van Vliet and Perks (1993), and Hough (1984).

Ecological Performance Objectives

Energy

Minimize energy consumption and establish mechanisms within the community for the production of renewable energy.

Design Guidelines

Build with more density. Designing communities with greater density encourages the creation of urban villages with local employment opportunities, a pedestrian atmosphere, supports transit use[6] and permits a wider range of land uses – including commercial. It also allows such energy-saving benefits as economy of scale, district heating, opportunities for reduced automobile trips, and reduced infrastructure costs and requirements (Newman 1997). Infrastructure requirements are lessened, for example, where the local street length of 17.5 metres per dwelling unit is required for single detached housing, an eight storey apartment building only requires one metre per dwelling unit (Walker and Rees 1997). The amount of road infrastructure then also

[6] Minimum density to support local bus service is 24 units per hectare (10 units per acre). Source: Peter Calthorpe 1993.

multiplies for collector and major roads, which are off-site, but must expand as the city expands in relation to the predominant development form. High density, mixed land use developments consume 10-15% less energy before any other energy-saving techniques are applied (Stenhouse 1992).[7] A San Francisco study by John Holtzclaw found that a doubling of density decreased per capita vehicle miles traveled by 30% (Woodhall 1992).

Detached housing consumes "the most operating and embodied energy per unit of floor space when other factors are held constant" (Walker and Rees 1997, p. 101). The choice to build with more density is appealing. Density, however, is not a panacea and it is difficult to prescribe an optimal range. Transit use requires a density of about 24 units per hectare. Densities of 30-40 persons per hectare (about 20 units per hectare) have been suggested as the target range for the creation of an urban village (Newman 1997). A British study found that district heating requires a minimum of 44 units per hectare (18 units per acre) to be cost effective (Walker and Rees 1997).

Densities of 100-150 units per hectare were found to be ecologically sound in a 1991 Amsterdam study by Gommars and Hendrikse (Tjallingii 1994). Grant (1996) suggests that a density level should be established that still allows the landscape to function. For example in redesigning a Calgary suburb, Andrea Wilton-Clark found that higher densities (40 units per hectare) need only be achieved in select areas of the project, which could then allow for the use of district heating (1996). Density increases can be achieved through smaller lot sizes, an increase in the proportion of multi-family dwelling units, devoting less land to roads and by including a wider range of housing

[7] A Calgary single family home consumes 667 kWh/month, a townhouse 558 kWh/month, and an apartment unit consumes 387 kWh/month. Source: Enmax – Calgary's Electric System phone interview 8 April 1998.

choices (i.e., ancillary suites, residential development over commercial, apartments) (Calthorpe 1993). Other options also include retrofitting of existing buildings and infill development (Van Vliet 1994).

Optimize exposure for passive solar radiation. House and lot orientation should be within 15-25° of south to maximize passive solar radiation gain (Charette 1995). Passive solar radiation gain helps to lower energy requirements for heating. Its effectiveness is influenced by the use of high-capacitance materials to store solar heat gain, providing solar-oriented interior zones for maximum solar heat gain, planning specific rooms or functions to coincide with solar orientation (Watson and Labs 1983). Building materials with high heat absorption capacities can store heat for release later when direct solar radiation is no longer available (Lyle 1994). The use of passive solar radiation for home energy requirements is greatly dependent upon building form, weather conditions, landform, and surrounding built form. This makes it difficult to define performance advantages for passive solar homes in comparison to a standard single-family home.

Use energy efficient building materials and technology, as well as recycling building materials in order to reduce demands on non-renewable resources (Grant 1996).

Treat community wastewater and other effluents on site. This not only retains what is considered a resource for the nutrient cycle, but also conserves the energy required for transporting the waste, its mechanical treatment, and the associated related infrastructure

capital costs. Options include such devices as living machines[8] and composting toilets (both are discussed later).

Include mechanisms for monitoring community energy consumption and production. An ecologically planned community in Holland has installed visible meters so that residents can monitor the amount of energy the community consumes in contrast to the amount its wind generators produce (Saunders 1997).

Design buildings to be adaptable over time for a variety of uses. This guideline can be achieved through planning for transitional sites that allow buildings and sites to be easily converted to a range of uses as needs change (Duany and Plater-Zyberk 1994).

Produce renewable energy on site – such as solar and wind energy. Not only does this help accomplish the continuation of a circular metabolism for the community's energy cycle, but the costs of transporting energy from distant generating facilities is avoided. Another option is co-generation and district heating. The process of co-generation involves capturing the heat by-product from generating electricity by combustion and then redistributing it through a district hot-water pipe system to heat homes (Wilton-Clark 1996). Co-generation consumes about 33% less fossil fuel than conventional methods (Perks and Van Vliet 1993). It is possible to employ district heating to serve small areas, such as neighbourhoods with small mobile group heating plants. Such systems are recommended for use when developing a larger scheme district heating area until the large central plant is functioning. It is also possible to recover heat for district heating from small incinerators, thereby contributing to the establishment of

[8] Living machines require on-site infrastructure to transport wastewater to the machine.

circular energy flows (Diamant and Kut 1981). A British study found that the minimum density for district heating to be effective is 44 units per hectare (Walker and Rees 1997).

Use naturalized landscaping to reduce maintenance requirements and promote biological integrity and diversity. Landscape architect James F. Worton defines naturalized or ecological landscaping as "the selection and management of native, and perhaps to some extent, non-native plants, which represent a more 'naturalized' landscape" (1993, p. 11). Naturalized landscaping greatly cuts down on maintenance requirements (e.g., energy) and creates habitat for wildlife. The initial cost to create a naturalized landscape can be three times that of a traditional manicured landscape, but annual maintenance costs are about one-third (Worton 1993). The result is a healthier system that does not require pesticides and is more resistant to disease due to its diversity. This could easily include replacing the ubiquitous lawn by xeriscaping[9] or other natural plantings. A suggested list of natural species for use in Calgary is included as Appendix 4.

Optimize tree plantings and other vegetative cover to facilitate the creation of favourable micro-climatic conditions. Up to 1/3rd of a house's space heating requirements in an Alberta winter is due to the effects of winter winds (Worton 1993). Planting of appropriate trees helps to moderate cold winter temperatures and aids cooling in summer. This technique is effective for a number of applications, including structures,

[9] Drought resistant landscaping.

open spaces, and streets. Trees planted to create a canopy can provide a cooling effect of up to 12°C when compared to temperatures in the open (Worton 1993). Stuttgart has utilized climatic planning techniques since 1932 (Shirvani 1985).

Include areas for food production to allow community gardening. Community gardening in Calgary's climate, without intensive green house operations, is unlikely to provide the total per capita vegetable requirement. It can, however, supplement store bought produce and the act of community gardening can be socially beneficial.

Water

Minimize water consumption, preserve the natural hydrological cycle, and improve the quality of effluent.

Urbanization generally affects hydrology in terms of: 1) peak flow characteristics, 2) increased total runoff, 3) water quality, and 4) general hydrological conditions (Shirvani 1985).

Design Guidelines

Utilize water saving features in building design, such as low flush toilets, recycling grey water, and low-flow faucets. The use of low water volume taps and shower heads, rainwater recycling for gardening and car washing, and grey water recycling for toilet flushing at a Dutch project cut daily water consumption per person from 136 litres to 78 litres – a reduction of 43% (Tjallingii 1993). Currently in Calgary, the average daily consumption is 594 litres per capita.[10] If grey water is to be used for irrigation, Bill Roley

[10] Consumption rate provided by Pamela Reid – City of Calgary Waterworks – 8 April 1998.

(1992) recommends that it be through underground distribution in a mini-leach field due to the dangers of contamination and that it not be used on vegetables.

Minimize impermeable surfaces. The design of urban space is directly related to the levels of flash flooding in rivers and streams (Beer 1994). It has been determined that polluted urban runoff is the greatest threat to water quality in the United States (Arnold and Gibbons 1996). Minimization of impermeable space can be accomplished through design by using narrower road rights-of-way, by using permeable paving surfaces, shale, or other similar materials, establishing shared parking schemes and on-street parking, and reducing building footprints (Hough 1984; Charette 1995). Minimizing impermeable surfaces is the most cost effective and feasible manner to address water pollution. This can also include siting structures on higher ground to avoid building on aquifer recharge zones (Hough 1984).

Retain community storm water runoff on site, including rain-water runoff from roofs in rain barrels or underground cisterns for domestic uses. Calgary's water consumption rises by 55-60% in the summer months to 1216 litres per person per day on the highest consumption day of the year.[11] Collected runoff can be used to supplement water needs, including for living machines. It is also possible to collect rainwater in roof top storage tanks, and in buildings of sufficient height to then use gravity feed. Retention ponds can be used at the community level. See Figure 2-2 for an illustration of the pre and post-urbanization hydrological cycle.

[11] Consumption rate provided by Pamela Reid – City of Calgary Waterworks – 8 April 1998. Higher summer conusumption rate is due to increased outdoor use for lawn watering, etc.

Treat and reuse wastewater on site. The traditional method of wastewater treatment is mechanical. It is based on the adage that "the solution to pollution is dilution" and it directly counters the natural processes of nature for cleansing water (Roley 1992, p. 102). Wastewater can be treated on site with living machines (polyculture greenhouses) such as designed by Todd, which also produce natural fertilizer that can be re-introduced to the nutrient cycle (Roley 1992). Living machines are designed specific to their needed function and water is their "medium of communication, connection and interchange" (Todd and Josephson 1994). A similar design by Serfling is the solar aquacell, which is contained in a green house structure. His "system creates a polycultural habitat in which a plastic substrate provides a surface for bacteria, which in turn are grazed by arthropods and other marine microorganisms. Floating water hyacinths take up the majority of nutrients in the effluent" (Van der Ryn and Calthorpe 1986a, p. 51). Its energy use is substantially less than a conventional treatment system and, as it is entirely self-contained, it is acceptable for use within communities (Van der Ryn 1986).

On-site treatment of wastewater eliminates the expense and energy required for transporting it to distant mechanical treatment facilities. This expense could dramatically increase if extensive off-site improvements are required to handle increased demand, such as sewage treatment. Other possibilities include composting toilets, which can be implemented quickly with no traditional infrastructure requirements.

Design hard surfaces with hydrological functions, for example, design parking lots to channel rain water to planting strips and incorporate oil separators to improve the quality of urban runoff (Hough 1984).

Install visible water meters on all buildings and charge according to use levels (City of Calgary 1995a; Charette 1995; Van Vliet 1994). Households that pay for water use based on consumption use about 40 percent less than flat rate households (Environment Canada cited in Pembina Institute 1997).

Retain and design natural drainage courses with ditches and swales, when possible, to improve percolation and moderate peak flow runoff times. This includes designing roads without curbs and gutters to facilitate ground water recharge and natural filtering (Charette 1995).

Plant vegetation in drainage courses to improve percolation. Water quality and percolation is enhanced by vegetation, it also contributes to the diversity of natural and human habitat (Hough 1984; Beer 1993).

Restore natural vegetation to reduce irrigation requirements for ornamental landscaping.

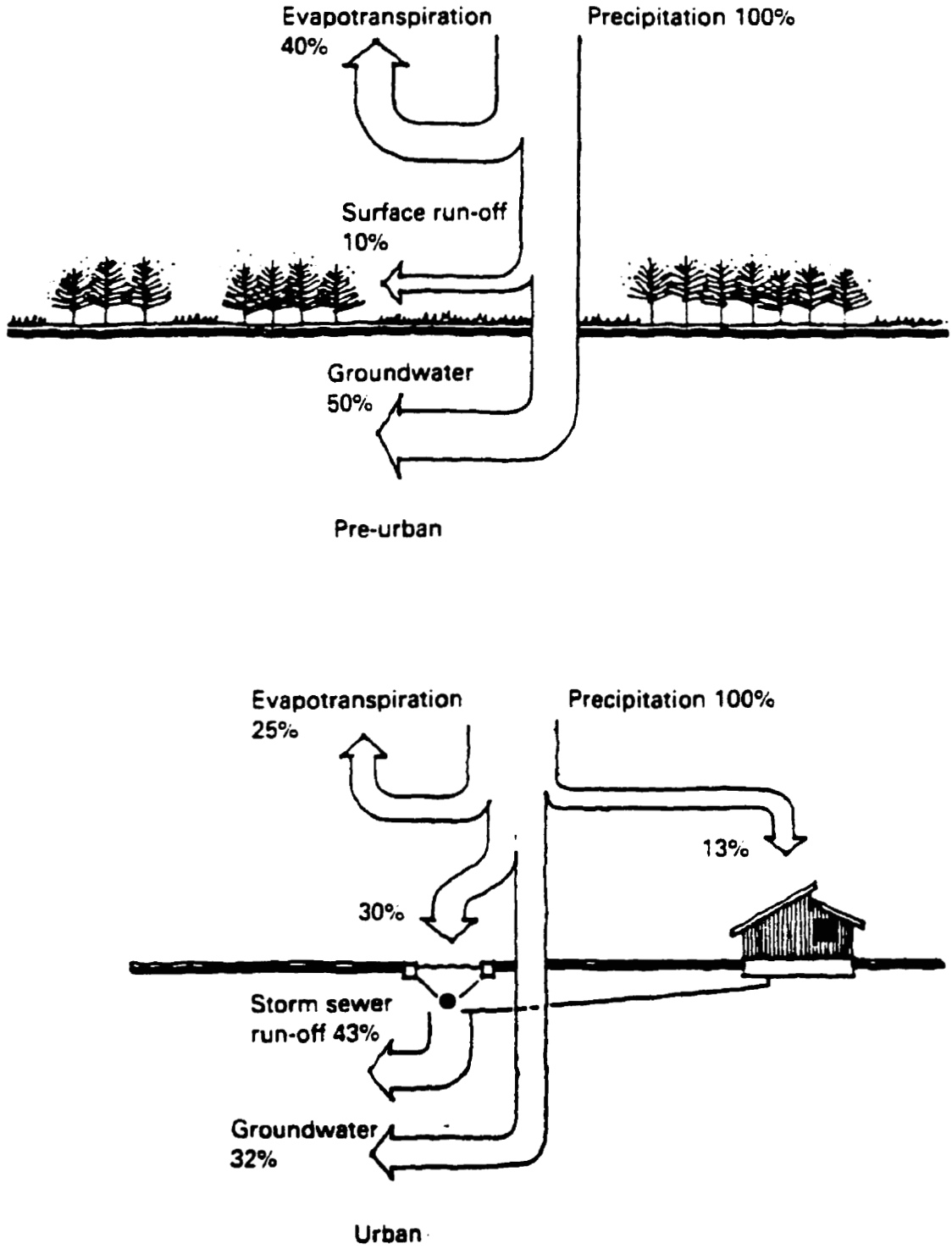


Figure 2-2 Pre and Post-Urbanization Hydrological Cycle (Hough 1984)

Nutrient Cycle

Design to support and allow the regeneration of vegetation and all elements of the natural environment

Ecosystems can be jeopardized "if carbon is recalcitrant or nitrogen, phosphorus, and potassium ratios out of balance, or trace elements not readily available.... Nutrient imbalanced systems become prone to disease and subject to biological impoverishment. Over time species in such systems die out" (Todd and Josephson 1994, p. 19). Hough writes, "productive soils are necessary to productive and diverse landscapes" (1984, p. 250) and that many urban soils "have been sterilized through constant disturbance and pollution" (Hough 1995, 228).

Design Guidelines

Build facilities that allow preservation of the nutrient cycle within the site, such as living machines that return nutrients to the site after sewage treatment, composting toilets, or recycling plant matter from fallen leaves or grocery waste (Hough 1984). We produce large amounts of waste in a city and then further tax the natural system by disposing of it through mechanical treatment instead of using it as a resource (Hough 1984).

Design to make nature a focus and a visible part of the community.

Design to promote the integrity of the nutrient cycle. Open spaces need to be connected to provide habitat and connecting paths for plants and animals to help preserve or link habitat areas (Tjallingii 1993; Grant 1996). Use filtration beds for grey water to return more nutrients to the soil (Van Vliet 1994).

Promote and preserve the naturalization of the landscape to promote biodiversity. Some very limited lawn landscaping can still be preserved both for aesthetic sensibilities and for its usefulness in design, such as defining edges (Hough 1990).

Provide sufficient green areas for functional and productive green space (Hough 1990; Beer 1993). Green areas can be designed not only for recreation, but also for productive purposes. By using organic gardening practices, people learn more about the nutrient cycle. Organic gardening, "the development of planting design techniques, inspired by natural plant succession and speeded up through management, has helped to prepare the soil through sequential plant associations" (Hough 1984, p. 250). The amount of green space should be based upon site specific and community requirements, instead of a blanket policy requiring a certain percentage (Charette 1995).

Food

Design to promote community food growing initiatives.

In addition to the social benefits of urban gardens, community gardens have been "primarily devoted to social goals of cleaning-up and beautifying neighbourhoods or designed as food supplements for programs for low-income city dwellers" (Katz 1986, p. 155). By designing for and encouraging their construction, urban gardens can contribute to the re-establishment of the connection between nature and cities (Hough 1995). As they work with nature, gardeners get a better understanding of nature's functions.

Use urban open spaces productively, for such activities as food production. The site's limitations, such as Calgary's short growing season, must be respected. It is unlikely that sufficient vegetables could be produced by families to replace store bought vegetables,

however, augmentation is certainly possible. This could result in fewer trips to the grocery store and the associated reduced transportation energy demands. A wide range of lands could be considered for gardening use, including yard space.

Use gardening to improve the nutrient cycle. The health of the soil is improved and the nutrient cycle is maintained through organic gardening methods.

3 Methodology

The goal of this MDP is to determine if it is possible to achieve The City of Calgary's stated planning objectives (see Appendix 1) for CFB East through an environmentally sensitive design approach that utilizes ecological planning. A case study approach is used to show a possible resulting urban form when community design for CFB East is approached from an ecological planning perspective. To determine its success in achieving this MDP's goal, the CFB East II concept will be assessed against the proposed CFB East Community Plan (1998).

The ecological planning method and site analysis used in this project follows the process of ecological planning as explained by Steiner in The Living Landscape: An Ecological Approach to Landscape Planning (1991). It allows the site's natural characteristics to determine appropriate development in conjunction with community needs. The steps are:

- identification of planning problems and opportunities;
- establishment of planning goals;
- landscape analysis, regional level;
- landscape analysis, local level;
- detailed studies to link the inventory and analysis information to the problem(s) and goal(s);
- planning area concepts, options, and choices;
- landscape plan;
- continued citizen involvement and community education;
- detailed designs;
- plan and design implementation; and
- administration.

Steiner's method is not necessarily conducted in a linear manner (see Appendix 3). The phases of the MDP methodology include all the steps of Frederick Steiner's (1991) ecological planning method and are described below.

1. Data Collection

The information gathered during the data collection phase was used to determine the opportunities and constraints of the site. To ensure thoroughness, the framework and elements examined for human and natural systems followed Steiner's (1991) suggested framework for completing an inventory of the biophysical environment and human community in ecological planning. The first four steps of Steiner's process were conducted in this phase. Sources include:

- Applicable local and City wide planning policies – including adjacent community plans. Main sources will include Proposed CFB East Community Plan (City of Calgary 1998) and the applicable City of Calgary policy documents.
- Natural Characteristics of CFB East – main sources will include Proposed CFB East Community Plan (City of Calgary 1998), Environmental Comprehensive Study of Base Closure Activities (UMA Engineering 1996), An Ecological Approach to Site and Subdivision Design (Worton 1993), and Phase I Environmental Site Assessment of CFB Calgary Currie Permanent Married Quarters (UMA Engineering 1997).

- Human Systems of CFB East – main sources include Proposed CFB East Community Plan (City of Calgary 1998) and community profiles available from the City of Calgary Planning and Building.

2. Determination of Opportunities and Constraints

The information gathered was reviewed to determine its implications for the redevelopment of CFB East. For ease of reference, when presented in the MDP document, they will be incorporated into the preceding data collection phase. It is recognized that the phrase *opportunities and constraints* is subjective. This phase corresponds to Steiner's step 5 – detailed studies to link the inventory and analysis information to the problem(s) and goal(s).

3 Performance Objectives and Design Tools

The proposed plan details a community designed with the methods of ecological planning. The community would strive to achieve performance objectives that contribute to the formation of an ecological community and that have been determined through the literature review. The performance objectives address energy, water, nutrient cycle, and

food. Additional community performance objectives address the social and economic aspects of community as interpreted directly from the planning objectives of the proposed CFB East Community Plan (City of Calgary 1998).[12] Design tools have come from a number of sources, as outlined in Chapter 2, including the following:

- Michael Hough, City Form and Natural Process (1984);
- Terren Institute, Urbanization and Water Quality (1994);
- James F. Worton, An Ecological Approach to Site and Subdivision Design (1993) a guide to developing ecological landscapes in Alberta;
- Hamid Shirvani, Urban Design Process (1985);
- David Van Vliet, Sustainable Subdivision Planning and Design: Analysis, Literature Review and Annotated Bibliography (1994);
- Sim Van der Ryn and Peter Calthorpe, Sustainable Communities: A New Design Synthesis for Cities Suburbs and Towns (1986); and
- Bob Walter, et al., Sustainable Cities: Concepts and Strategies for Eco-City Development (1992).

4. Generation of Alternative Design Concepts

Three alternative, or potential, designs that illustrate land use, street orientation, and open space systems were generated. The three alternatives explored a range of options. The first examined retaining most of the current site layout and military housing. The second examined eliminating all built form from the site and starting with a blank

[12] See assumptions in Section 1.4 pertaining to meeting the City of Calgary planning objectives.

slate. The third was a compromise between the first alternative of retention and the third of starting new. Each was considered to determine which best accomplished the goal of environmentally sensitive design. The environmental criteria for assessment were identical to those used for the comparative analysis of the CFB East II against the proposed community plan; however, the level of detail in the assessment was not as great due to the alternative plans' lower level of refinement.[13] Each alternative design will also was assessed in terms of its ability to meet the City's planning objectives and goals as explained in Section 1.4.

The design alternatives were produced using the Computer Aided Design (CAD) program ArchiCAD version 5 on a PC platform. There are several advantages in using CAD for this project. These include the ease of generating alternative designs and doing revisions, the ability to quickly perform a wide range of calculations (such as land use area), improving the ease of creating perspective views from many vantage points, and the portability of computer graphic images (Levy 1995). The option that best satisfied the criteria of environmentally sensitive design was chosen for refinement in the phase 5.

5. Design Refinement

The chosen design was refined to the level of a conceptual design using CAD. The deliverables consist of:

- a land use concept map;
- a massing study including sufficient massing of the surrounding area to provide context;
- a delineation of natural open space;
- movement systems; and
- other images necessary to illustrate key components and conduct a comparative assessment of the conceptual plan.

[13] See phase 6 of methodology for assessment criteria.

The design illustrates the urban form that results from achieving the City of Calgary's planning objectives in an environmentally sensitive manner. For ease of comparison between designs and to clearly demonstrate the potential for lessening environmental impacts, CFB East II has **met** the City of Calgary planning objectives but, has not greatly surpassed them. CFB East II must be viewed as a starting point for further refinement of environmentally sensitive design of CFB East and is addressed further in Chapter 6.

6. Design Evaluation

The aim of the evaluation is to determine if CFB East II has met its goal: *to achieve The City of Calgary's stated planning objectives for CFB East through an environmentally sensitive design approach that utilizes ecological planning.* CFB East II is comparatively assessed against the Proposed CFB East Community Plan.[14] Data sources for the Community Plan are the CFB East Outline Plan Submission (Walker Brown Urban Consultants 1997)[15] and the Proposed CFB East Community Plan (City of Calgary 1998). The criteria for assessment are restricted to those elements contributing to environmentally sensitive design in the context of the natural systems of CFB East. The criteria have been restricted to address ecological components as it is assumed each design (CFB East I and CFB East II) will meet the remaining City of Calgary planning objectives by meeting the standards outlined in Section 1.4.

[14] Hereafter referred to as CFB East I.
[15] Including CAD files.

The criteria were determined through a review of the proposed CFB East Community Plan (1998) and ecological community design elements outlined in Chapter 2. The criteria used for determining the MDP plan's success in meeting the City of Calgary's planning objectives, drawn directly from the proposed CFB East Community Plan (1998), were:

- achieving, as a minimum, a **density** of 27 units per hectare (11 units per acre);
- providing, as a minimum, 1600 **housing units**;
- providing a mix of **housing types**; and
- providing, as a minimum, 4.45 hectares (11 acres) of **open space**.[16]

The CFB East II concept must achieve the City of Calgary's planning objectives in an environmentally sensitive manner. Its success in this is measured with ecological criteria, determined through the literature review, within the performance objective framework of energy, water, nutrient cycle, and food. Where possible, the performance is measured in quantifiable terms, otherwise it is measured in relative terms of "less" or "more." Quantifiable performance calculations follow the general steps of using the CAD model to calculate amounts of variables such as dwelling type totals and area calculations. The totals are then be transferred into a spreadsheet, where comparisons between CFB East I and CFB East II are calculated using consumption figures provided by the City of Calgary.

[16] These quantities are the levels achieved in CFB East I. They were determined through the public planning process.

Energy

There are a number of community and building design features which reduce energy consumption and create opportunities for on-site energy production. The criteria within the energy performance objective are:

- Density – in recognition that higher densities consume less energy (see Section 2.8). Density measurements for CFB East I are taken from CFB East Supporting Information Outline Plan and Land Use Redesignation (Walker Brown Urban Consultants 1997), and for CFB East II are calculated directly from the CAD model.
- Residential street frontage within 15-25° of south orientation for passive solar collection. Measurements for both CFB East I and II are taken directly from the CAD model.
- On-site energy production opportunities.

Water

The community performance objective for water is to minimize water consumption, preserve the natural hydrological cycle, and improve the quality of effluent. The criteria within the water performance objective are:

- Water savings through innovative building and site design features. Water consumption figures for analysis are provided by the City of Calgary and are based upon per capita consumption per day.
- Impermeable surface area – building footprints, roads and its relationship to stormwater runoff amounts. Impermeable surface area for both CFB East I and II is calculated from the CAD models.
- On site wastewater treatment opportunities.

Nutrient Cycle

The criteria within the nutrient cycle performance objective are:

- Amounts and types open space that contribute to the enhancement of the nutrient cycle. The open space characteristics for both CFB East I and II are calculated from the CAD models. The calculations for CFB East I are confirmed with totals in CFB East Supporting Information Outline Plan and Land Use Redesignation (Walker Brown Urban Consultants 1997).
- Types of green space: productive, recreational, naturalized, passive.

Food

The criteria within the food performance objective are:

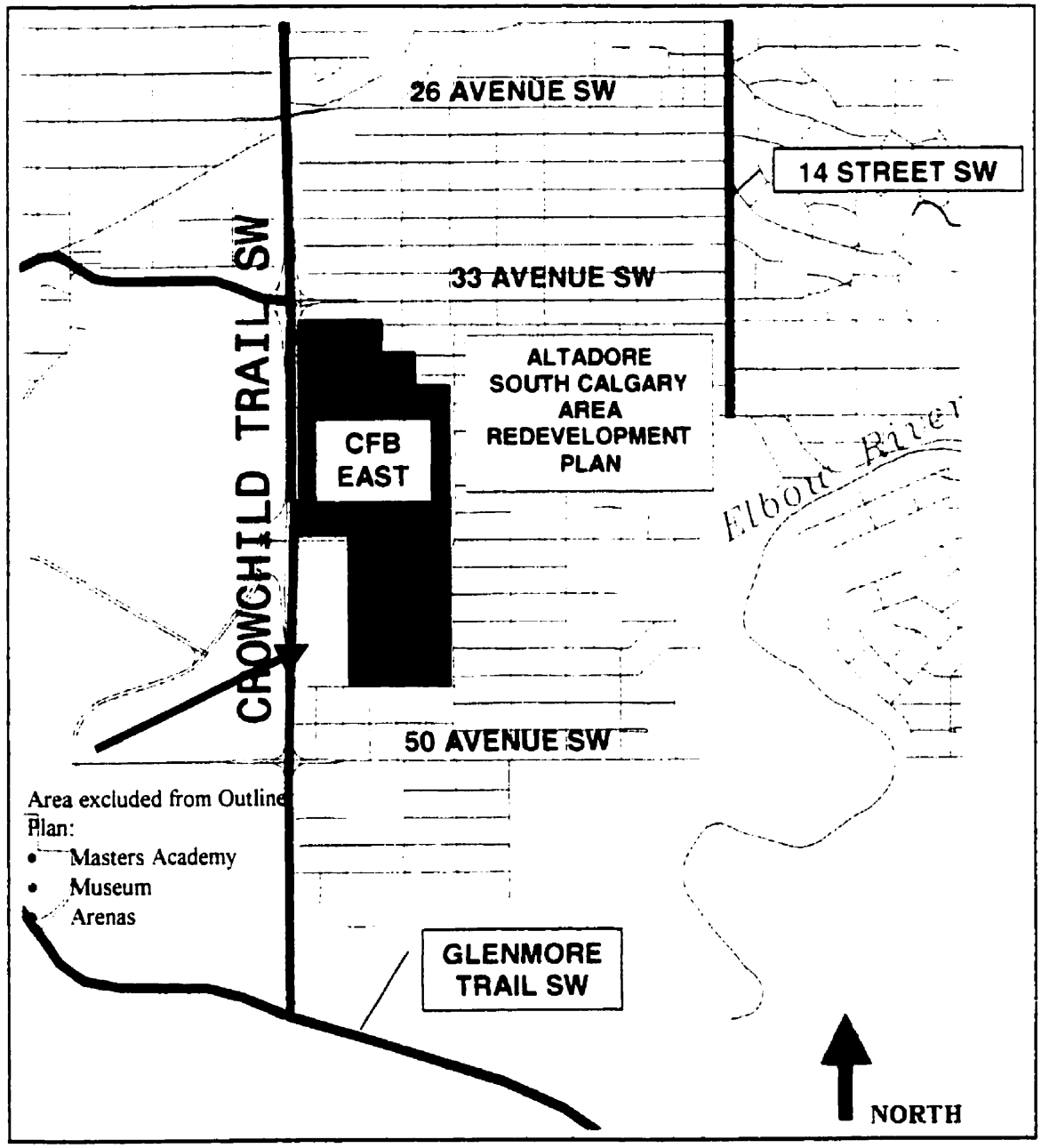
- Amount of open space dedicated to food production. The area calculations are produced from the CAD models.

7. Conclusion and Recommendations

The final phase provides a synopsis of barriers to and recommendations on the future use of ecological planning methods for redevelopment projects. Further recommendations also address possibilities for furthering ecological sensitive design for CFB East and implementation concerns

4 Detailed Site Analysis

The detailed analysis of site characteristics of CFB East is organized by policy context, natural systems and human systems. Following each assessment section is an overall assessment of its opportunities and constraints for redevelopment. The CFB East planning area, as defined by the City of Calgary, is located in southwest Calgary and is bounded by Crowchild Trail on the west; 34th, 35th, and 36th Avenue on the north; 20th Street southwest on the east; and 47th Avenue on the south (see Map 4-1 and Figure 4-1). The planning area is 71.3 hectares in size and outline plan area is 59.29 hectares. Calculations in this MDP will use the outline plan area of 59.29 hectares. This discrepancy is due to the exclusion of the Masters Academy, Museum of the Regiments and the Calgary Centennial Arenas from any design proposals.



Map 4-1 Location (Source Walker Brown Urban Consultants 1997)

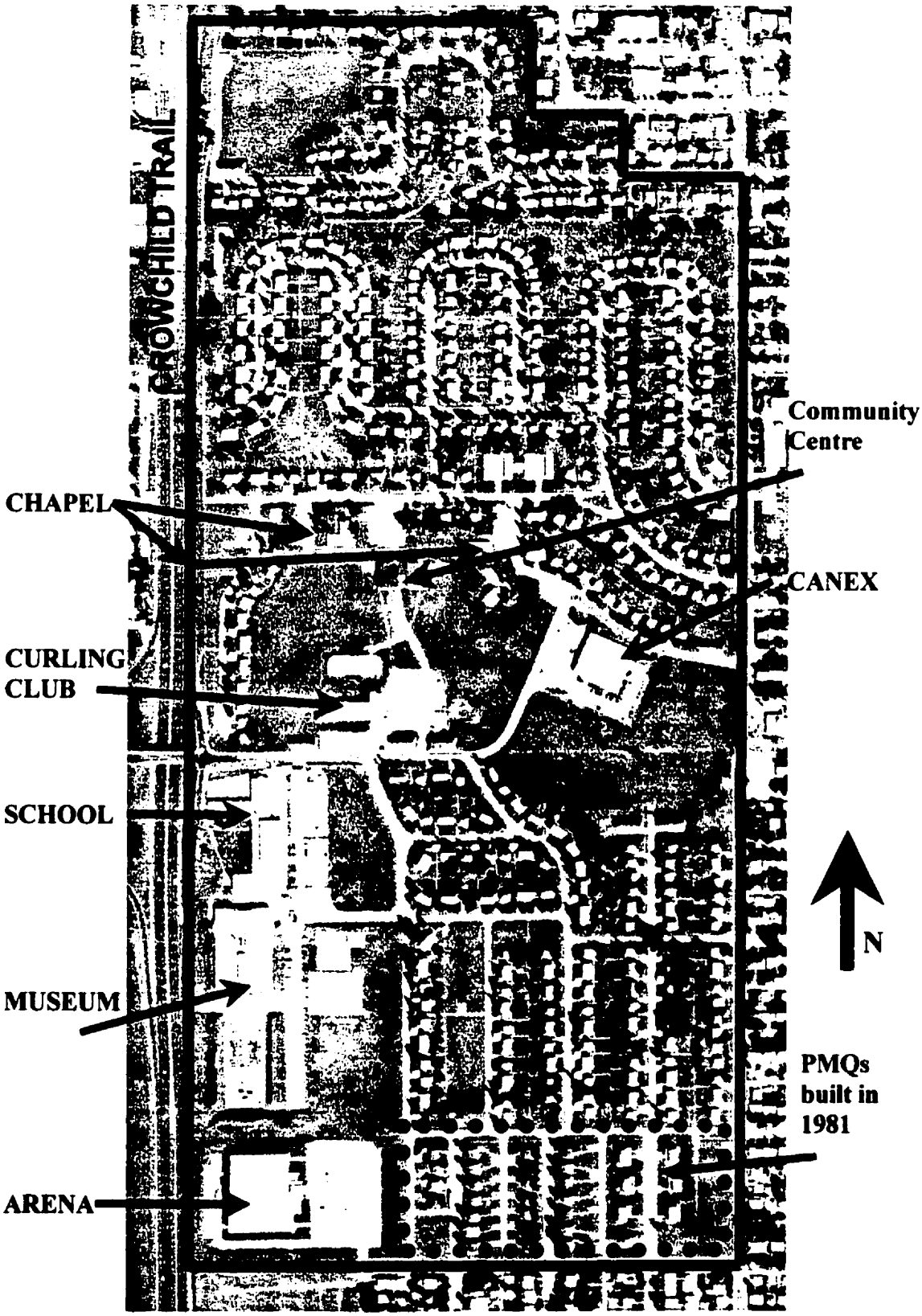


Figure 4-1 CFB East Existing Development

4.1 Policy Context

This section reviews the policies and their implications for the redevelopment of CFB East.

Calgary General Municipal Plan

In accordance with the provincial Municipal Government Act, Calgary's General Municipal Plan is being updated and will be replaced in 1998 by the new Municipal Development Plan. Until adoption, the existing Municipal Plan remains applicable to the redevelopment of CFB East. It identifies CFB Calgary as an institutional land use and assumes its continued operation, hence it has little effect upon redevelopment beyond the need for rezoning.

Calgary Transportation Plan

The Calgary Transportation Plan (City of Calgary 1995b) was initiated to ensure that community and environmental quality, mobility, costs, and affordability would be incorporated into Calgary's new developments. It did not anticipate the closure of CFB Calgary. There are a number of key policies within the plan that should be considered in the redevelopment of CFB East. These include:

- sensitively intensify neighbourhood housing to promote mixed use, a variety of housing types, and to reduce infrastructure costs;
- design development to encourage walking, cycling and transit use;
- achieve a minimum density of at least 7 units per acre;
- encourage new housing close to transit facilities;
- offer a reasonable choice of travel modes and accessibility;
- facilitate access to transit for seniors and persons with disabilities;
- the pedestrian environment will be a design element in all land uses and plans for roads, LRT and transit facilities; and
- recognize cycling as a component of Calgary's transportation system (City of Calgary 1998).

Sustainable Suburbs Study

The Sustainable Suburbs Study (1995a) is intended to help implement the objectives of the Calgary Transportation Plan (1995b) by designing new suburbs as more sustainable communities. As directed by Calgary City Council, applicable elements of the Sustainable Suburbs Study should be considered in the redevelopment of CFB East. The relevant principles and objectives include:

- *Compact Form* - communities should have "somewhat higher density to use land more effectively" and to generate sufficient population to support local amenities.
- *Community Centres Neighbourhood Nodes* - these should be designed as mixed use centres to provide services and employment.
- *A Wide Choice of Housing Types* - by providing a wide choice of housing types, people of different income levels, age groups, and household composition can live in the same community.
- *Open Space* - any open space systems should be part of a linked system, as opposed to "isolated pieces of land." In addition, the open spaces should accommodate different types and levels of recreational activities (i.e., passive vs. active).
- *Transportation* - the transportation system should be designed to encourage walking, cycling, and transit. Roads should accommodate pedestrians and the automobile equitably. Techniques to accomplish this include using a grid street layout, traffic calming features, and streetscape amenities.
- *Environmental Issues* - environmental issues should be considered beyond encouraging people to use transit more. Such community design characteristics as waste audits on new home construction, using recycled materials in new home construction, water saving devices in buildings, alternative stormwater management techniques, and community design to reduce energy consumption (City of Calgary 1995a, 1995b, 1998).

The City of Calgary Environmental Policy, Principles and Goals

The City of Calgary Environmental Policy, Principles and Goals is used as a guide to "ensure that environmental stewardship and performance is implemented and maintained by staff" (City of Calgary 1998). This is carried through in all decisions made by the City of Calgary and specifics of the Environmental Policy address air quality, stewardship of water resources, effective waste management and responsible land

use (City of Calgary 1998). Hence, redevelopment of CFB East should accommodate these elements.

South Calgary/Altadore Area Redevelopment Plan

The only local planning policy that is applicable in the redevelopment of CFB East is the South Calgary/Altadore Area Redevelopment Plan (ARP). The ARP supports the revitalization of the Marda Loop as the community commercial centre. It also identifies the need for seniors' housing in the area. Both of these concerns could be satisfied in future plans for CFB East.

Heritage Recommendations

As of January, 1998, the City of Calgary Heritage Advisory Board (HAB) was the only body that had evaluated and made recommendations for CFB East. It has recommended that the existing street names, which commemorate World War I battles in which Calgary stationed units fought, be retained. It has also recommended that a representative portion of the existing site plan and housing types that form Somme Crescent should be retained in any future development. This is primarily in recognition of the Radburn plan layout of the site. Portions of CFB East exhibit elements of Radburn's plan, including the reversed interior and exterior layouts of the PMQs, the central spine open space with pathways, cul-de-sacs, and the hierarchical roadway network. This is a somewhat limiting constraint; however, the HAB's recommendation is not very strong as the Radburn characteristics were not evaluated.

4.1.1 Policy: Consolidated Opportunities and Constraints

CFB East II attempted to meet the objectives, principles, and recommendations of the above mentioned documents. This task may appear daunting, however, when considered holistically many of the documents examined above are complementary to each other and to ecological planning principles.

4.2 Natural Systems

Geology

The site's bedrock is of the Balzac Drift overlying thick bedded, cherty, calcareous mudstone of the Porcupine Hills formation (Green 1972 cited in UMA 1996). This bedrock is suitable for most kinds of development.[17]

Physiography

The site is gently undulating and slopes gently to the south east (See map 4-2). There are several noticeable minor depressions. CFB East's highest point elevation is 1116 metres and its lowest is 1099 metres. There are no slope stability problems for development, nor is there a great effect on the site's microclimate due to topography. The natural slope to the southeast, however, should be heeded when considering drainage.

Groundwater

The water table is at a depth of approximately 2-4 metres throughout CFB East. The probable ground water flow rate within the sandstone bedrock is between 4.5 and 22.7 litres per minute (UMA 1996). It is a former source of domestic water supply within the City of Calgary. The silty-clay soil limits aquifer recharge throughout most of

[17] Discussion with Dr. Grant Ross of the Faculty of EVDS, The University of Calgary.

the site, as does the degree of impermeable ground cover and turf lawn. The ground water shows some signs of contamination due to leaking underground storage tanks. The groundwater presents few implications for redevelopment. Remediation of the contamination is necessary for the health of the ecosystem. A remediation plan has been developed by the landowner, Canada Lands Company (City of Calgary 1998).

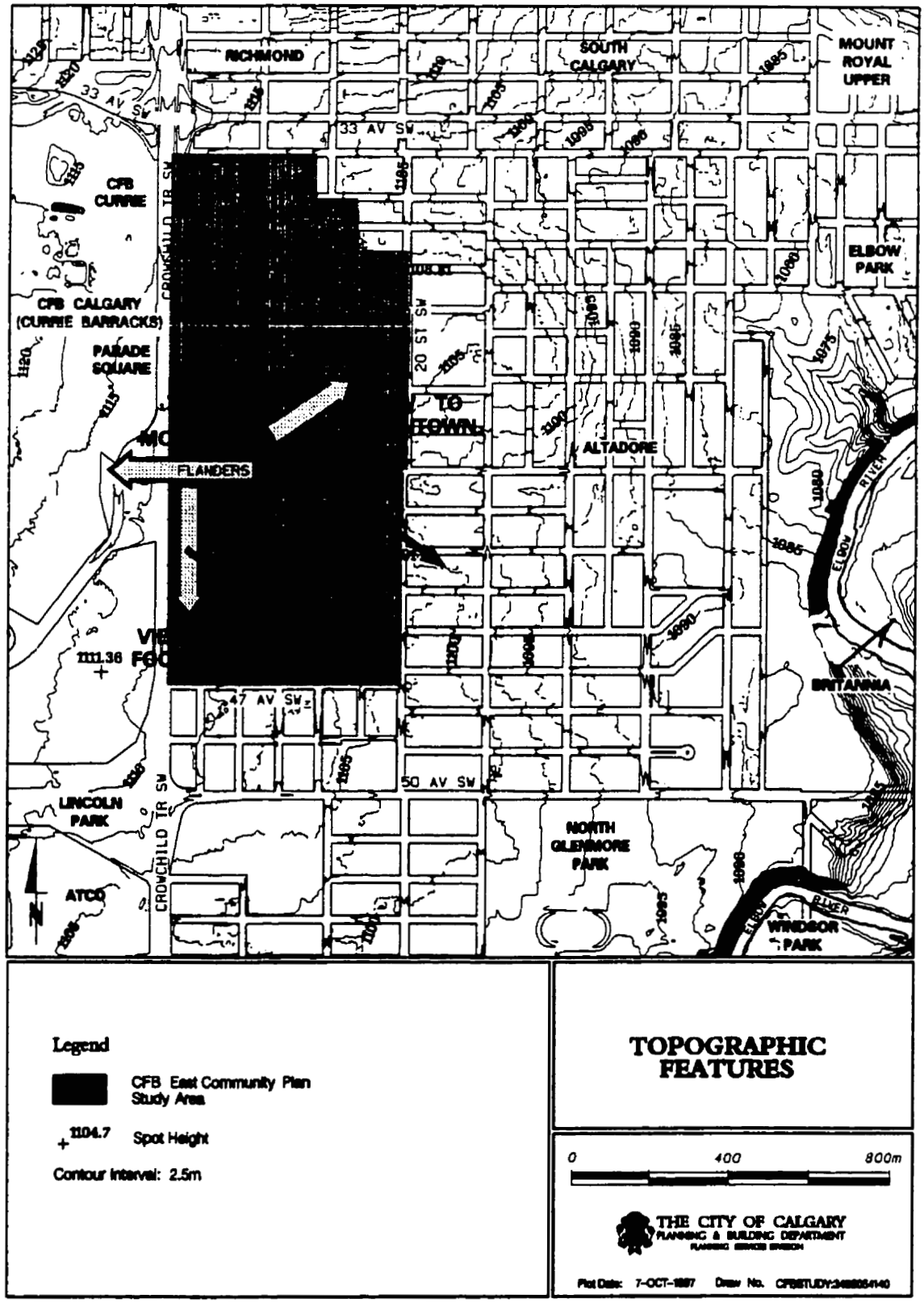
Surface water

Presently there is no standing or running surface water within CFB East. Historical aerial photos indicate the former presence of several small ponds in the low ground where the Canex is now located (see Figure 4-1).

Soils

CFB East's soils are primarily shallow, fine grained sand, silt, and clay overlying pebble loam (Moran cited in UMA 1997; UMA 1996). Such soils have poor infiltration rates,[18] generally in the range of 0.17 – 0.04 inches per hour, as compared to sand's rate of 8.27 inches per hour (Woodward Clyde Consultants 1990). There are several implications for redevelopment as a result of CFB East's soil characteristics. Poor drainage limits the range of overland storm water drainage solutions, however, this is somewhat moderated by Calgary's low precipitation levels. An analysis of runoff impact and management strategies must accompany any intensification of development. It is also safe to assume that the nutrient levels in the soil would be deficient due to limited nutrient cycling and chemical landscaping practices.

[18] Discussion with Dr. Grant Ross, EVDS.



Map 4-2 Topography (Source City of Calgary Planning and Building Department)

Climate

Climatic data for the site was interpreted from the Calgary International Airport weather data. Local winds are screened to a degree by the existing mature vegetation and built form. The site's coldest winter winds are from the north, however, the most frequent winds blow from the west and south (see Appendix 5 for a summary of weather statistics). There are no structures or natural features which have a significant effect on solar exposure. Future development, including landscaping and built forms, could be designed to improve the microclimate.

Vegetation

CFB East's open spaces are generally planted with commercial grass mixes and maintained with fertilizer, pesticides, and mowing. The manicured lawns are mostly planted with kentucky blue-grass (UMA 1996). Throughout the site there is a variety of mature ornamental trees (40-50 years old) and shrubs. There is approximately a 50% split of deciduous and coniferous trees. Tree types include spruce, ash, and poplars (City of Calgary 1998). Despite not being naturally occurring species for the region, the vegetation forms a valuable natural system which could easily be enhanced through progression to natural landscaping to promote ecological integrity and diversity. Existing vegetation, particularly mature trees, should be retained in future redevelopment.

Wildlife

The present species of wildlife include the following:

- Richardson Ground Squirrel - feeds mainly on the roots, stems, leaves, and seeds of grasses and some herbaceous plants. It hibernates in underground burrows from October until March.
- White-tailed Jack Rabbit - feeds mostly on organic matter.
- Gray Squirrel - a common mammal found throughout the Calgary urban environment.

- Typical Migratory and resident birds - include such species as Gray Partridge, Rock Dove, House Sparrow, Downy Woodpecker, Black-billed Magpie, and Black-capped Chickadee.

None of these species are rare, endangered, or threatened. The distribution of shrubs and trees provides edge condition habitat (UMA 1996). Any redevelopment should preserve and enhance the existing habitat, particularly edge conditions and linkages to natural areas. Linkages for resident and migratory birds would be the easiest to promote.

Natural Systems: Consolidated Opportunities and Constraints

Table 4-1, below, provides a summary of the natural systems' opportunities and constraints.

Feature	Opportunity	Constraint
Physiography	• Little impact for site development.	• Slight natural slope to south-east enhances natural overland drainage.
Ground Water	Nil	• Remediation necessary due to leaking underground storage tanks.
Surface Water	Nil	Nil
Soils	Nil	• Poor infiltration characteristics demand careful consideration of stormwater management. • Likely nutrient deficient due to constant disturbance and pollution (including pesticides/fertilizers). Nutrient cycle will require human intervention to improve and maintain health.
Climate	• Few local influences provide a relatively clean palette for improving the microclimate by working with the existing built form and vegetation. • The site's proportion of sunny days, low profile of surrounding built form, and relatively flat topography all provide opportunities for solar collection.	Nil
Vegetation	• Opportunities to re-introduce native species. • Much existing habitat for birds.	• Mostly non-native. • Excluded from external linkages.
Wildlife	• Opportunity to provide	• Limited diversity.

Feature	Opportunity	Constraint
	linkages for bird population.	• Limited opportunities for re-creation of complete trophic structure due to context.

Table 4-1 Natural Systems Consolidated Opportunities and Constraints

4.3 Human Systems

Existing Land Use and Land Use Designations

Since development in the early 1950s, CFB East has been a military residential community with some local services (see Map 4-3). As the base goes through the closure process, vacant permanent married quarters (PMQs)[19] are being leased to the public on an interim basis (see Figure 4-2). Currie Elementary School is now a private school -- Masters Academy. Both the Museum of the Regiments and the Centennial Arena are located on land owned by DND. The **land use designation** was Public Service (PS) while CFB East was an active military base. The intent of this land use district is to accommodate major institutional services, including military establishments. To allow for interim rental use the site has been redesignated to Direct Control.

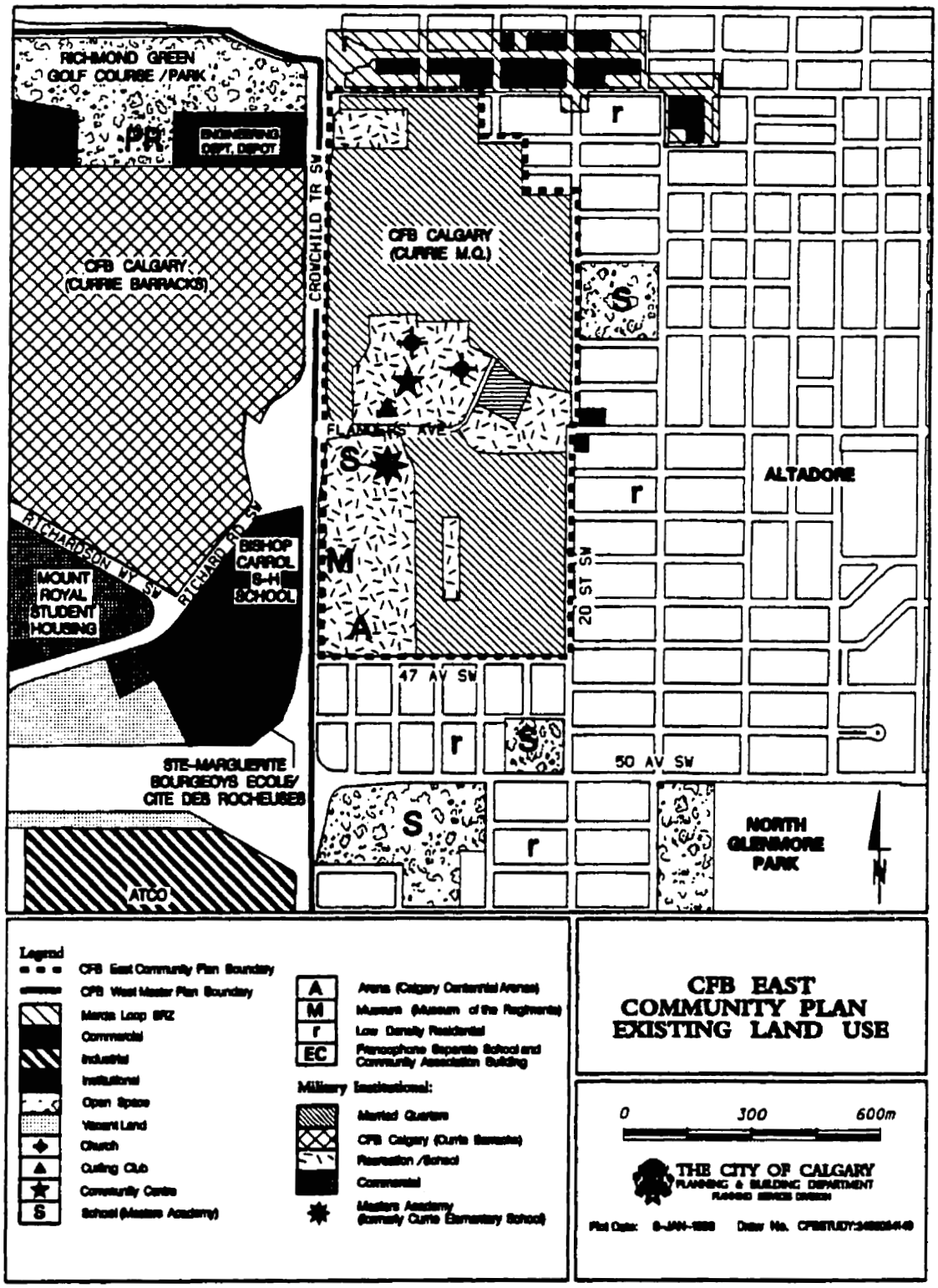
Housing

As a former military residential housing area, the majority of structures on the site are houses. There is a total of 560 PMQs, of which 316 are single-detached and 244 are

[19] Former military family housing.

semi-detached. Approximately half are 1 or 1 1/2 storeys with the remainder being 2 storey. The houses are typical of post-war housing stock in style and size. Most are laid out in a Radburn site planning style. The houses are simple, but generally have been well maintained by the military. The gross density is about 3 units per acre.

Figure 4-2 Typical PMQ



Map 4-3 – Existing Land Use (Source City of Calgary 1998)

Additional Facilities

The military base was designed to function as a small, self-contained community, hence many typical local commercial and service facilities are found within CFB East. Most are located in the central portion of the site, within easy walking distance of the majority of the PMQs. Facilities include (see Map 4-3):

- two small chapels, one Protestant and the other Catholic;
- eleven 8 bay garages in communal parking areas;
- curling club, with two sheets of ice;
- community centre;
- retail building (Canex). Services included a convenience store, barber shop, military credit union, restaurant, and dental office. At one time it was also the site of a gas station, which is the source of some environmental contamination (see Environmental Contamination in this section);
- elementary school - Masters Academy;
- outdoor tennis courts;
- outdoor rink;
- three tot lots;
- sports field;
- Museum of the Regiments; and
- Calgary Centennial Arenas.

All are now on land owned by Canada Lands Company, with the exception of the privately owned school, the federally owned Museum of the Regiments and Calgary Centennial Arena (which is on land leased from DND). Most of the facilities are in fair shape, with the exception of the exterior of the Curling Club. The majority of the buildings were built in the 1980s. A detailed list of structures is included as Appendix 6.

Roads

CFB East has good external access. It has its own grade separated interchange with Crowchild Trail, and both 33rd and 50th Avenues are easily reached. Some of the residential streets that are aligned with those in the surrounding community have been blocked off with concrete barriers.

Figure 4-3 – Internal Roads

The internal roads of CFB East are a combination of looping roads and a north-south grid pattern. The majority of the paved roads were constructed to DND's own standards. They are substantially narrower than City of Calgary street standards with only 7 metres of paved surface and generally without curbs or sidewalks. The majority of the streets are residential with Flanders Avenue providing main access off of Crowchild Trail and linking CFB East with Currie Barracks (CFB West).

The roads that were constructed in 1981 (see Figure 4-1, page 42) in the area of the newer PMQs were built to City of Calgary standards (including curbs and gutters) with gravel laneways. Generally, CFB East's roads are in fair condition (City of Calgary 1998).

The road system offers good potential for reuse, however, much of the below grade infrastructure is contained within the road right of way. Any upgrading of the below grade services may then provide an opportunity for roadway realignment. One attractive characteristic is the narrowness of the streets, which reduces maintenance costs, minimizes impermeable surfaces, and creates a safer pedestrian and cyclist environment.

Pedestrian Pathways

There is an extensive system of mostly asphalt pedestrian pathways, which extend throughout CFB East's open space system. There are few sidewalks on the streets. An elevated pedestrian overpass connects CFB East with Currie Barracks to the west. The existing plan has generally created a pleasant walking environment, however, nighttime safety could be a concern due to vegetation and limited lighting. The open space pedestrian system would not be very comfortable in winter due to limited snow clearance.

Storm Sewers

When compared to existing City of Calgary standards, the below grade storm sewer system is very basic (City of Calgary 1998). Most drainage is through surface discharge along swales and shallow ditches. There are only two sewer pipes that accept discharge from the site. The first is a 900-millimetre storm sewer that cuts the site approximately in half north-south. Most surface run off from the central portion of the site is directed towards this pipe. The second is a 200-millimetre pipe in the southern portion of the site, which accepts discharge from the area of the 1981 PMQs with gutters and curbs. The existing system could be retained, but must be augmented if the site is

developed in accordance with City of Calgary standards. However, the presence of a functioning overland storm drainage system presents an interesting alternative, which, with some improvements to help contain increased runoff, could be used for future redevelopment.

Sanitary Sewers

CFB East is sufficiently serviced by sanitary sewers in good condition, which are connected to the City of Calgary system. The pipes generally discharge to the east of the site (City of Calgary 1998).

If developed in accordance with City of Calgary standards, any intensification will require improved sanitary sewers (City of Calgary 1998). Another possibility is alternative sewer treatment (including grey water recycling), such as self-contained living machines.

Watermains

CFB East is serviced by City water, with two, 900 hundred millimetre water transmission mains in the northern portion of the site.

These utility rights of ways must be maintained in future development and any development intensification will require upgrading of the water transmission system (City of Calgary 1998).

Environmental Contamination

As with all developments, the City of Calgary has required an environmental site assessment for CFB East as part of the development process. Previous environmental assessments show that the site is relatively clean, with the exception of soil and

groundwater contamination in the vicinity of the Canex building. The source was leaking underground storage tanks from a gas station, which was demolished several years ago.

This is not an unusual environmental problem. It is possible, in fact necessary, to remediate the contaminated soil to the appropriate standards to allow residential uses.

Socio-Economic Context

This section discusses the socio-economic characteristics of the communities which surround CFB East (hereafter referred to as the CFB East communities – see map 4-3): Richmond, Knob Hill, South Calgary, Altadore, and North Glenmore Park . All characteristics discussed in this section are presented as graphs in Appendix 7.

Since the 1960s, the surrounding communities have experienced close to a 25% decline in population. This is typical of many older Calgary communities (City of Calgary 1998). Census data shows that the decline is primarily due to changing family compositions (e.g., smaller families, divorce rates, single-parent families, non-family households, etc.), and the aging of the area population (City of Calgary 1998).

Over the same time frame, the number of housing units in the area has increased due to infilling, apartment construction, and the addition of suites to existing single-family units. The area has a wide range of housing types, with only 50% being single-family houses, while the remainder are a mix of apartments, suites, and duplexes (City of Calgary 1998). The average density, excluding existing development in CFB East is 14.6 units per hectare.

The occupancy rate (number of persons per dwelling unit) in the area has been in concert with the declining trend exhibited citywide. In the communities surrounding CFB East, this has been attributed to lifestyle changes and the change of housing types (City of Calgary 1998).

The age profiles for the CFB East communities are similar to other inner-city communities, with the highest proportions of residents being in the 25-44 and 65+ age groups and fewer school age children than the city average.

The ethnic backgrounds, education, participation in the labour force, and occupations of the residents of the CFB East communities are similar to those for the rest of Calgary. The household income, however, is slightly lower (City of Calgary 1998).

The social needs for the area, as measured by the City of Calgary, exceeds the city average for seniors living alone, lone parent families, and dwellings requiring major repair (City of Calgary 1998).

Human Systems: Consolidated Opportunities and Constraints

The consildated human systems' opportunities and constraints are presented below in Table 4-2.

Feature	Opportunity	Constraint
Land Use	• Only one land owner. • High proportion of open space.	• Will require land use redesignation. • Surrounded by residential. • Directed by City Council to be developed as a residential community.
Housing	• Existing low density allows a wide range of redevelopment options. • Possibility of reusing PMQs.	• Houses are old and not very energy efficient.
Facilities	• Possibility of reuse and conversion.	• Existing footprint and building location suggests future development locations. • Chapels may contain asbestos.
Roads	• Good external access. • Narrow paved surface in fair condition. • Alignment with below grade servicing offers possibility of realignment if infrastructure is replaced.	• Existing orientation is primarily north-south. • Limited integration with surrounding community.
Stormwater Management	• Existing system of overland drainage is conducive to considering a wider range of management alternatives in the redevelopment.	• Poor soil percolation and relatively small size of the site demands that on-site stormwater management be closely scrutinized.
Sanitary Sewer	• Existing standard system available for use. • Requirement of upgrading for any development intensification may offer possibility for innovation.	• Presence of existing 'standard' system may make innovation during redevelopment less likely. • Must keep sewer rights of way clear.
Watermains	Nil	• Must keep watermain rights of way clear.
Environmental	• Limited contamination.	• Existing minimal contamination must be remedied.

Feature	Opportunity	Constraint
Socio-economic	• Redevelopment offers the possibility to address many of the surrounding communities socio-economic shortfalls (i.e., aging population housing needs, increase number of families in area).	Nil

Table 4-2 Human Systems Opportunities and Constraints

5 Conceptual Design and Comparative Analysis

The key purpose of the conceptual design, CFB East II, is to demonstrate the possibility of achieving the City of Calgary's planning objectives for the redevelopment of CFB East in an ecologically sound manner. CFB East II is a planning study of the effectiveness of ecological planning. The concept presented and compared against the proposed CFB East Community Plan should not be considered as the ultimate solution, instead it should be viewed as a starting point for further study and design refinement. The CFB East II concept presents many opportunities for further innovation (these are discussed in Chapter 6).

This chapter introduces the CFB East II concept and determines if it satisfies the goal of the MDP –*if it is possible to achieve the City of Calgary's stated planning objectives (see Appendix 1) for CFB East through an environmentally sensitive design approach that utilizes ecological planning.* The assessment criteria are organized by City of Calgary planning objectives and ecological performance objectives as discussed in Section 2.8.

The illustrated massing of the City of Calgary's proposed CFB East Community Plan (hereafter referred to as CFB East I) required some interpretation of built form, dwelling unit type, and land use. This was necessary due to the limited level of firm design detail required at the community and outline plan stage by the City of Calgary. Sources used to guide in this task included the CFB East Supporting Information Outline Plan and Land Use Redesignation (1997), CFB East Community Plan (1998), The Calgary Land Use By-law (City of Calgary Bylaw 2P80), and AutoCAD files supplied by

Walker Brown Urban Consultants Limited.[20] The resulting computer model and images are solely intended for this study's comparison purposes.

5.1 Conceptual Design

This section describes and illustrates CFB East II (see Figures 5-1, 5-2, 5-3). It attempts to achieve the City of Calgary planning objectives and ecological performance objectives discussed in Chapter 2, and was developed using ecological planning methods. The employment of specific ecological design tools and their effectiveness is discussed and assessed in Section 5.2 – Comparative Analysis. Refer to the land use key, illustrated in Figure 5-1, throughout this chapter.[21]

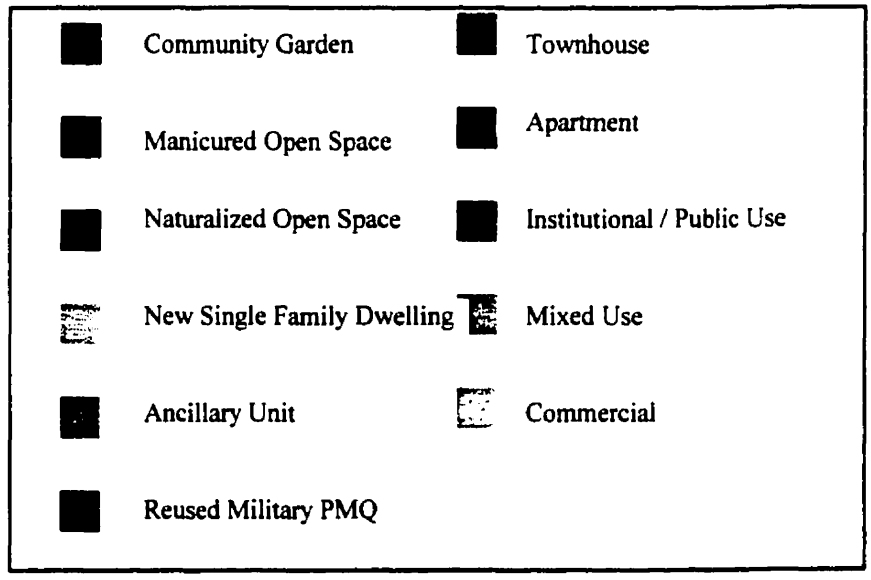


Figure 5-1 – Land Use Key for Concept Maps

[20] Now known as Brown and Associates Planning Group Ltd.
[21] Ancillary units are normally a small rental unit located on the same lot as a single family house and is commonly built above the garage (Calthorpe 1993).

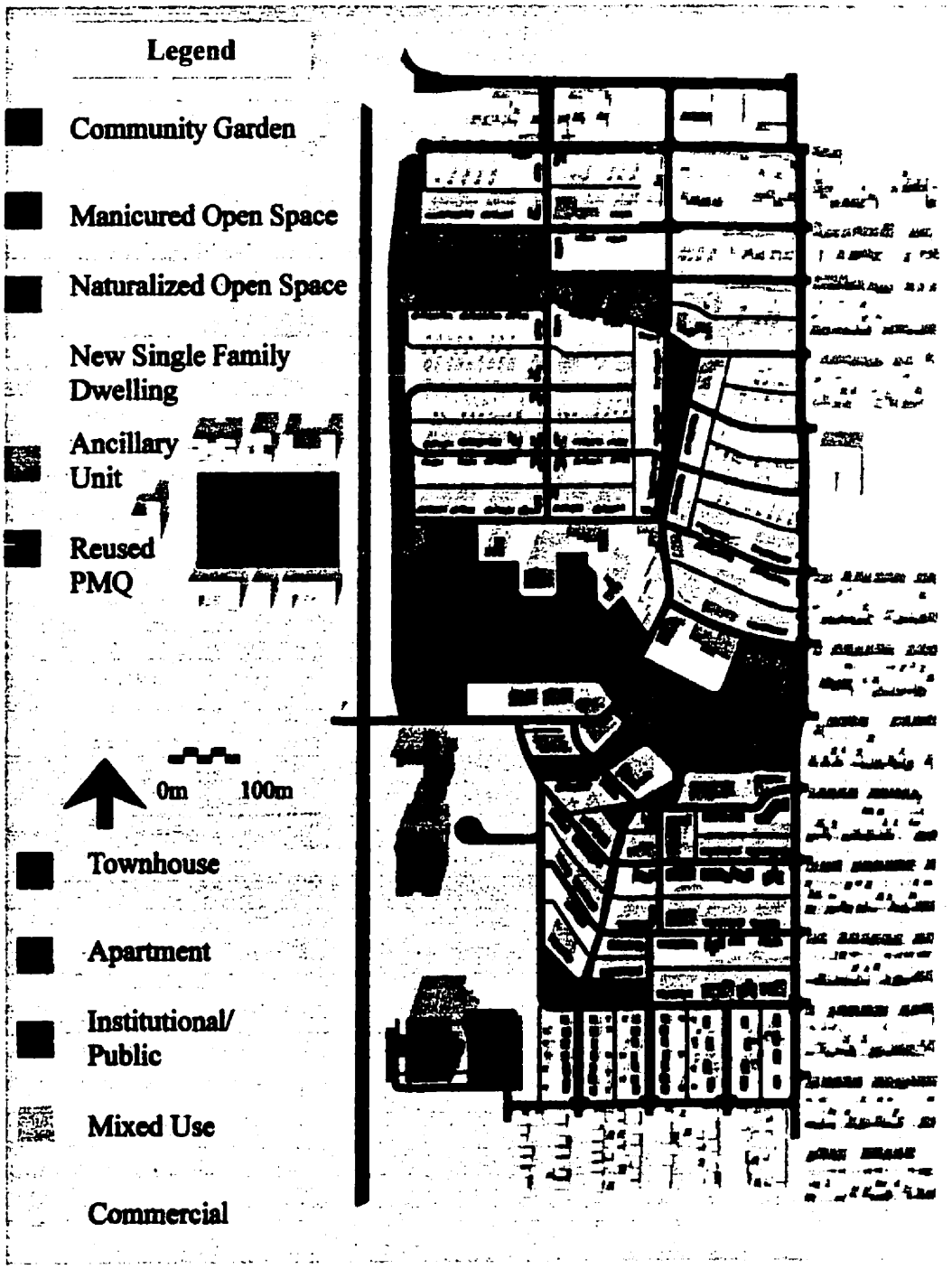


Figure 5-2 CFB East II Concept

CFB East II is focussed on the central open space, which provides a variety of functional and productive spaces. The redevelopment attempts to minimize impact on the environment and to provide opportunities for naturalized landscaping. CFB East II employs a range of environmentally sound practices, which are discussed in Section 5.2. Assuming average City of Calgary occupancy rates,[22] it can accommodate about 3,500 residents in a range of housing types totaling 1,603. There is a noticeably low proportion of single family residences (see Table 5-1). Only those PMQs built in the southern

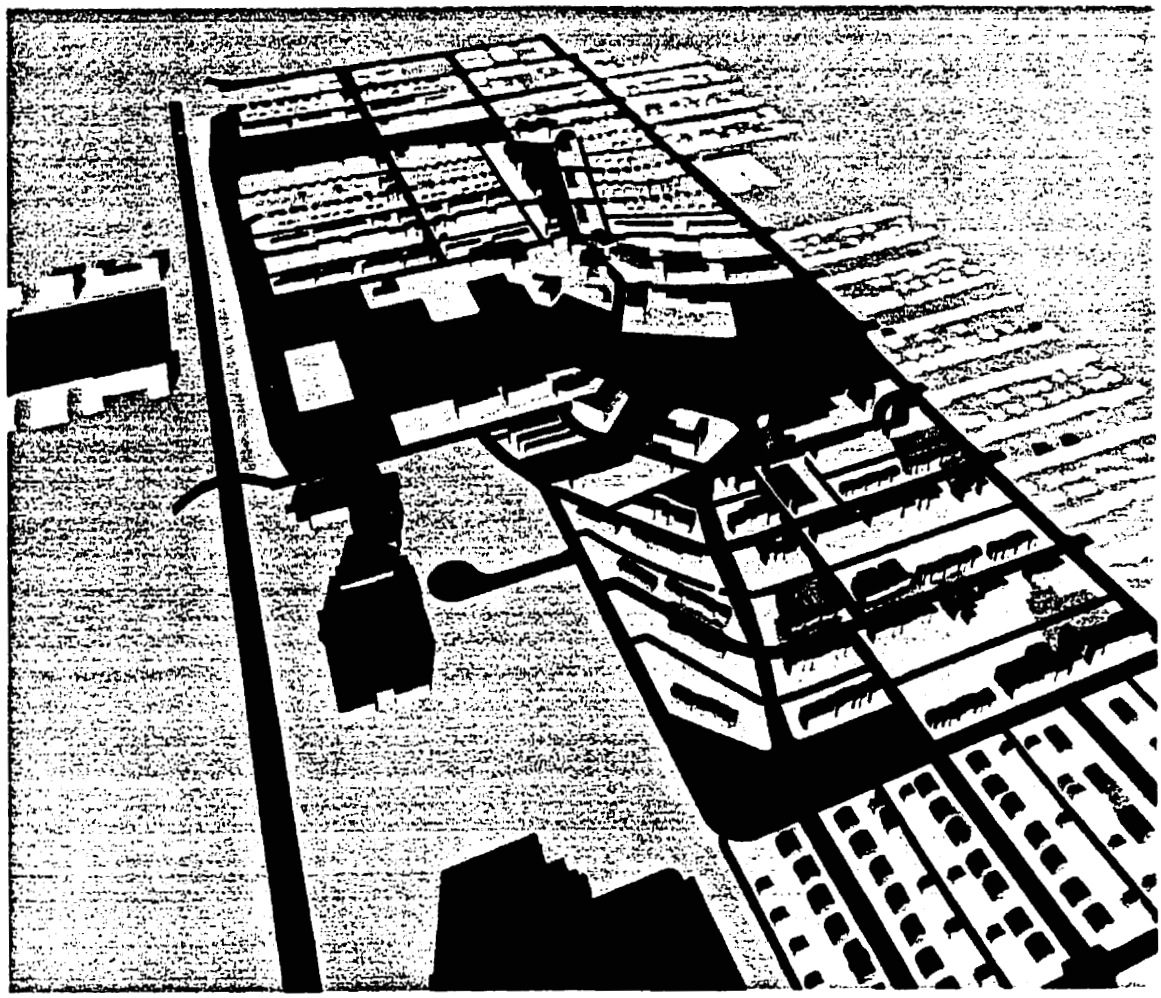


Figure 5-3 CFB East II Conceptual Plan

[22] See Appendix 7.

extreme of the site in 1981 and selected others in good condition were retained. This was due to the PMQs' low level of energy efficiency and primarily east-west orientation of building mass that limits passive solar collection. The link to the military past was maintained by providing linkages to CFB West and the Museum of the Regiments and by retaining representative original PMQs.

In accordance with City of Calgary intentions, the site remains residential with limited integrated commercial, institutional, and public uses. The limited commercial and service uses are integrated into a mixed use community node (see Figure 5-2) with apartments located above the first storey. As explained in Section 1.4 it is assumed that future redevelopment of CFB West will include substantial employment opportunities.

The movement system is hierarchical with three street classifications (main street, residential street, and lanes)[23] that were designed to integrate with the surrounding community and oriented to maximize solar exposure. Pedestrian and bicycle movement is accommodated on all streets. Linking open space facilitates easy movement with integrated pathways that provide linkages both within CFB East II and to the surrounding community (see Figure 5-4).

[23] Main street: 10 metres paved surface; Residential street: 8.5 metres paved surface; Lane: 4 metres paved surface. These street standards were adopted from the proposed CFB East Community Plan.

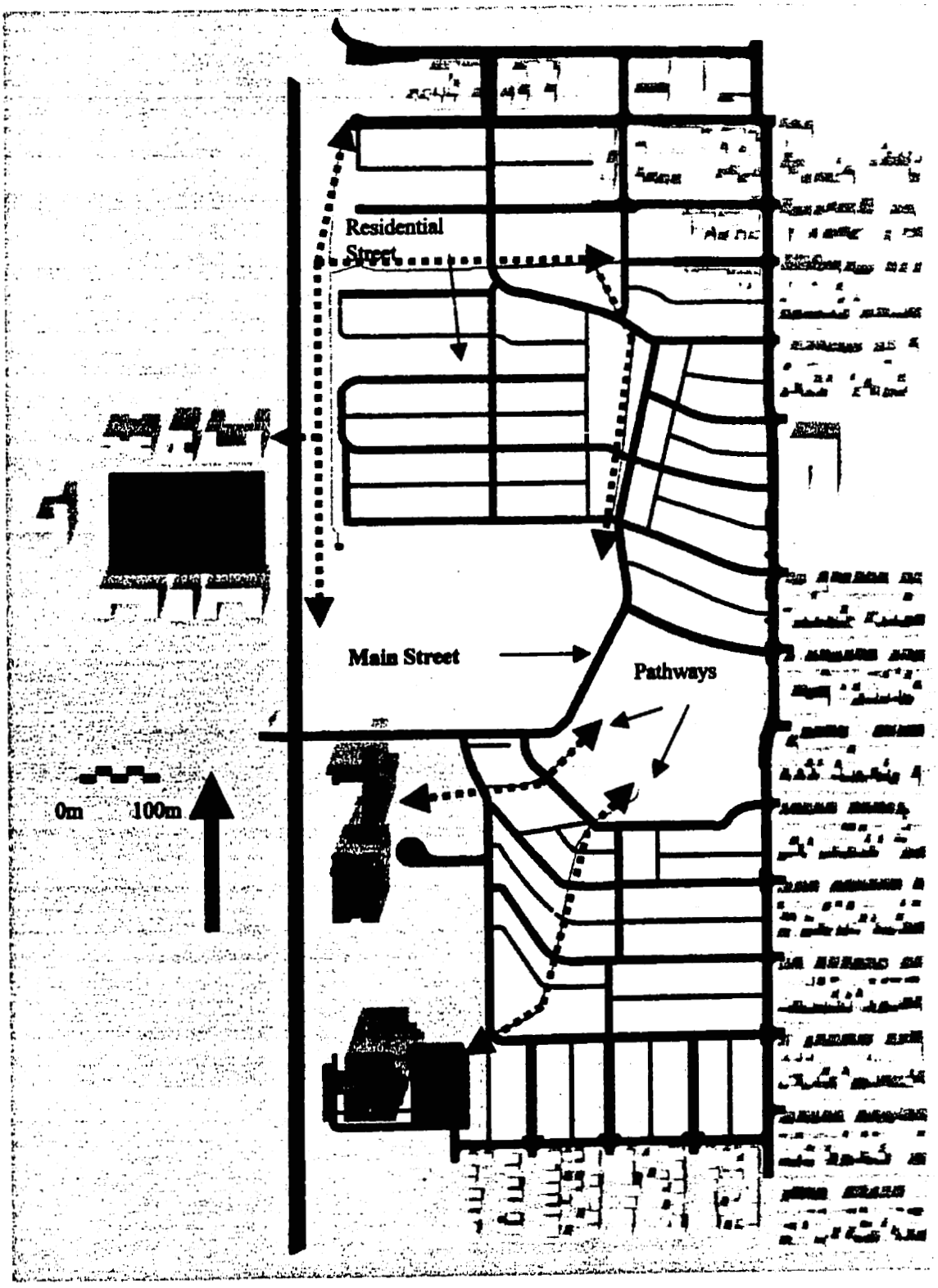


Figure 5-4 CFB East II Movement System

The redevelopment of CFB East will take place over a number of years and this provides the opportunity for gradual adoption of many of the more innovative features discussed in the section 5.2 (i.e., on site wastewater treatment, limited composting toilet use, energy co-generation and district heating). Recommendations are discussed further in Chapter 6.

5.2 Comparative Analysis

This section is organized by performance objective and, where possible, performance is quantified in terms of appropriate measurements (i.e., litres of water). Otherwise performance is assessed in relative terms of "less" or "more."[24] This section is primarily concerned with site specific benefits and implementation of ecological design tools (general benefits of ecological design are discussed in Section 2.8). The CFB East I plan is illustrated in Figure 5-5. The production of images of CFB East I required interpretation from both the community plan and CFB East Supporting Information Outline Plan and Land Use Redesignation (Walker Brown 1997).

[24] All calculations, formulae, and spreadsheets are included in Appendix 8.

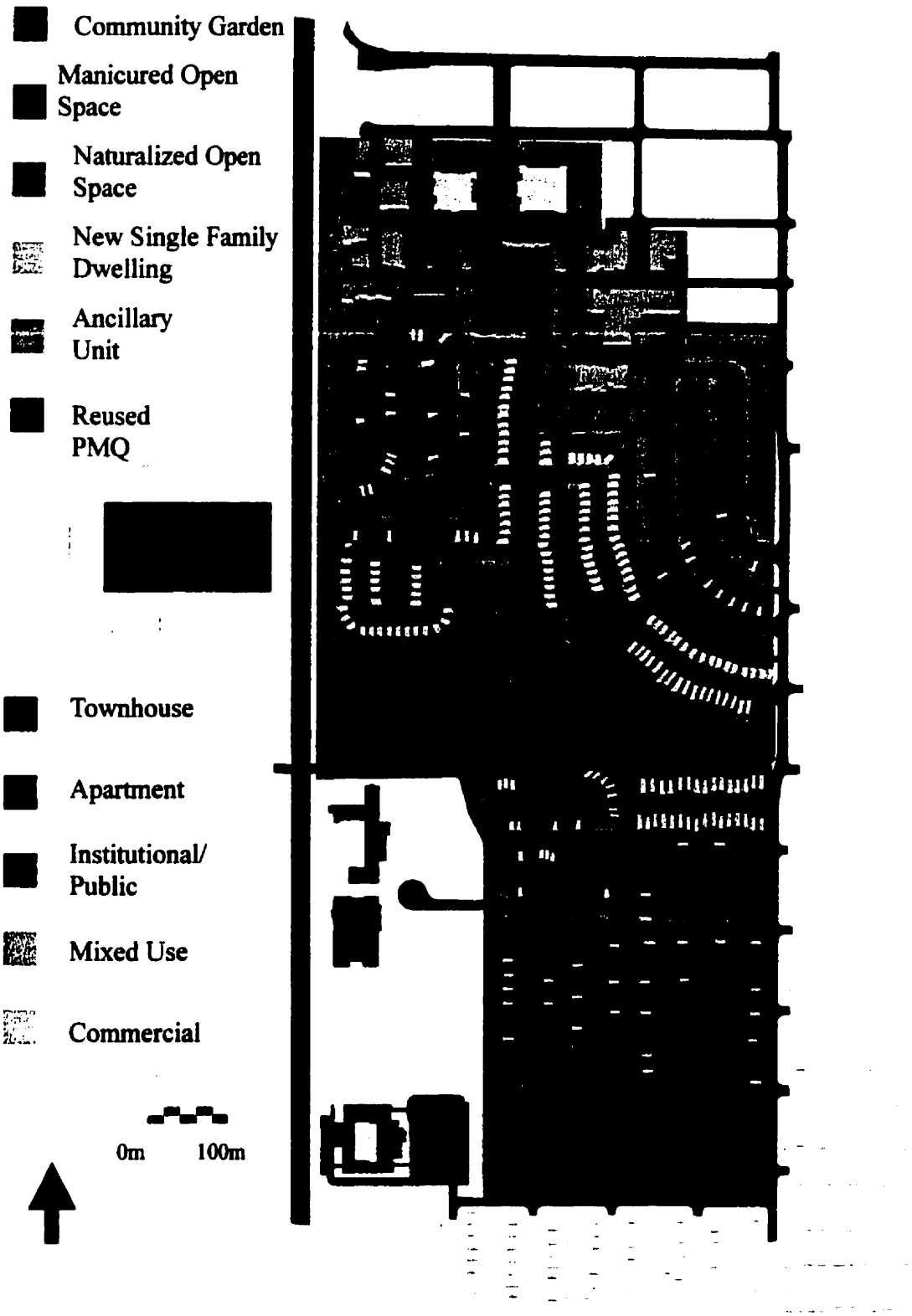


Figure 5-5 CFB East I Concept

City of Calgary Planning Objectives

As discussed in Sections 1.4 and 2.9, CFB East II is assumed to have met the City of Calgary's planning objectives by meeting CFB East I density levels, number of housing types, providing a range of housing types, and providing, as a minimum, the same amount of open space (see Table 5-1).

City of Calgary Planning Objectives		CFB East I	CFB East II
Density (units per hectare)		26.8	27
Number of Housing Units		1,590	1603
Type of Housing Units	Apartment	739	677
	Townhouse	151	693
	Ancillary	0	91
	Single Family	700	142
Amount of Open Space (hectares)		4.74	16.1

Table 5-1 City of Calgary Planning Objectives Comparison

Ecological Performance Objectives Assessment

This section is organized by CFB East II's ecological performance objectives of energy, water, nutrient cycle, and food. The aim of this section is to assess if CFB East II is more environmentally sensitive than CFB East I.

Energy

Performance objective: minimize energy consumption and establish mechanisms within the community for the production of renewable energy.

Density

Overall, both plans have similar density levels, but CFB East II has a larger area of higher density housing. As discussed in Section 2.8, a benefit of building at higher density levels is the opportunity to employ district heating with a reduction in fossil fuel consumption of about 30%. Figures 5.6 and 5.7 show where sufficient densities are achieved in CFB East I and II. Area totals appropriate for district heating are about 8 hectares for CFB East I and 16 hectares for CFB East II. Other nearby sites for district

heating consideration include the Master's Academy, Museum of the Regiments, and Centennial Arenas. Other areas of the site could eventually be developed at densities and mixed uses that would make district heating feasible. The appropriate delivery infrastructure should be put in place during upgrading of local infrastructure during redevelopment. Until conversion to district heating, residents could continute to use existing heating systems.

Building at higher densities allows for a wider range of housing types. Single family homes consume "the most operating and embodied energy per unit of floor space when other factors are held constant" (Walker and Rees 1997, p. 101). This is typified by monthly electricity consumption levels reductions of 5% in CFB East II.[25] It should be noted that the energy consumption level of CFB East II would be further reduced by the employment of renewable energy techniques discussed later in this section. See Appendix 9 for calculation process used in this MDP's comparative analysis.

Electricity Consumption		Average Electricity Consumption/Month /unit (kWh) **(A)**	Number of Units: CFB East I **(B)**	Number of Units: CFB East II **(C)**
Type of Housing Unit	Apartment	387	739	677
	Townhouse	558	151	693
	Ancillary	387 [26]	0	91
	Single Family	667	700	142
Total Monthly Electrical Consumption for site (kilowatt hour)			837,151 kWh	778,624 kWh

Table 5-2 Electricity Consumption Comparison

[25] Electricity consumption levels provided by City of Calgary Enmax – Tom Kanasut – 8 April 1998.
[26] Enmax had no figures for ancillary units. Due to its small size (one bedroom) the same electrical consumption figure as an apartment was used.

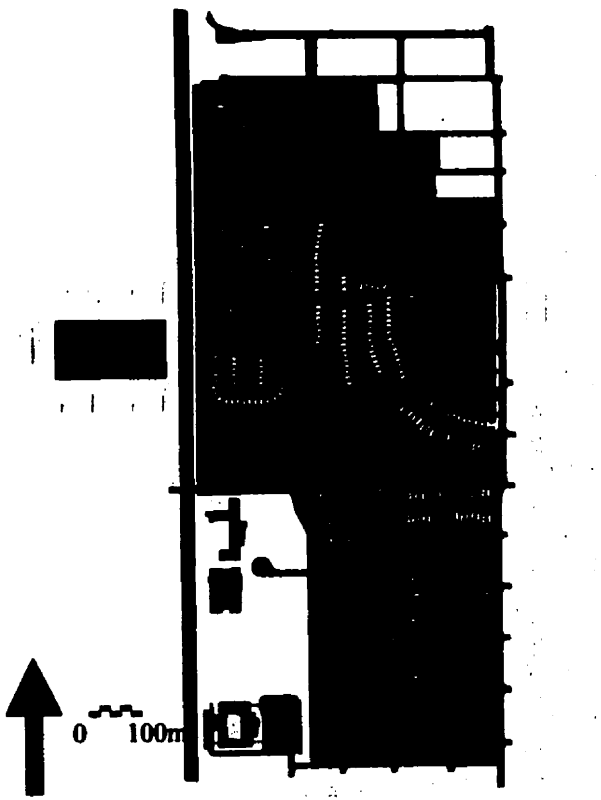


Figure 5-6 CFB East I- Potential district heating

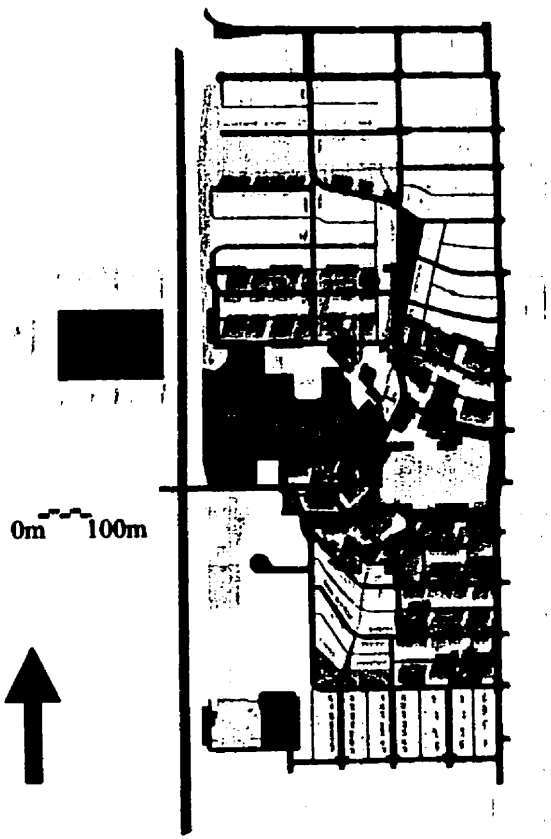


Figure 5-7 CFB East II – Potential district heating

Solar Radiation

Passive solar radiation gain helps to lower energy requirements for heating. Solar gain requires appropriate building orientation. Charette (1995) suggests that in Canada this should be within 15-25° of south. CFB East II used the opportunity of redevelopment and the need to upgrade infrastructure for any development intensification to adjust street alignment to optimize solar gain (see Figure 5-3). As discussed in Section 2.8, individual building design greatly influences the effectiveness of passive solar radiation as a heating source.

Residential Street Frontage within 15-25° of South	CFB East I	CFB East II
	2,101 metres	4,354 metres

Table 5-3 Residential Street Frontage Comparison

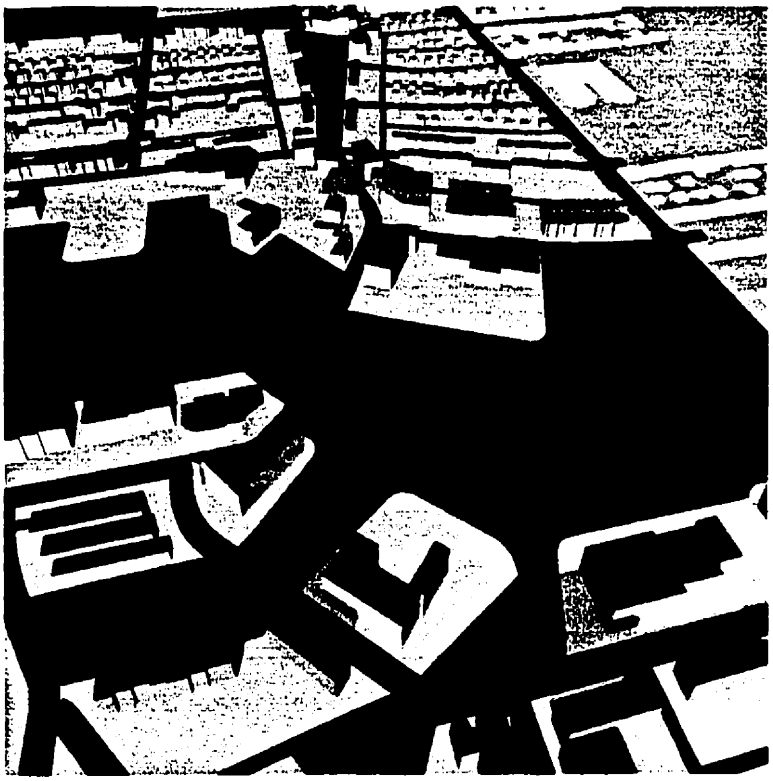


Figure 5-8 Solar Orientation example of CFB East II

Energy Production

On site energy production contributes to the creation of a circular energy metabolism. This has already been partially addressed with passive solar radiation collection opportunities. On site energy can be produced through photovoltaic solar collectors and on-site district co-generation and heating facilities. Energy saving benefits of district heating have already been discussed. Solar collection is facilitated by the site's southerly design orientation, restricting maximum building height to four storeys, and conducting sun studies to ensure solar access. CFB East II's circular energy metabolism can be improved if the fuel consumed in the district heating plants is from on site sources (such as refuse). As not all of CFB East II is at an appropriate density to make district heating feasible (44 units per hectare), small neighbourhood co-generation district heating facilities can be constructed until overall site density makes a larger plant economically feasible. An ideal site for a larger plant in the future would be near the Centennial Arenas. Ideally, the plant should serve mixed use areas so that the complementary energy consumption patterns of residential and non-residential users can be utilized. For areas not served by district heating, the conventional natural gas system should remain in place for supplementary energy. To emphasize the site's circular energy flow publicly visible consumption and production meters should be installed.

Naturalized Landscaping

Naturalized landscapes require less maintenance, thereby requiring less energy expenditure. The amount and distribution of naturalized open space is discussed later in this section.

Use of Trees and Shrubs to Improve Microclimate

Appropriate siting and selection of trees and shrubs can significantly reduce energy consumption. Coniferous trees planted to act as wind breaks can reduce winter heating requirements of a single-family house by one-third (Worton 1993). Deciduous trees, planted to provide shade in the summer, can provide a cooling effect of up to 12° Celsius. For CFB East, windbreak trees should be planted to intercept cold west winds during the two coldest months of the year -- December and January (see Appendix 3 for weather data). Shade trees should be planted along streets to improve the pedestrian environment and to the south to shade structures. Appropriate native trees and shrubs are listed in Appendix 2. Both CFB East I and II use street trees, but CFB East II proposes that site specific planting is needed to improve microclimatic conditions.

Water

Performance Objective: *minimize water consumption, preserve the natural hydrological cycle, and improve the quality of effluent.*

Water Saving Features in Building and Site Design

This section addresses the reduction of water consumption through water saving features in building design, grey water recycling, and the retention and reuse of stormwater. Water saving features in building design are proposed for both CFB East I and II. Low flow toilets and faucets use about 50% less water than standard appliances and fixtures. By implementing the more innovative features of reuse of stormwater, grey water recycling, and reducing the number of reused PMQs, CFB East II uses much less domestic water (see Table 5-4). Figures for CFB East I assume that water saving features would be used in newly constructed dwelling units not renovated PMQs. As stated in CFB East Supporting Information Outline Plan and Land Use Redesignation (1997), the developer only proposes to upgrade the exterior of reused PMQs. The number of reused PMQs in CFB East I was calculated based upon conceptual drawings of phase I development (City of Calgary 1998).[27] For a more detailed explanation of assumptions and calculations see Appendix 8.

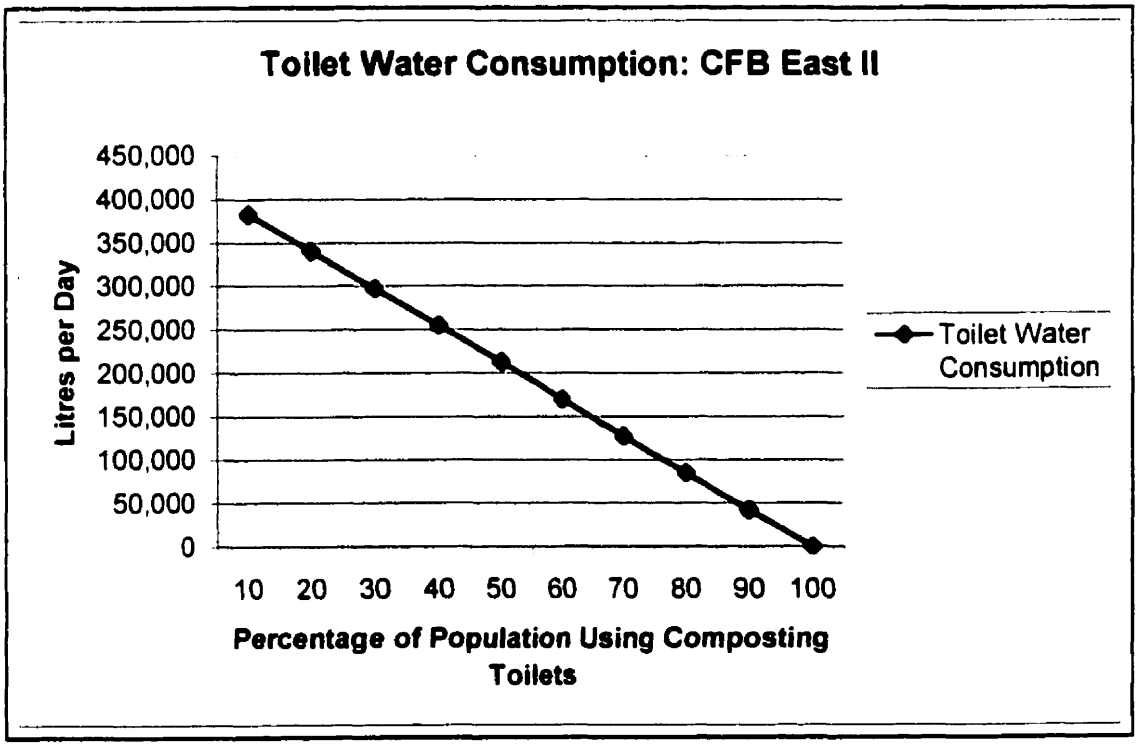
Site Water Saving	CFB East I	CFB East II
Low flow appliances	710,801 litres/day	975,155 litres/day
Rain Water Collection	0 litres/day	262,037 litres/day
Total for site	710,801	1,237,192 litres/day

Table 5-4 Potential Water Saving Comparison

[27] Ultimate numbers of reused PMQs depends upon market acceptance (City of Calgary 1998). The total number used in this calculation is 417 reused PMQs for CFB East I.

Further water savings could be realized through grey water recycling and the use of composting toilets. The use of low water volume taps and shower heads, rainwater recycling for gardening and car washing, and grey water recycling for toilet flushing at a Dutch project cut daily water consumption per person from 136 litres to 78 litres – a reduction of 43% (Tjallingii 1993). If grey water is to be used for irrigation, Roley (1992) recommends that it be through underground distribution in a mini-leach field due to the dangers of contamination and that it not be used on vegetables. Irrigation needs for manicured landscaping can be greatly reduced by practicing xersicaping.

Graph 5-1, below, illustrates water savings if composting toilets are used instead of standard flow toilets.



Graph 5-1 Toilet Water Consumption for CFB East II

Minimize Impermeable Surfaces

Minimizing impermeable surfaces reduces the amount of, and increases the time to peak flow for, stormwater runoff. To reduce impermeable surfaces, CFB East II was designed with reduced paved surfaces on all roads, a higher proportion of multi-family dwelling units, and it is envisioned that parking requirements for non-residential use would be reduced through shared parking schemes (see Table 5-5).

Impermeable Surface Area (metres ^{2})	CFB East I	CFB East II
Building footprints	84,570	72,866
Roads and lanes	147,715	81,418
Total	232,285	154,285

Table 5-5

Retain Stormwater on site

Retaining stormwater on site not only provides the opportunity to reuse this resource, it also reduces the negative impact of disposing it off site. It is envisioned that this would be accomplished in CFB East II by collecting rainwater in rain barrels for homes and underground cisterns for larger buildings. Additional runoff from roads and other impermeable surfaces is channeled into a number of stormwater collection ponds. The retained stormwater can then be used for local irrigation and other outdoors needs. As illustrated in table 5-4, this can result in a minimum saving of 250,000 litres of water per day when averaged over one year. It would be desirable to design the community retention ponds in such a manner that they can be connected to the traditional stormwater system for drainage when desired. Such a need could arise with abnormally high spring runoff or to drain stagnant water in summer months if not used for irrigation.

Retaining stormwater on site facilitates continuation of the hydrological cycle through percolation. Due to the poor infiltration characteristics of CFB East's soils,

natural drainage courses should be planted with native species to improve percolation. Conversely, CFB East I has been designed with traditional storm sewers, curbs, and a dry pond to quickly remove all stormwater runoff.

Treat and Reuse Wastewater on site

If all dwelling units in CFB East were to be built with low flow toilets, they would produce approximately 255,225 litres of wastewater per day.[28] Self-enclosed living machines that act as ecologically engineered marshes can treat wastewater so that it is converted into natural fertilizers and water suitable for irrigation of open spaces. The use of living machines, when coupled with rainwater collection and recycling of grey water can virtually eliminate the flow of water off of the site. It should be emphasized that living machines must be designed specifically for their site. This project does not propose a specific living machine design for CFB East II, but does envision that living machines will treat a portion of CFB East II wastewater as a demonstration project.

[28] Calculated using a per capita wastewater production of 75 litres per day (City of Calgary 1995a).

Nutrient Cycle

Performance Objective: design to support and allow the regeneration of vegetation and all elements of the natural environment.

Preservation of Nutrient Cycle

CFB East II preserves the nutrient cycle by using living machines to treat waste water and returning its nutrients to the soil, dedicating a large proportion of open space to a naturalized landscape, and the inclusion of community organic gardens. Table 5-6 and figures 5-11 and 5-12 illustrate the types, amount, and location of open spaces in CFB East I and II.

Open Space (hectares)	CFB East I	CFB East II
Manicured (conventional)	4.59	5.86
Naturalized	0	8.31
Community Garden	0	1.92
Total	4.59	16.1

Table 5-6 Open Space Comparison

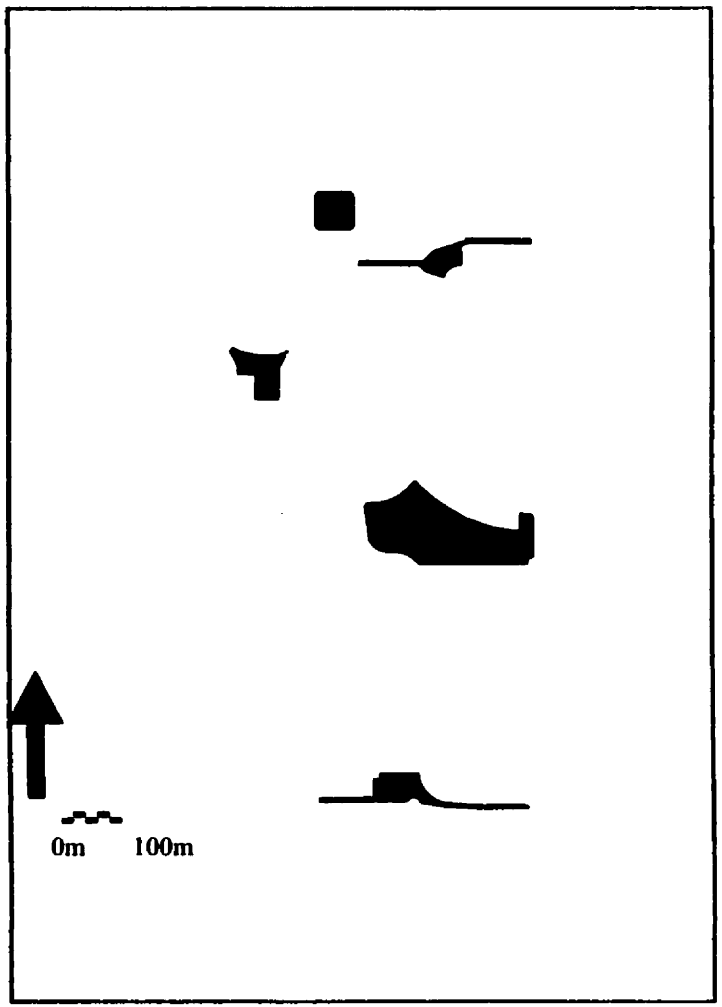


Figure 5-9 CFB East Distribution of Open Space

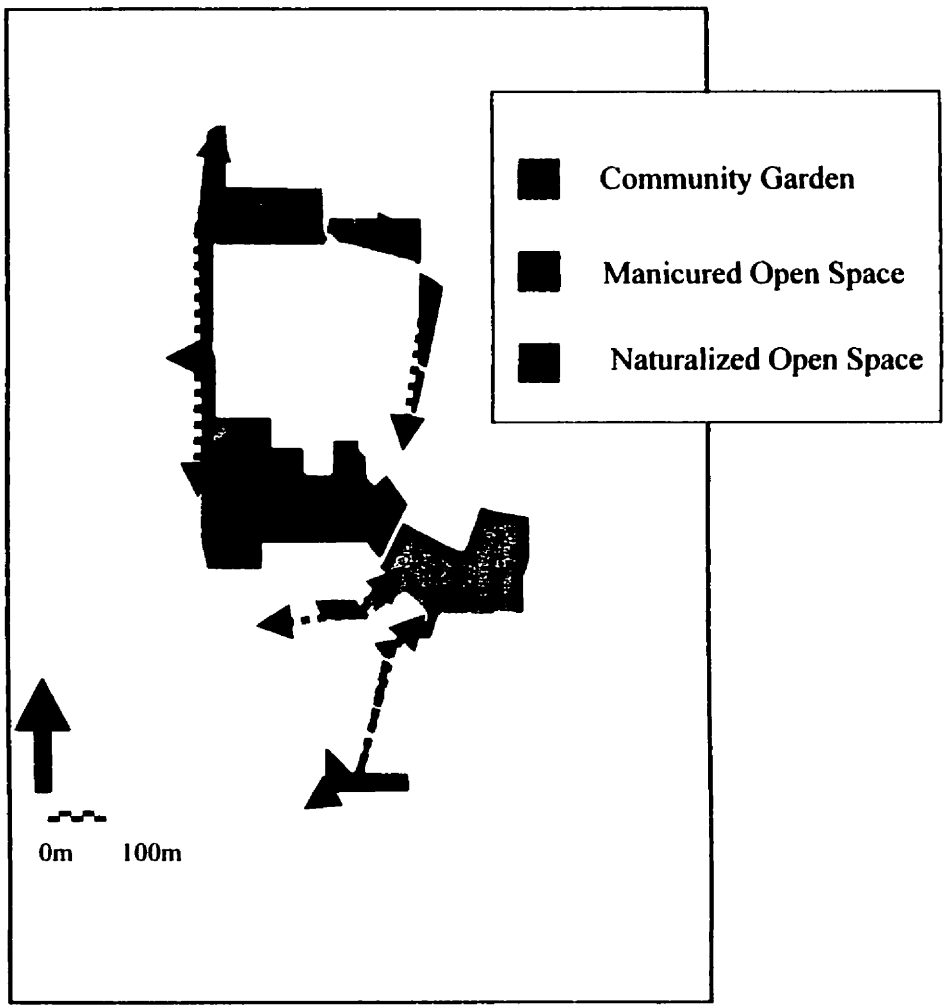


Figure 5-10 CFB East II Distribution of Open Space

Food

Performance Objective: Design to promote community food growing initiatives.

Community Gardens

The benefits of community gardening are varied and include social benefits, reducing energy used for trips to the grocery store, replenishing the nutrient cycle through organic gardening, and re-establishing a link with nature. CFB East I has no dedicated community garden space programmed, while CFB East II has 1.92 hectares of community gardens, which allows about 25 square metres of community garden per household. It is recognized that without the use of greenhouses, Calgary's climate will only support gardening to a dietary supplemental level. The location of community garden space in CFB East II is shown in Figure 5-12.

Summary

In addition to the differences in energy, water, nutrient cycle, and food production afforded in CFB East II, there are many other changes that are possible by further refinement within the frameworks analyzed. These are possible by addressing such elements as engineering and community stewardship. Regardless, conclusions as to the effectiveness of the proposed design tools for CFB East II can still be drawn.

Energy

Energy use in CFB East II is reduced through higher density development with a range of units, taking advantage of both passive and active solar radiation, providing opportunities for district heating, reducing landscape maintenance needs, and using site appropriate naturalized tree and shrub planting to improve microclimatic conditions.

Water

Water consumption is reduced and effluent improved by building design features, grey water recycling, rainwater collection and recycling, and on-site wastewater treatment. It is possible to almost fully preserve the function of the hydrological cycle depending on consumer acceptability and engineering capabilities.

Nutrient Cycle

CFB East II's nutrient cycle is improved through the recovery of nutrients from wastewater with living machines and organic community gardening. In addition 14% of public land is returned to its naturalized to state in order to promote ecological diversity and integrity, reduce the need for pesticides and fertilizers, and to provide natural habitat and linkages for local wildlife species listed in Section 4.2. Due to missing components in the nutrient cycle of this former grassland, human intervention, such as organic gardening is needed.

Food

Food production in CFB East II benefits the natural environment, re-establishes a link with nature, and provides an alternative to automobile trips to the supermarket for vegetables. In CFB East II, the open space is a productive component of the community.

Overall, the ecological design tools considered for implementation in CFB East II have achieved the City of Calgary's planning objectives (as governed by this MDP's assumptions discussed in Section 1.4) in an environmentally sensitive manner. Recommendations for further study and development of CFB East are addressed in Chapter 6.

6 Conclusion and Recommendations

6.1 General

The first five chapters of this MDP examined ecological planning, provided design tools to accomplish environmentally sensitive design, and presented a planning study that tested their effectiveness. CFB East was chosen as the test site due to its urban setting, its impending redevelopment due to its closure as a military base, and the opportunity for it to alleviate some of Calgary's outward growth pressures. As has been emphasized, the path towards sustainability is incremental and infill opportunities must be exploited to their fullest. CFB East I is more urban than suburban in nature and does little to alleviate the impact on the environment. The CFB East II conceptual design developed with ecological planning methods lessened the redevelopment's impact on the environment and promoted re-integration with natural systems. This MDP assumed that CFB East II would meet the planning objectives and goals of the City of Calgary by meeting similar land use, density, and population levels as those in the proposed CFB East Community Plan (City of Calgary 1998). This assumption was necessary to provide a framework for an assessment focussed on ecological performance. Issues such as urban design and the fulfillment of social and community needs were secondary in this study.

6.2 Barriers to Implementation and Recommendations

Despite a favourable environmental assessment, there would be difficulties in implementing the ecological design tools outlined in this MDP. The use of living machines for wastewater treatment, and significantly reducing the proportion of single family homes, for example, are radical departures from the status quo of urban development in Calgary. One of the key design tools used in CFB East was building with

a higher proportion of multi-family dwellings. Two potential barriers which must be examined with this strategy are public acceptance and market absorption of multi-family dwelling units. The multi-family housing forms in CFB East II are townhouses and apartment buildings. Involving the local community in the design process and encouraging a wider range of multi-family housing forms that are designed to be compatible (both in scale and permeability) with existing adjacent development can help facilitate public acceptance. The market feasibility of the proposed high proportion of multi-family dwellings in CFB East II should be examined closely prior to implementation to develop an appropriate phasing strategy. Multi-family demand should be closely monitored throughout the project's build out. A market analysis was conducted for CFB East I, which showed an increased demand in Calgary's western sector for multi-family dwelling units from 1,100 per annum to 1,400 per annum (City of Calgary 1998).

An additional potential barrier is the absence of municipal and provincial regulations to encourage ecological design. Municipal governing bodies receive their planning authority from the Province of Alberta's Municipal Government Act. Neither provincial legislation, nor City of Calgary bylaws address environmental concerns such as energy consumption or energy production by communities, which are essential elements of ecological design. The City of Calgary has adopted the Sustainable Suburbs Study (1995a), which provides recommendations that included ecological design features, such as considering alternative wastewater management systems; however, the document is a policy document without statutory authority. It is recognized that public acceptance and approval of ecological design will not be achieved solely through

legislation; however, the absence of suitable enforcement mechanisms seriously impedes ecological design initiatives.

Another institutional barrier is City of Calgary engineering standards that demand urban infrastructure adhere to strict guidelines. Standards, such as those for wastewater treatment methods, do not correspond to the concepts of ecological design. The benefits of adopting uniform engineering standards include ease in considering development applications and public confidence in a regulated, centralized infrastructure system. Ecological design, however, is site specific and solutions to such issues as wastewater treatment must be considered on a case by case basis. The current method of infrastructure engineering must become more flexible in order to accommodate ecological innovation.

The value of education on the benefits of ecological design and the usefulness of demonstration projects was emphasized in the reviewed literature. CFB East could become such a site in Calgary. Education must go beyond educating the public and future residents and include education for planners and others involved in the task of community building. Such steps would help provide decision-makers with a framework to make informed decisions about the result of the continuation of the suburban development status quo and, conversely, the benefits of ecological design. Incentives for ecological design implementation could be provided to developers and prospective residents. One example is to reduce tax rates for ecological communities due to their decreased demands on municipal infrastructures.

The range of innovative ecological tools proposed for CFB East suggests that implementation should be conducted in phases over time. It is recommended that the

initial phases of development be in presently undeveloped areas, such as the open space south of the Canex building. This would allow the continued use of existing housing and infrastructure as the development progresses. Innovative ecological features, such as living machines, would be accepted with greater ease in subsequent phases if their effectiveness could be proven on a portion of the site.

In this MDP, difficulty was encountered in acquiring natural systems site specific information. A wide based Geographic Information System would help alleviate this problem and would aid in the future monitoring of the site's effectiveness in meeting its performance objectives. It would also enhance information sharing between communities to help others achieve the goal of sustainability. Information on the site's built form and policy context was somewhat easier to obtain. This was largely due to the ongoing City of Calgary planning process for CFB East.

In conclusion, the opportunity afforded by the redevelopment of such a large infill parcel is rare for a city of Calgary's size. A key in successfully encouraging the adoption of ecological planning is the completion of a large-scale demonstration project Having analyzed the benefits of approaching development in an ecological manner, such an approach would have been ideally suited to the redevelopment of CFB East. The CFB East II conceptual design presents a starting point from which to consider further study of the site and its best utilization within the larger context of the City of Calgary. The resulting four-fold increase in open space, for example, presents great opportunities, including development intensification, the establishment of local employment, the creation of permaculture, and many others. In addition, an alternative method to reduce impact on the environment could have been to greatly intensify development, using

ecological design methods, with the objective of significantly reducing outward suburban growth. Urban design within such a densely developed site would require close attention. These issues should receive attention in further study of any design refinement conducted for CFB East. The redevelopment of CFB West and the Bow Valley Centre are opportunities that still exist in Calgary to employ ecological planning methods and produce a large-scale demonstration project. The difficulties in achieving this have been discussed, but progress is being made as shown by the popularity of the concept of sustainability and its emergence in our everyday lives. The widespread acceptance and implementation of ecological planning methods is desirable and will aid in striving towards sustainability.

References

Arnold, Chester L., jr. and C. James Gibbons. 1996. "Impervious Surface Coverage: The Emergence of a Key Environmental Indicator," Journal of the American Planning Association, Spring, 243-258.

Beer, Anne. 1994. "Developing tools to monitor the effectiveness of development plans," in Sustainable Urban Development: Research and Experiments Proceedings of a PRO/ECE workshop held in Dordrecht, November 1993. Eds. Van der Vegt, H., Henk ter Heide, Sybrand Tjallingii and Dick van Alphen, 69-85. Delft: Delft University Press.

Bruce, David, Jocelyn Ollerhead, Jennifer Rowe, and Bill Ashton. 1995. A Primer on Military Base Reuse in Canada. Sackville: Mount Allison University.

Calthorpe, P. 1993. The Next American Metropolis: Ecology, Community, and the American Dream. New York: Princeton Architectural Press.

Canfield, C. 1994. "Cerro Gordo: Eco-Village Building and Eco-City Networking," in Futures by Design: The Practice of Ecological Planning. Ed. Doug Aberley, 87-91. Gabriola Island: New Society Publishers.

Charette, Catherine. 1995. "Introduction," in Issues in Canadian Urban Design: Occassional Paper 33. Winnipeg: Institute of Canadian Studies.

City of Calgary. 1997. The Calgary Land Use Bylaw.

City of Calgary. 1995a. Sustainable Suburbs Study. Calgary: City of Calgary.

City of Calgary. 1995b. Transportation Plan. Calgary: City of Calgary.

City of Calgary. 1998. CFB East Community Plan (proposed). Calgary: City of Calgary.

Duany, A. & Plater Zybeck. 1991. Towns and Town Making Principles, eds. Alex Krieger and William Lennertz. Cambridge MA: Harvard Graduate School of design; New York: Rizzoli.

Gibson, R, Donald Alexander, and Ray Tomalty. 1997. "Putting Cities in their Place: Ecosystem-based Planning for Canadian Urban Regions," in Eco-City Dimensions: Healthy Communities, Healthy Planet. Ed. Mark Roseland, 25-39. Gabriola Island: New Society Publishers.

Girling, C. and Kenneth Helphand. 1994. Yard, Street, Park: The Design of Suburban Open Space. New York: John Wiley & Sons, Inc.

Gordon, D., ed. 1990. Green Cities: Ecologically Sound Approaches to Urban Space. Montreal: Black Rose Books.

Grant, J., Patricia Manual, and Darrell Joudry. 1996. "A Framework for Planning Sustainable Residential Landscapes," Journal of the American Planning Association, Vol. 62, No. 3, Summer, 331-344.

Guerstein, P. 1993. "The Role of Urban Design in the Creation of Sustainable Communities," in Issues in Canadian Urban Design: Occassional Paper 33. 45-62. Winnipeg: Institute of Canadian Studies.

Hersperger, Anna M. 1994. "Landscape Ecology and Its Potential Application to Planning," Journal of Planning Literature, Vol. 9, No. 1, August, 14-29.

Hough, M. 1984. City Form and Natural Process: Towards a New Urban Vernacular. New York: Routledge.

Hough, M. 1990. "Formed by Natural Process – A Definition of the Green City," in Green Cities: Ecologically Sound Approaches to Urban Space. ed. David Gordon, 15-20. Montreal: Black Rose Books.

Hygeia Consulting Services And Reic Ltd. 1995. "Changing Values Changing Communities: A Guide to the Development of Healthy, Sustainable Communities," Ottawa: CMHC.

Katz, P. 1993. The New Urbanism: Toward an Architecture of Community. New York: McGraw Hill.

Katz, P. 1986, "Metropolitan Food Systems and the Sustainable City," in Sustainable Communities: A New Design Synthesis for Cities, Suburbs and Towns. Eds. Sim Van der Ryn and Peter Calthorpe, 148-166. San Francisco: Sierra Club Books.

Levy, Richard M. 1995 "Visualization of urban alternatives," Environment and Planning B: Planning and Design, Vol. 22, 343-358.

Lyle, J. 1985. Design for Human Ecosystems. New York: Von Nostrand Reinhold Company.

Lyle, J. 1994. Regenerative Design for Sustainable Development. New York: John Wiley & Sons, Inc.

Manning, Owen. 1979. "Designing for Nature in Cities," in Nature in Cities, The Natural Environment in the Design and Development of Urban Green Space. ed. Ian C. Laurie. New York: Wiley.

McHarg, Ian. 1969. Design with Nature. Garden City, NY: Natural History Press.
Middelton, D.S. 1997. "The Woodlands: Designed with Nature," Urban Land, June, 26-30.

Newman, Peter. 1997. "Greening The City: the Ecological and Human Dimensions of the City Can Be Part of Town Planning," in Eco-City Dimensions: Healthy Communities, Healthy Planet. Ed. Mark Roseland, 14-24. Gabriola Island: New Society Publishers.

Pembina Institute for Appropriate Development. 1997. Building Eco-Efficient Communities: A How-To Guide. Drayton Valley: The Pembina Institute for Appropriate Development.

Perks, W. and David Van Vliet. 1993. Assessment of Built Projects for Sustainable Communities. Calgary: Faculty of Environmental Design, The University of Calgary.

Pitt, D., Kenneth Soergell II and Ervin Zube. 1979. "Trees in the City," in Nature in Cities The Natural Environment in the Design and Development of Urban Green Space. ed. Ian C. Laurie. New York: Wiley.

Roley, Bill. 1992. "Home and Community Water Management," in Sustainable Cities: Concepts & Strategies for Eco-City Development. eds. Bob Walter, Lois Arkin, and Richard Crenshaw. Los Angeles: Eco-Home Media.

Roseland, M., ed. 1997. Eco-City Dimensions: Healthy Communities, Healthy Planet. Gabriola Island: New Society Publishers.

Sackett, J. 1997. "Sustainable Development for the 21st Century," Urban Land, June, 23-25, 74-77.

Saunders, Todd. 1997. "Ecology and Community Design: Lessons from Northern European Ecological Communities," in Eco-City Dimensions: Healthy Communities, Healthy Planet. Ed. Mark Roseland, 113-124. Gabriola Island: New Society Publishers.

Shirvani, Hamid. 1985. The Urban Design Process. New York: Van Nostrand Reinhold Company.

Steiner, F. 1991. The Living Landscape: An Ecological Approach to Landscape Planning. New York: McGraw-Hill.

Stenhouse, Douglas. 1992. "Energy Conservation Benefits of High-Density Mixed-Use Land Development," in Sustainable Cities: Concepts & Strategies for Eco-City

Development. eds. Bob Walter, Lois Arkin, and Richard Crenshaw. Los Angeles: Eco-Home Media.

Terrene Institute in cooperation with U.S. Environmental Protection Agency. 1994. Urbanization and Water Quality. Washington, D.C.: Terrene Institute.

Tjallingii, Sybrand. 1994. "An ecological approach to urban planning," in Sustainable Urban Development: Research and Experiments Proceedings of a PRO/ECE workshop held in Dordrecht, November 1993. Eds. Van der Vegt, H., Henk ter Heide, Sybrand Tjallingii and Dick van Alphen, 17-51. Delft: Delft University Press.

Todd, J. and Beth Josephson. 1994. "Living Machines: Theoretical Foundations and Design Precepts," Annals of Earth, Vol. XII, No. 1, 16-24.

Todd, N.J. and John Todd. 1994. From Eco-Cities to Living Machines: Principles of Ecological Design. Berkley: North Atlantic Books.

Tregay, R. 1979. "Urban Woodlands," in Nature in Cities The Natural Environment in the Design and Development of Urban Green Space. ed. Ian C. Laurie. New York: Wiley.

Tyler, M. and William Perks. Presentation overhead transparencies for the International Urban Ecology Conference, Leipzig, June 1997.

Tyler, M. 1994. "Ecological Plumbing in the Twenty-First Century," Plan Canada, July, 169-176.

UMA Egineering. 1996. Environmental Comprehensive Study of Base Closure Acitivities. Calgary: UMA Engineering.

UMA Egineering. 1997. Phase I Environmental Site Assessment of CFB Calgary Currie Permanent Married Quarters. Calgary: UMA Engineering.

Van der Ryn S. and Peter Calthorpe. 1986. Sustainable Communities: A New Design Synthesis for Cities, Suburbs and Towns. San Francisco: Sierra Club Books.

Van der Ryn S. and Peter Calthorpe. 1986a. "The New Suburban Fabric," in Sustainable Communities: A New Design Synthesis for Cities, Suburbs and Towns. eds. Sim Van der Ryn and Peter Calthorpe, 54-106. San Francisco: Sierra Club Books.

Van der Ryn, S. and Stuart Cowan. 1996. Ecological Design. Washington, D.C.: Island Press.

Van der Vegt, H., Henk ter Heide, Sybrand Tjallingii and Dick Van Alphen, eds. 1994. Sustainable Urban Development: Research and Experiments Proceedings of a

PRO/ECE workshop held in Dordrecht, November 1993. Delft: Delft University Press.

Van Vliet, D. 1994. Sustainable Subdivision Planning and Design: Analysis, Literature Review and Annotated Bibliography. Winnipeg: Institute of Urban Studies, The University of Winnipeg.

Walker, Lyle A. and William E. Rees. 1997. "Urban Density and Ecological Footprints – An Analysis of Canadian Households," in Eco-City Dimensions: Healthy Communities, Healthy Planet. ed. Mark Roseland, 96-112. Gabriola Island: New Society Publishers.

Walker Brown Urban Consultants Ltd., 1997. CFB East Supporting Information Outline Plan and Land Use Redesignation. Calgary.

Walter, Bob, Lois Arkin, and Richard Crenshaw, eds. 1992. Sustainable Cities: Concepts & Strategies for Eco-City Development. Los Angeles: Eco-Home Media.

Wilton-Clark, A. 1996. Re-Designing Suburbia. EVDS Master's Degree Project, University of Calgary.

Woodhall, Joel. 1992. "How alternative forms of development can reduce traffic congestion," in Sustainable Cities: Concepts & Strategies for Eco-City Development. eds. Bob Walter, Lois Arkin, and Richard Crenshaw, Los Angeles: Eco-Home Media.

Woodward-Clyde Consultants. 1990. Urban Targeting and BMP Selection: An Information and Guidance Manual for State Nonpoint Source Program Staff Engineers and Managers. Oakland.

Worton, James F. 1993. An Ecological Approach to Site and Subdivision Design. Edmonton: Alberta Municipal Affairs.

Appendices

Appendix 1: Goals and Objectives of the proposed CFB East Community Plan (1998)

This appendix outlines the goals and objectives from the City of Calgary's (1998) proposed CFB East Community Plan. The goals and objectives are intended to support the vision for CFB East:

> *To ensure all existing and new development contributes to the enhancement of CFB East as a unique and sustainable inner-city neighbourhood.* (City of Calgary 1998)

Goal 1: Implement Relevant Strategic City Policies

Objectives:

- *To meet the City's long-term strategic objectives through the efficient use of land, infrastructure, and services.*
- *To provide for a transportation system which improves travel choices, while enhancing the quality of the environment and maintaining accessibility.*

Goal 2: Support Sensitive Residential Intensification

Objectives:

- *To enable opportunities for increasing residential density and population through sensitive redevelopment.*
- *To ensure a compact and adaptable form of redevelopment which uses land and services in an effective and efficient manner.*
- *To increase population to support existing and future commercial uses and community facilities in the area.*

Goal 3: Create a well designed, livable, integrated community

Objectives:

- *To design an attractive and liveable inner-city neighbourhood that meets the needs of its residents.*
- *To encourage innovative building design, site layouts and urban design features which would contribute to defining a unique community.*
- *To provide for a variety of housing opportunities (e.g. housing and dwelling types, affordability levels) to accommodate people of different ages, diverse needs and lifestyles, with the ability to adapt to changing needs over time.*
- *To provide opportunities to reduce vehicle trips within the community by enhancing opportunities for walking, biking, and taking transit.*
- *To provide for a variety of open spaces that integrate with, and complement existing open space.*

Goal 4: Incorporate principles of sustainable development

Objectives:

- *To encourage the adaptive reuse of existing housing, infrastructure, and facilities where possible.*
- *To preserve and incorporate existing landscaping and mature vegetation into the plan where possible.*
- *To ensure that the plan is economically viable, flexible, and able to respond to changing demographics and lifestyles over time.*
- *To reduce environmental impacts through community and building design.*

Goal 5: Ensure Timely redevelopment

Objectives:

- *To reduce the amount of time that the land and buildings remain vacant thereby reducing the uncertainty for area businesses and services.*
- *To provide for a range of housing opportunities that can successfully respond to* changing market demands and are achievable in the short to medium term.

Goal 6: Integrate the CFB East Plan area with the larger Altadore community and enhance and complement existing development

Objectives:

- *To integrate CFB East community with the adjacent community of Altadore.*
- *To ensure an appropriate interface with and linkages to existing communities.*
- *To recognize and enhance Marda Loop as the commercial focal point for the community.*
- *To enhance and complement existing communities and minimize potential impacts (e.g., by supporting the sharing of facilities, and by addressing downstream impacts).*

Goal 7: Recognize where possible the military legacy

Objectives:

- *To incorporate or integrate important elements of existing planning patterns where possible.*
- *To integrate and enhance elements which recognize CFB's historical ties to Calgary (i.e., Museum of the Regiments, use of historical street names or features).*

Appendix 2: Principles in Applying Ecological Planning

Todd Saunders (1997): Recommendations for translating Ecological Theory into Practice

1. Monitor Input and Output of Community Resources.
2. Involve the Community.
3. Employ Alternative Housing Arrangements.
4. Design for the Pedestrian.
5. Incorporate Natural Areas into the Community.
6. Use Experimental Projects to Induce Gradual Change of Opinion.
7. Change the Role of the Community Designer.
8. Plan in Stages and For the Long Term.
9. Share Information.
10. Maintain a Balance.

Van der Ryn and Cowan (1996): Broad Principles of Ecological Design

1. Solutions Grow From Place.
2. Ecological Accounting Informs Design.
3. Design with Nature.
4. Everyone is a Designer.
5. Make Nature Visible.

Grant, et al. (1996): Principles of Sustainable Communities

1. Maintain and restore landscape processes and functions.
2. Minimize settlement impacts on ecosystems.
3. Reduce waste outputs from residential developments.
4. Increase public involvement in promoting sustainability.
5. Promote healthy social environments.

Lyle (1994): Design Strategies for Regenerative Design

1. Letting nature do the work.
2. Considering nature as both the model and the context.
3. Aggregating, not isolating.
4. Seeking optimum levels for multiple functions, not the maximum level for any one.
5. Matching technology to need.
6. Using information to replace power.
7. Providing multiple pathways.
8. Seeking common solutions to disparate problems.
9. Managing storage as the key to sustainability.
10. Shaping form to guide flow.
11. Shaping form to manifest process.
12. Prioritizing for sustainability.

Appendix 3: Steiner's Steps of Ecological Planning (1991)

Step 1 – Identification of Planning Problems and Opportunities
This step entails the identification of planning problems that face a site and is particularly concerned with "the interrelationship between people and nature" (Steiner 1991, p. 11). Once a planning problem is identified, a number of planning issues becomes evident. For example, land use conflicts, funding, and the protection of the environment.

Step 2 – Establishment of Planning Goals
Planning goals state the community's vision of a solution to the planning problem. Steiner (1991) emphasizes the importance of establishing goals at the local level.

Step 3 – Landscape Analysis, Regional Level
This step is closely related to step four. Each attempt to provide an inventory of landscape features but at different scales. Steiner writes that watersheds have been suggested as a useful regional planning boundary, but recognizes that more often political boundaries are used.

Step 4 – Landscape Analysis, Local Level
In step four, processes and features at the local level are studied. The categories include geology, physiography, groundwater, surface water, soils, climate, vegetation, wildlife, and people.

Step 5 – Detailed Studies
Step five links the landscape analysis information of steps three and four with the identified problem(s) and goal(s). The aim of this step is to basically determine the opportunities and constraints of the site within the local context. One method is to conduct a suitability analyses that "can be used to determine the fitness of a specific place for a variety of land uses based on thorough ecological inventories and on the values of land users" (Steiner 1991, pp. 14-15). It is vital that any study used in this step be conducted within the local context.

Step 6 – Planning Area Concepts, Options, and Choices
In step six, concepts for development are produced that give a general idea of how the planning problem may be solved and the goals achieved. Normally, more than one scenario is presented and they are evaluated on their fulfillment of the planning goals.

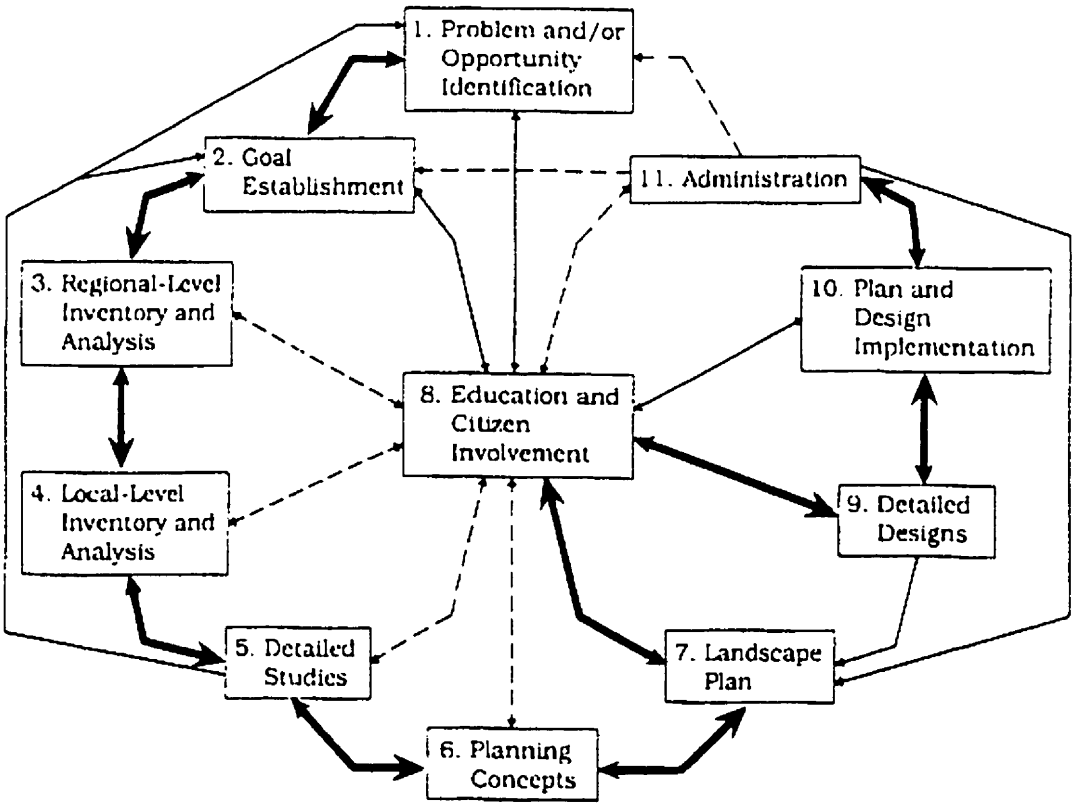
Step 7 – Landscape Plan
Step seven is the consolidation of concepts and options into a plan "that gives a strategy for development at the local scale" (Steiner 1991, p. 17). For comparison, this step results in the production of a plan such as the proposed community plan for CFB East that includes guidelines for implementation.

Step 8 – Continued Citizen Involvement and Community Education
This step should be the continuation of a continual process of public involvement in the production of the landscape plan. Its inclusion at this point is to emphasize the need for public education and information sessions on the plan produced in step seven.

Step 9 – Detailed Designs
Step nine is the production of detailed designs that clearly show the physical form of the proposed plan in order to "help decision makers visualize the consequences of their policies" (Steiner 1991, p. 18).

Step 10 – Plan and Design Implementation
Step 10 refers to the implementation strategies to ensure that policies and plans are fulfilled as intended by their makers. Steiner emphasizes that performance standards or criteria are useful tools of implementation in ecological planning that "must be met before a certain use will be permitted" (Steiner 1991, p. 19).

Step 11 – Administration
This step calls for the monitoring and evaluation of the plan that was implemented



Source Steiner 1991

Appendix 4: Recommended Plantings for Calgary

Arctic Willow	Aspen
Balsam Poplar	Bebb's Willow
Blue Clematis	Bog Birch
Bog Cranberry	Bracted Honeysuckle
Buckbrush	Chokecherry
Common Juniper	Common Wild Rose
Creeping Juniper	Creeping Mahonia
Douglas Fir	Gold Currant
Gooseberry	Green Alder
Honeysuckle vine	Kinnikinnick
Labrador Tea	Limber Pine
Lodgepole Pine	Low Bush Cranberry
Pincherry	Potentilla
Prickly Rose	Red Elder
Red Twig Dogwood	River Alder
River Birch	Round Leaf Hawthorne
Russet Buffaloberry	Sagebrush
Sandbar Willow	Saskatoon
Silverberry	Snowberry
Thimbleberry	Thornby Buffaloberry
Three Lobed Sumac	White Clematis
White Spruce	Wild Red Raspberry
Yellow Twig Willow	

Source: The City of Calgary, Parks and Recreation Department.

Appendix 5: Weather Data – Calgary International Airport (51° 07'N 114° 01' W 1077 metres)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily Mean Temp (°C)	-9.6	-6.3	-2.5	4.1	9.7	14.0	16.4	15.7	10.6	5.7	-3.0	-8.3
Precipitation (mm)	12.2	9.9	14.7	25.1	52.9	76.9	69.9	48.7	48.1	15.5	11.6	13.2
Wind Direction	W	S	S	N	NW	NW	NW	NW	S	S	S	W
Sunshine (hrs)	113.8	136.8	174.0	214.8	256.0	285.5	320.1	284.4	201.8	179.0	125.4	102.5

Source: Environment Canada 1961-1990 Normals

Appendix 6: CFB East Facilities Buildings List

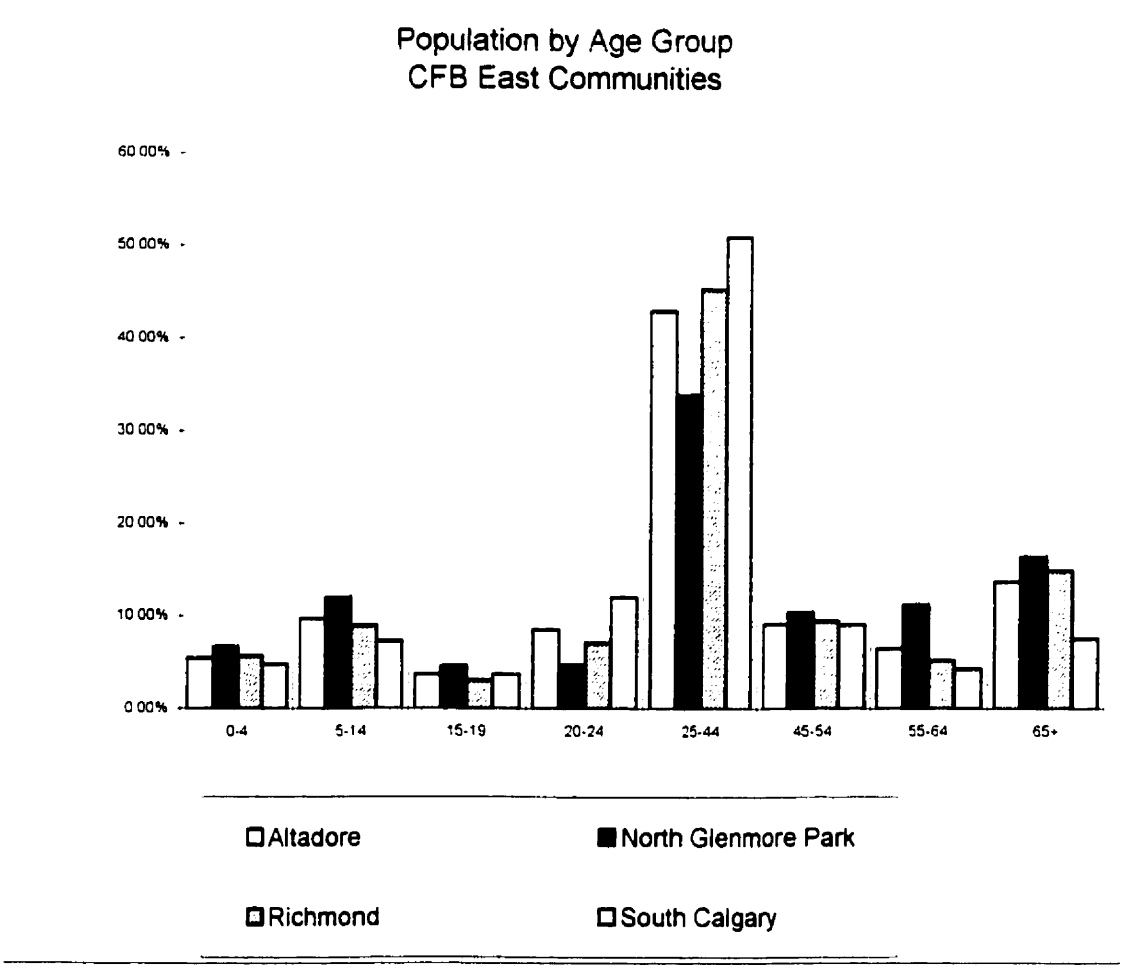
Previous Military Use	Construction Date	Storeys
Protestant Chapel	1956	1
Roman Catholic Chapel	1956	1
12 - 8 Bay Garages	1958	1
Curling Club	1988	2
Community Centre	1982	1
Canex (Retail, Professional)	1983	1
Museum	1988	1
Elementary School	1956	2

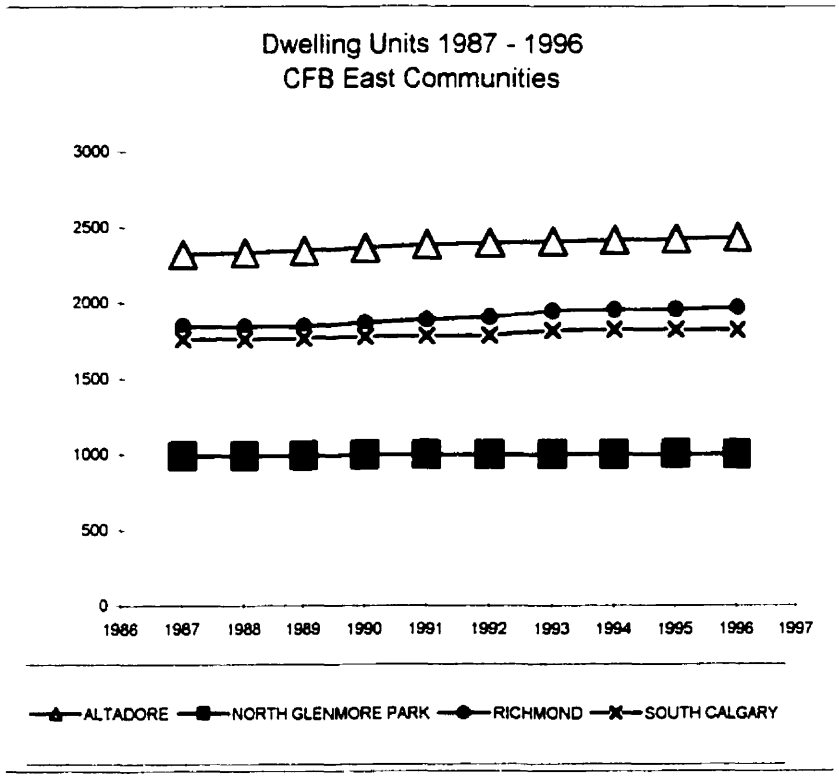
Note: The Curling Club was originally built in 1961 and was rebuilt after a fire in 1988.

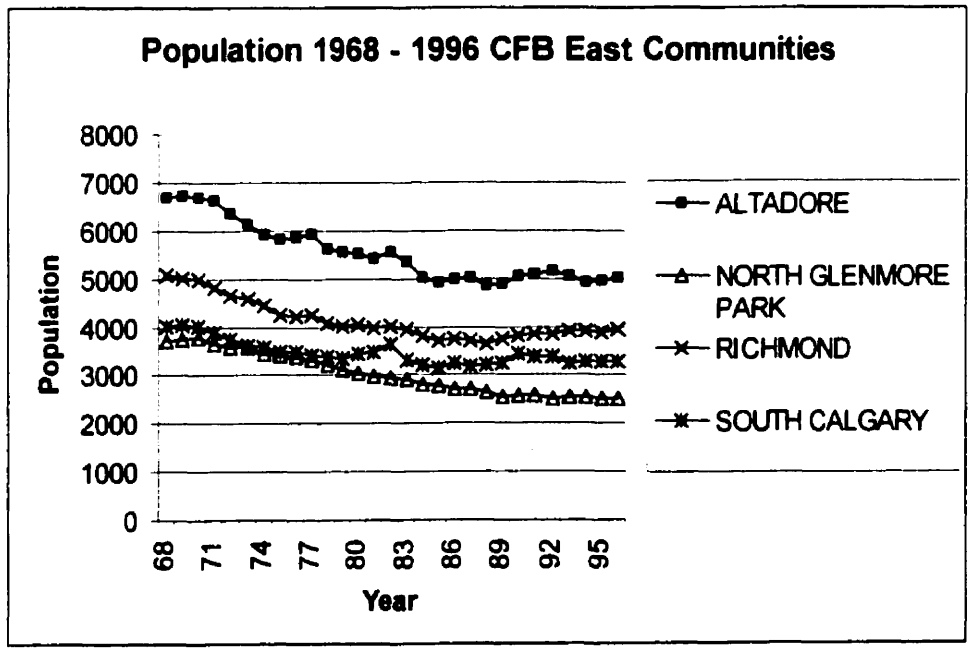
Source: CFB Calgary Base Construction Engineering Officer

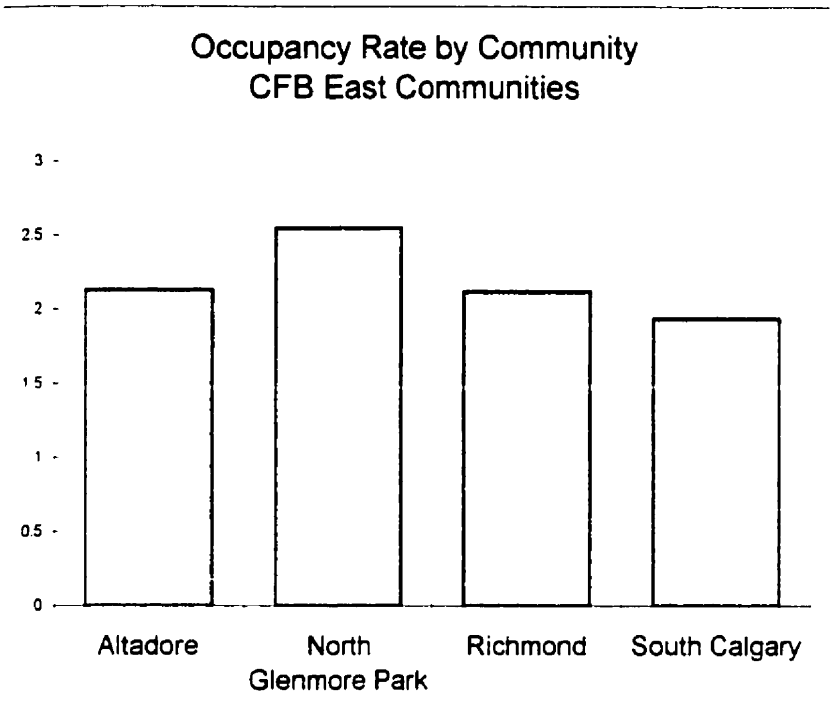
Appendix 7: Socio-Economic Data

Source: City of Calgary, Planning and Building Department, Civic Census 1996




Dwelling Units 1987 - 1996
CFB East Communities
3000
2500
2000
1500
1000
500
0
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997
ALTADORE
NORTH GLENMORE PARK
RICHMOND
SOUTH CALGARY


Population 1968 - 1996 CFB East Communities
Population
8000
7000
6000
5000
4000
3000
2000
1000
0
68 71 74 77 80 83 86 89 92 95
Year
ALTADORE
NORTH GLENMORE PARK
RICHMOND
SOUTH CALGARY


Occupancy Rate by Community
CFB East Communities
3
2.5
2
1.5
1
0.5
0
Altadore
North Glenmore Park
Richmond
South Calgary

Appendix 8: Comparative Analysis Spreadsheets
CFB East Housing Statistics

CFB East I

Dwelling Unit Type	Number of Units	Occupancy Rate	Projected Population
Single Family	700	3.07	2149
Ancillary	0	1.96	0
Townhouses	151	2.51	379
Apartment	739	1.55	1145
Total	**1590**		**3673**
Density	26.8 units per hectare		

Assumptions:
1. Occupancy Rates base on City of Calgary 1996 census.
2. Ancillary occupancy rate assumed to equal that of converted units.
3. CFB East site area = 56.29 hectares
4. Multi-family housing unit totals for CFB East II were calculated using an average unit size of 120 square metres. This included any additional floor area in the structure for hallways, etc.
5. Unit totals for CFB East I were calculated from CFB East Supporting Information Outline Plan and Land Use Redesignation

CFB East II

Dwelling Unit Type	Number of Units	Occupancy Rate	Projected Population
Single Family	142	3.07	436
Ancillary	91	1.96	178
Townhouses	693	2.51	1739
Apartment	677	1.55	1049
Total	**1603**		**3403**
Density	28.48 units per hectare		

CFB East Electricity Consumption

CFB East I Dwelling Unit Type	Electricity Consumption by unit type (kilowatt hours/month)	Number of Units	Total Electricity Consumption (kWh/month)
Single Family	667	700	466,900
Ancillary	387	0	0
Townhouses	558	151	84,258
Apartment	387	739	285,993
Total		**1590**	**837,151**

CFB East II Dwelling Unit Type	Electricity Consumption by unit type (kilowatt hours/month)	Number of Units	Total Electricity Consumption (kWh/month)
Single Family	667	142	94,714
Ancillary	387	91	35,217
Townhouses	558	693	386,694
Apartment	387	677	261,999
Total		**1603**	**778,624**

Assumptions:

1. Electricity consumption for ancillary units was assumed to be the same as apartments

.

2. Consumption figures provided by Enmax, City of Calgary, April 1998.

CFB East II Composting Toilet Conversion 'Estimation

CFB East II

Percentage of Population Using Composting Toilets	10	20	30	40	50	60	70	80	90	100
Toilet Water Consumption	382,847	340,308	297,770	255,231	212,693	170,154	127,616	85,077	42,539	0

Assumptions:

1. Daily water Useage:	Composting	Low Flow	Standard
(litres/person/day)	0	63	125

2. CFB East II population 3,403

3. Remainder of population is using standard flow toilets.

CFB East Water Consumption

CFB East I

Dwelling Unit Type	Number of Units	Occupancy Rate	Projected Population
Single Family	700	3.07	2149
Ancillary	0	1.96	0
Townhouse	151	2.51	379
Apartment	739	1.55	1145
Total	**1590**		**3673**

Daily Water Savings	
Low Flow Fixtures/Appliances	710,801 litres/day
Rain Water Collection	0 litres/day

Water Consumption	L/person/day
Average	594
Summer Peak	1216
Typical	517

CFB East II

Dwelling Unit Type	Number of Units	Occupancy Rate	Projected Population
Single Family	142	3.07	436
Ancillary	91	1.96	178
Townhouse	693	2.51	1739
Apartment	677	1.55	1049
Total	**1603**		**3403**

Daily Water Savings	
Low Flow Fixtures/Appliances	975,155 litres/day
Rain Water Collection	262,037 litres/day

Definitions

Average: Average daily use, including summer increase

Summer Peak: Highest use day of the year

Typical: Use without accounting for summer useage increase

(Source: City of Calgary Waterworks)

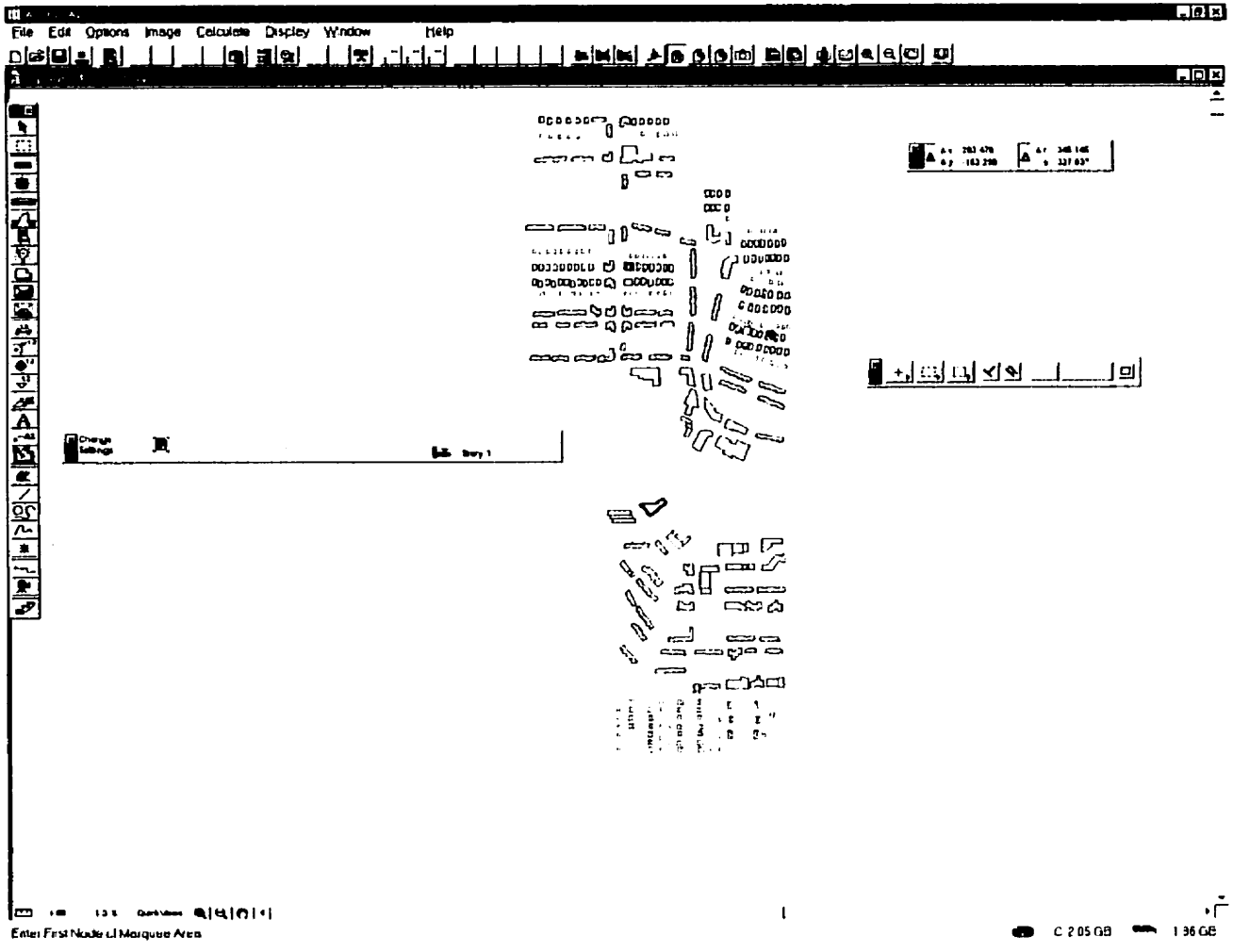
Assumptions:

1. Low flow fixtures and appliances use about 1/2 the water of ordinary fixtures and appliances (BSA Architects 1991 cited in Wilton-Clark 1996).
2. Rain water collection provides enough water to eliminate increase due to summer outdoor irrigation increase (77 litres/person/day).
3. Only newly constructed units will have low flow fixtures and appliances -- not reused PMQs.
4. Number of Reuse PMQs in CFB East I = 417. This was interpreted from proposed Phase I reuse cell shown in proposed CFB East Community Plan (City of Calgary 1998).
5. Number of Reuse PMQs in CFB East II = 39.

Appendix 9: Calculation Method Example
CFB East Electricity Consumption

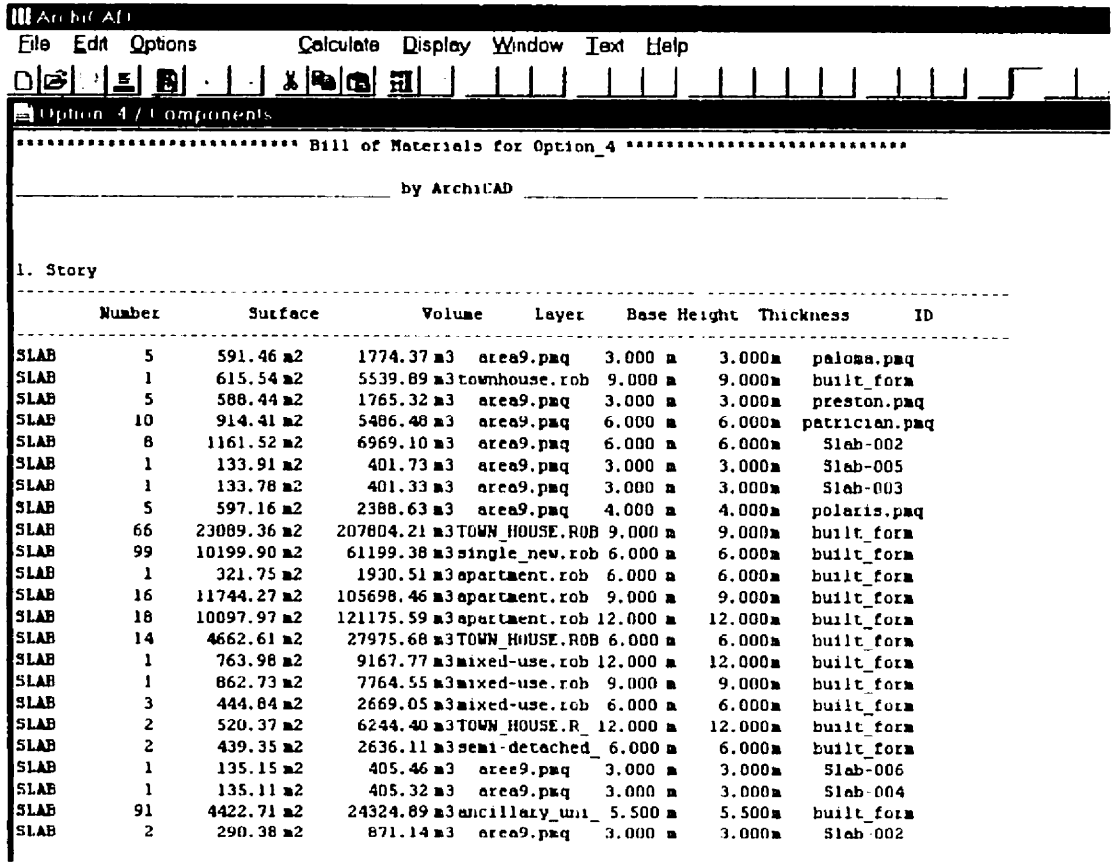
Step 1

Using ArchiCAD, display the layers showing built form. Under the calculate option, calculate the 'bill of materials' for the shown layers. This will then show the numbers of units as organized by the project layers – see Step 2.



Step 2

The image to the right is the bill of materials screen from ArchiCAD. It shows the number of units (slabs), surface area, layers (which corresponds to housing type), and height (which corresponds to number of storeys as 3 metres is equal to one storey). This information is then imported into the spreadsheet program "MS Excel.'



ArchiCAD

File Edit Options Calculate Display Window Text Help

Option 4 / Components

********** Bill of Materials for Option_4 **********

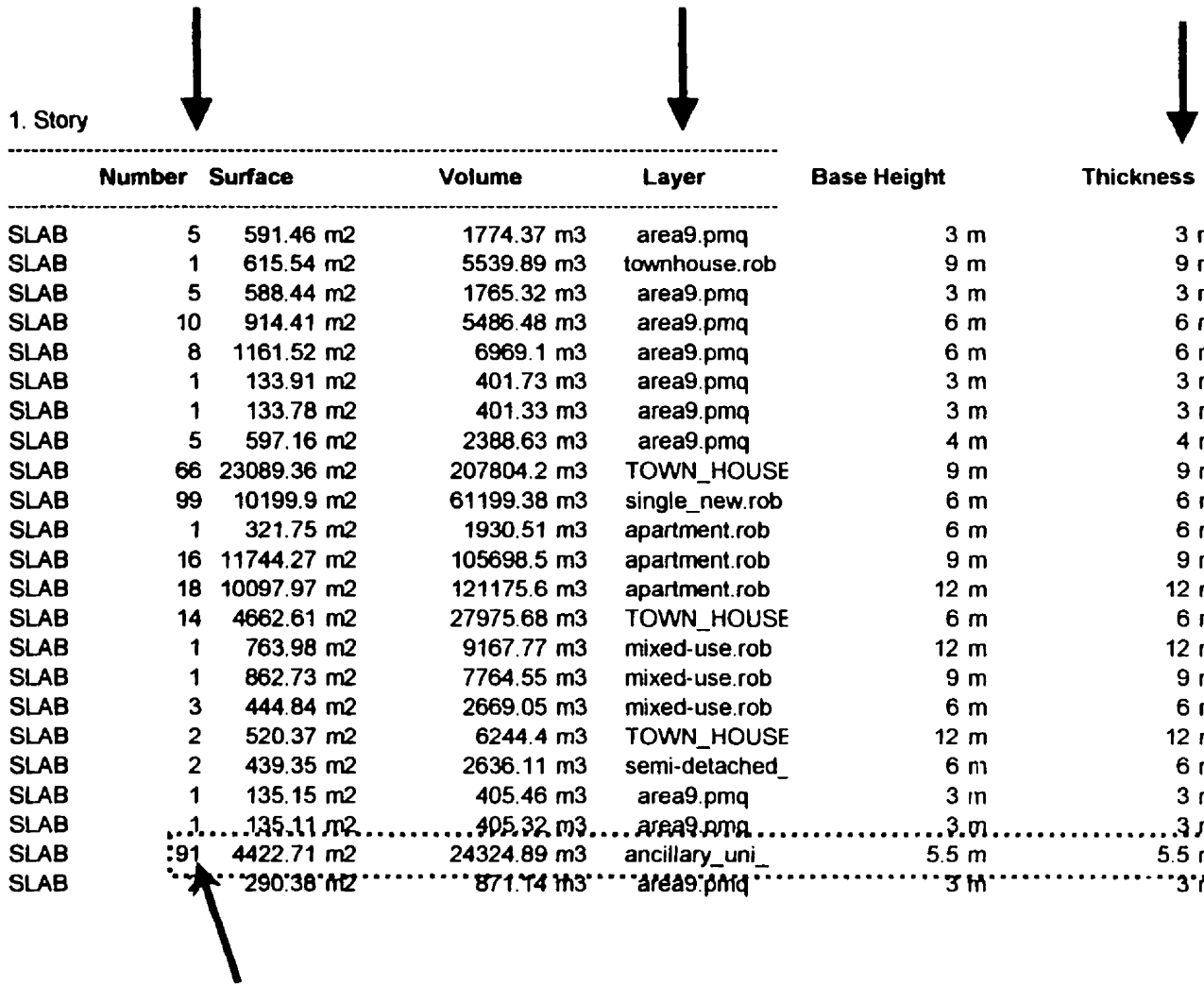
by ArchiCAD

1. Story

	Number	Surface	Volume	Layer	Base Height	Thickness	ID
SLAB	5	591.46 m2	1774.37 m3	area9.pmq	3.000 m	3.000m	paloma.pmq
SLAB	1	615.54 m2	5539.89 m3	townhouse.rob	9.000 m	9.000m	built_form
SLAB	5	588.44 m2	1765.32 m3	area9.pmq	3.000 m	3.000m	preston.pmq
SLAB	10	914.41 m2	5486.48 m3	area9.pmq	6.000 m	6.000m	patrician.pmq
SLAB	8	1161.52 m2	6969.10 m3	area9.pmq	6.000 m	6.000m	Slab-002
SLAB	1	133.91 m2	401.73 m3	area9.pmq	3.000 m	3.000m	Slab-005
SLAB	1	133.78 m2	401.33 m3	area9.pmq	3.000 m	3.000m	Slab-003
SLAB	5	597.16 m2	2388.63 m3	area9.pmq	4.000 m	4.000m	polaris.pmq
SLAB	66	23089.36 m2	207804.21 m3	TOWN_HOUSE.ROB	9.000 m	9.000m	built_form
SLAB	99	10199.90 m2	61199.38 m3	single_new.rob	6.000 m	6.000m	built_form
SLAB	1	321.75 m2	1930.51 m3	apartment.rob	6.000 m	6.000m	built_form
SLAB	16	11744.27 m2	105698.46 m3	apartment.rob	9.000 m	9.000m	built_form
SLAB	18	10097.97 m2	121175.59 m3	apartment.rob	12.000 m	12.000m	built_form
SLAB	14	4662.61 m2	27975.68 m3	TOWN_HOUSE.ROB	6.000 m	6.000m	built_form
SLAB	1	763.98 m2	9167.77 m3	mixed-use.rob	12.000 m	12.000m	built_form
SLAB	1	862.73 m2	7764.55 m3	mixed-use.rob	9.000 m	9.000m	built_form
SLAB	3	444.84 m2	2669.05 m3	mixed-use.rob	6.000 m	6.000m	built_form
SLAB	2	520.37 m2	6244.40 m3	TOWN_HOUSE.R_	12.000 m	12.000m	built_form
SLAB	2	439.35 m2	2636.11 m3	semi-detached_	6.000 m	6.000m	built_form
SLAB	1	135.15 m2	405.46 m3	area9.pmq	3.000 m	3.000m	Slab-006
SLAB	1	135.11 m2	405.32 m3	area9.pmq	3.000 m	3.000m	Slab-004
SLAB	91	4422.71 m2	24324.89 m3	ancillary_uni_	5.500 m	5.500m	built_form
SLAB	2	290.38 m2	871.14 m3	area9.pmq	3.000 m	3.000m	Slab-002

Step 3

The image below shows a clearer spreadsheet version of the ArchiCAD bill of materials. For the case of ancillary units, it shows a total of 91 units.



1. Story

	Number	Surface	Volume	Layer	Base Height	Thickness	ID
SLAB	5	591.46 m2	1774.37 m3	area9.pmq	3 m	3 m	paloma.pmq
SLAB	1	615.54 m2	5539.89 m3	townhouse.rob	9 m	9 m	built_form
SLAB	5	588.44 m2	1765.32 m3	area9.pmq	3 m	3 m	preston.pmq
SLAB	10	914.41 m2	5486.48 m3	area9.pmq	6 m	6 m	patrician.pmq
SLAB	8	1161.52 m2	6969.1 m3	area9.pmq	6 m	6 m	Slab-002
SLAB	1	133.91 m2	401.73 m3	area9.pmq	3 m	3 m	Slab-005
SLAB	1	133.78 m2	401.33 m3	area9.pmq	3 m	3 m	Slab-003
SLAB	5	597.16 m2	2388.63 m3	area9.pmq	4 m	4 m	polaris.pmq
SLAB	66	23089.36 m2	207804.2 m3	TOWN_HOUSE	9 m	9 m	built_form
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SLAB	1	321.75 m2	1930.51 m3	apartment.rob	6 m	6 m	built_form
SLAB	16	11744.27 m2	105698.5 m3	apartment.rob	9 m	9 m	built_form
SLAB	18	10097.97 m2	121175.6 m3	apartment.rob	12 m	12 m	built_form
SLAB	14	4662.61 m2	27975.68 m3	TOWN_HOUSE	6 m	6 m	built_form
SLAB	1	763.98 m2	9167.77 m3	mixed-use.rob	12 m	12 m	built_form
SLAB	1	862.73 m2	7764.55 m3	mixed-use.rob	9 m	9 m	built_form
SLAB	3	444.84 m2	2669.05 m3	mixed-use.rob	6 m	6 m	built_form
SLAB	2	520.37 m2	6244.4 m3	TOWN_HOUSE	12 m	12 m	built_form
SLAB	2	439.35 m2	2636.11 m3	semi-detached_	6 m	6 m	built_form
SLAB	1	135.15 m2	405.46 m3	area9.pmq	3 m	3 m	Slab-006
SLAB	1	135.11 m2	405.32 m3	area9.pmq	3 m	3 m	Slab-004
SLAB	91	4422.71 m2	24324.89 m3	ancillary_uni_	5.5 m	5.5 m	built_form
SLAB	2	290.38 m2	871.14 m3	area9.pmq	3 m	3 m	Slab-002

Step 4

The final step involves importing unit totals and multiplying this by electricity consumption figures (for housing unit type) provided by Enmax, City of Calgary. This allows the total monthly consumption for each alternative to be totalled and compared.

CFB East I

Dwelling Unit Type	Electricity Consumption by unit type (kilowatt hours/month)	Number of Units	Total Electricity Consumption (kWh/month)
Single Family	667	700	466,900
Ancillary	387	0	0
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Dwelling Unit Type	Electricity Consumption by unit type (kilowatt hours/month)	Number of Units	Total Electricity Consumption (kWh/month)
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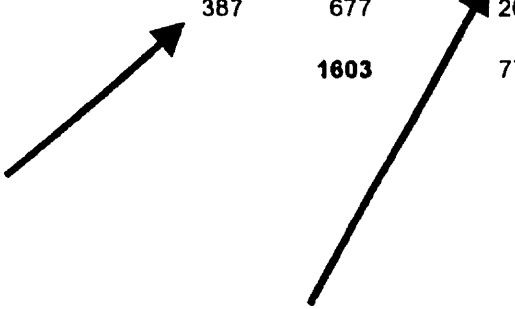

Assumptions:

1. Electricity consumption for ancillary units was assumed to be the same as apartments.
2. Consumption figures provided by Enmax, City of Calgary, April 1998.