AN ECOLOGY CENTRE AND TRAIL SYSTEM FOR THE TSOLUM RIVER WATERSHED

by

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Abstract

The Tsolum River flows through the Comox Valley on Vancouver Island, British Columbia, Canada. A local stream stewardship group, the Tsolum River Restoration Society, has been working to restore the river's once-plentiful salmon population. The Society's director has expressed an interest in developing an interpretive trail system, based at an ecology-centre facility, to link their salmon habitat enhancement projects and explain them to the public.

From this idea, the project's scope was expanded by the author, based on the rationale that the trail planning should encompass a broader program. As public trail development opportunities are rare, it was felt that the system should achieve the Society's goals, while providing an enjoyable recreational experience; accessing outstanding cultural and natural features; linking to other routes or trails; and providing an aesthetic experience. This project provides planning and design recommendations for achieving these objectives.

Results of the project, including maps, diagrams, plans, and drawings, will be presented and discussed. Suitability analysis, utilizing a Geographic Information System, is the primary method used in data synthesis and trail layout. A theoretical paradigm, the Ecological Aesthetic, and associated methodologies will be discussed, and applications to the project will be described and assessed.

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1. Introduction

Project Goal

The Tsolum River flows through the Comox Valley on Vancouver Island, British Columbia, Canada. A local stream stewardship group, the Tsolum River Restoration Society, has been working to restore the river's once-plentiful salmon population. The Society's director has expressed an interest in developing an interpretive trail system, based at an ecology-centre facility, to link their salmon habitat enhancement and restoration sites and explain them to the public. This project will provide design recommendations for achieving these objectives, and for revealing the diverse natural and cultural features of the watershed to trail users, while providing an enjoyable recreational and learning experience.

Project Objectives

1. To locate and develop a design for an outdoor eco-centre interpretive facility to accommodate about 20-40 people;

2. To develop a trail system based at the centre, that explores a diversity of ecosystems, including several salmon habitat enhancement projects;

3. To suggest a trail system to include access to nearby outstanding natural and cultural features in the watershed, and links to existing routes.

Intent

Ecologist & writer Aldo Leopold saw knowledge and experience as key components in the aesthetic appreciation of natural ecosystems. An interpretive trail through an ecologically restored area can be a powerful way to provide such experience and knowledge, while raising public awareness of restoration goals.

This study will begin with a discussion of the theoretical context underlying the project, followed by a description of the project area. An overview of the planning process and the resulting maps will lead to a description of the eco-centre design process. The site plan and drawings will be discussed, before brief concluding comments are presented.

2. Theoretical Context

Fine (1997) has identified three constructions of nature that have predominated in Western worldviews at different times. The humanist (or utilitarian) view sharply differentiates culture and nature, suggesting that nature exists primarily to be a vast storehouse of potentially useful goods for human society. In the protectionist view, nature is seen as authentic and uncontaminated, and thus distinct from human life. In the organic (holistic) view, the line between culture and nature is seen as blurred if it exists at all. "This is not to say that a nonhuman world is somehow unreal or a mere figment of our imaginations – far from it. But the way we describe and understand that world is so entangled with our own values and assumptions that the two can never be fully separated" (Cronon, as cited in Brunson, 2000).

In the discussion that follows, the ideas share a common origin in the organic/ holistic view. Another similarity is the focus on ecological and aesthetic landscape values. Ecological and aesthetic values may be more closely linked at this time in western civilization than ever before. Aesthetic appreciation may well be a critical aspect of sustainable development. "Survival that depends on human attention might be called cultural sustainability. Landscapes that are ecologically sound, and that also evoke enjoyment and approval, are more likely to be sustained by appropriate human care over the long term. People will be less likely to redevelop, pave, mine, or improve landscapes that they recognize as attractive" (Nassauer 1997).

An emerging aesthetic paradigm, primarily (but not exclusively) concerned with ecology, will be explored in this essay: the ecological aesthetic. Two related design approaches, ecological restoration and eco-revelatory design, will also be discussed. Concluding comments will discuss the applicability of the theories and processes described.

The Ecological Aesthetic

1. The ecological aesthetic is defined by Thorne and Huang as "the union of ecological integrity and aesthetic appeal" (Thorne and Huang 1991). Their diagram of the components of the ecological aesthetic is shown in Figure 2. 1. Their definition of aesthetic appeal includes "not only the visual appeal of an environment, but also the way that an environment appeals to all our senses and sensibilities, including sound,

smell, touch, and even taste. It also refers to cultural and natural heritage, meaning, uniqueness and identity..." (Thorne and Huang 1991).

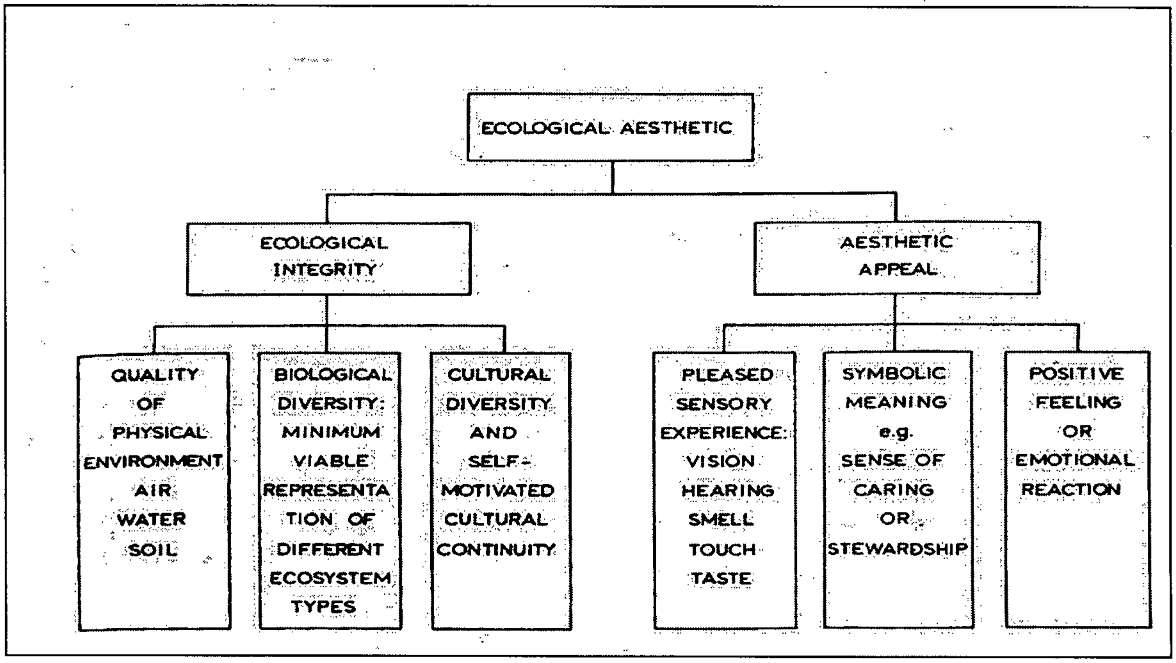

Figure 2. 1 Elements of the Ecological Aesthetic (From Thorne & Huang 1991)

Paul Gobster argues that fundamental differences exist between the ecological aesthetic and the scenic aesthetic currently dominating our society. "In the scenic aesthetic, the pursuit of pleasure (affect) is primary and derives directly from viewing the landscape, irrespective of its ecological integrity. In contrast, in an ecological aesthetic, pleasure comes from knowing about the landscape and knowing it is ecologically 'fit'" (Eaton 1997, as cited in Gobster 1999). To most people, the attributes that make landscapes aesthetically pleasing have more to do with their structural components than with their ecological function. Gobster suggests that much of our urban and rural landscape (which has the structural character of a savanna) is low in biodiversity, and has been managed to discourage many ecological functions (Gobster 1995). This type of management can be seen in the clean-mown lawns that are preferred in our parks and suburban areas (Kaplan, 1984, as cited in Gobster 1995); and the popularity of fastgrowing, non-native tree species in our parks, yards, and street corridors (Nowak and Sydnor, 1992, as cited in Gobster 1995).

Gobster suggests methods for integrating ecological and aesthetic concerns in forest planning, including educating both the general public and forest landscape managers in the ecological aesthetics of ecosystem management. Thayer suggests that people must see and experience an ecological aesthetic in order to understand and appreciate it (Thayer 1989, as cited in Gobster 1995). Thus, in order to facilitate a change in public aesthetic expectations, ecological management practices such as prescribed burns, dead trees, and downed woody material should be kept visible. Initially, these management practices can be perceived negatively by many people, especially in urban areas.

Application: Ecological Restoration

The ecological aesthetic seems to be the obvious theoretical basis for work in ecological restoration. The National Research Council defines restoration as "the return of an ecosystem to a close approximation of its condition prior to disturbance. In restoration, ecological damage to the resource is repaired. Both the structure and the function of the ecosystem are recreated" (NRC 1992:1, as cited in McGinness et al 1999. Often, restoration requires historical research in order to approximate the previous condition of the ecosystem.

Active public participation in restoration efforts is a way to encourage understanding of the meaning and purpose behind these activities, and a way of raising ecological awareness. Seasonal maintenance activities such as brush-bonfires can become celebrations that can bring restoration, and the ecological aesthetic, into popular culture (Siewers 2001). Raising public awareness of the goals of restoration projects through community outreach may be critical to the overall success and acceptance of a project, and provides a means to educate the neighbouring community. This education may include not only information regarding the ecology of the site, but the aesthetic changes to be expected over the stages of a project. Photo-simulation and 3-D visualization can be effective tools in providing realistic predictions of the visual results of restoration projects.

Design cues can help to "reveal" restoration activities and processes. In urban areas, for example, fencing helps to frame and call attention to restorations so that people know that relatively "messy" ecological practices show human care and stewardship rather than neglect or mistreatment (Nassauer 1993, as cited in Gobster 1995). Yet values are specific to a particular location; and what counts as "messy" at the scale of gardens will not count as messy in a forest (Nassauer 1995, as cited in Eaton 1997). Sheppard (2001) proposes a theory of visible stewardship: "...we find aesthetic those things that clearly show people's care for and attachment to a particular landscape; in other words, that we like man-modified landscapes that clearly demonstrate respect for nature in a certain place and context" (Sheppard 2001). This theory builds on the ecological aesthetic and the work of Nassauer and others, but is especially applicable to landscapes where at least some human modification is visible.

A Complimentary Process: Eco-Revelatory Design

Eco-revelatory designs " show local communities in a relationship with their local environments" (Merchant, 1998). Merchant suggests that attention to ecological partnerships may be the overriding guideline for a proposed reconstruction. Her "partnership ethic" involves four precepts: equity between human and nonhuman nature; promotion of both cultural diversity and biodiversity; consideration of both nature and humanity as actors; and ecologically sound management that is consistent with the continued health of both the human and nonhuman communities (Merchant 1998).

Robert Thayer coined the term "visual ecology", referring to "a landscape aesthetic that reflects humanity's total dependence upon the land system" (Thayer 1976, as cited in Thayer 1998). His subsequent writings have aimed beyond a simple ecosystem revelation towards "healing – the deliberated manifestation of a normative, corrective process in the landscape" (Thayer 1998). Thayer sees healing as the obvious "end" of the revelatory process.

Thayer points out that ecosystem structures and functions can be partly visible and understandable, but that ultimately ecosystems are too complex to fully reveal. "Quite simply, we see and notice surfaces and relatively simple, visible processes...so in addressing eco-revelatory design, we grab onto whatever small handles we might find to make a bit more sense of the world" (Thayer 1998). The following quote from Berque seems to confirm this view of landscape as only a part of a greater whole:

"Landscape is not the environment. The environment is the factual aspect of a milieu: that is, of the relationship that links a society with space and with nature. Landscape is the sensible aspect of that relationship. It thus relies on a collective form of subjectivity..." (Berque 1993, as cited in Corner 1999).

The following examples are taken from the 1998 exhibit Nature Constructed / Nature Revealed, described in a special issue of Landscape Journal. Eco-revelatory design can be used to address environmental problems, as in Kristina Hill's submission. Her design goal was to reveal to residents of an abandoned coal-mining region in the former East Germany the dynamics of toxic groundwater that threatens the city of Senftenberg. "Her submission calls for an ingenious system of raised, tree-lined, linear corridors super-imposed on the old coal-hauling corridors, punctuated by monitoring wells that sample and measure the depth and condition of the groundwater at certain key nodes. If a plume of polluted water is discovered at any test well site, that well then operates a draw-down well, extracting polluted water for delivery to a treatment system and creating a groundwater "depression" far beneath the surface, thereby reversing the flow direction of the polluted water away from the city" (Thayer 1998).

In Joseph Eade's "Urban Grass Waterways" design, a channelized river is allowed to assume its former course through the centre of Bladensburg, Maryland. Nature's older meander is revealed, the new channels are lined with native riparian vegetation, and wetlands are re-established to aid in removing pollutants. As a result, the river becomes a partner to town residents; it removes stormwater runoff, provides habitat for riparian bird and animal life, and offers possibilities for river walkways (Merchant 1998).

In "Watermarks at the Nature Center", Richard Hansen proposes three interventions, each marked by a pictorial bronze icon. The interventions are: reconstructed wetland pockets to capture, purify, and celebrate stormwater runoff; simple rock check dams in the gullies of a formerly overgrazed pasture; and the redirection of overflow runoff away from a gravel road and onto a former hayfield, to reinstitute faint traces of a former river meander and to re-establish cottonwood seedlings on the remnant point bars. "Hansen's gentle, healing work calls just enough attention to itself to engage the imagination and offers sufficient formal engagement to whet the aesthetic appetite" (Thayer 1998).

Methodologies for Design and Planning

The influence of the ecological aesthetic has been described in the growing practice of restoration ecology and the emerging eco-revelatory design process. Methodologies for achieving the ecological aesthetic in design and planning have been identified by Thorne and Huang (1991). A number of these methodologies have particular relevance to this project, and so are summarized briefly below:

- Consideration of spatial configuration and temporal sequencing. The interspersion of natural corridors with zones of human use provides a rhythm of alternating land use.
- Assuring representation of different ecosystem types. To reflect the setting for the design and to conserve the natural heritage of a region, the use of native

plant species constitutes an initial step. Recognition and stewardship of sensitive and locally unique ecosystems is another important goal.

- Conservation of cultural heritage. Viable representation of regional cultural diversity can be achieved through recognition and protection, and integration with conservation of biodiversity.
- Enhancing visual appeal. Formalizing landscape configurations shows aspects of obvious stewardship. The concept of "fittingness" of development within a forested landscape considers ecological and visual standards simultaneously.

3. Project Area

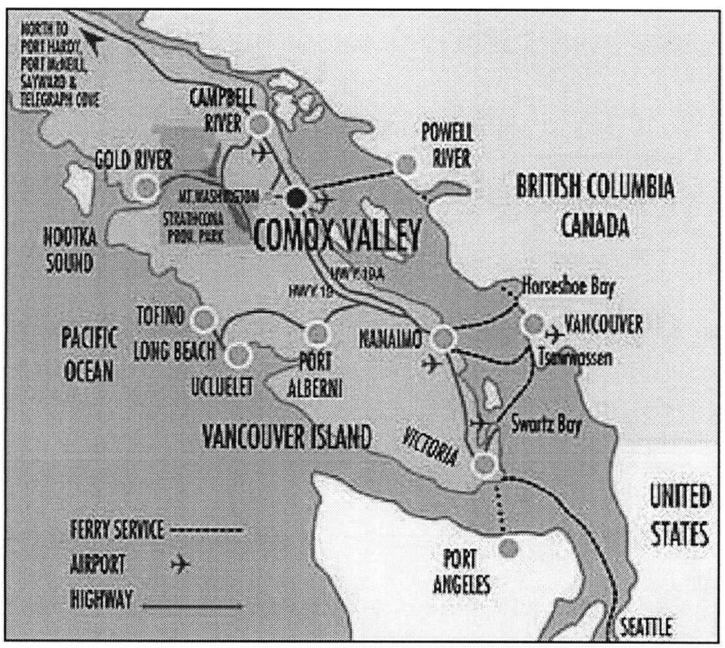

Figure 3. 1 Comox Valley Location

"The east coast of Vancouver Island and the adjacent Gulf Islands form an ecological region unique in Canada. The Mediterranean-type climate and long growing season support many rare plants, animals, and plant communities. These features also make this area highly desirable for human habitation, and as a result this region has become one of the most threatened in British Columbia" (McPhee et al. 2000).

Setting: The Comox Valley

Situated within the ecological region described above, the Tsolum River flows from the alpine regions of Mount Washington through the forests and agricultural land of the Comox Valley (Figure 3.1). The river enters the outskirts of the community of Courtenay before joining with the Puntledge River and draining into the Strait of Georgia. Courtenay is one of three Comox Valley municipalities, and with a (2001) population of approximately 18,000 is the largest incorporated municipality in the region (Statscan 2001, as cited in Comox Valley Chamber of Commerce 2003 p.5). To the southwest is the Village of Cumberland, and a few kilometres east of the city is the Town of Comox. "Courtenay held the distinction for being the fastest growing of the larger communities in BC each year from 1991 through 1995 (in fact its population grew by over 45%). The growth rate between 1996 and 2001 (the Census years) levelled to 5.2%" (Comox Valley Chamber of Commerce 2003 p.5).

The Tsolum River watershed covers an area of 258 km2 (Figure 3.2). The cumulative effects of land-uses in the Tsolum watershed have resulted in its 1998 distinction as the #1 most endangered river system in British Columbia. There is little protected land in the watershed and few recreational opportunities, despite its wildland character, scenic beauty, proximity to communities, and biodiversity values. The effort of local stewardship groups in the watershed has provided the inspiration and the opportunity to establish a base for exploring and learning about this threatened environment.

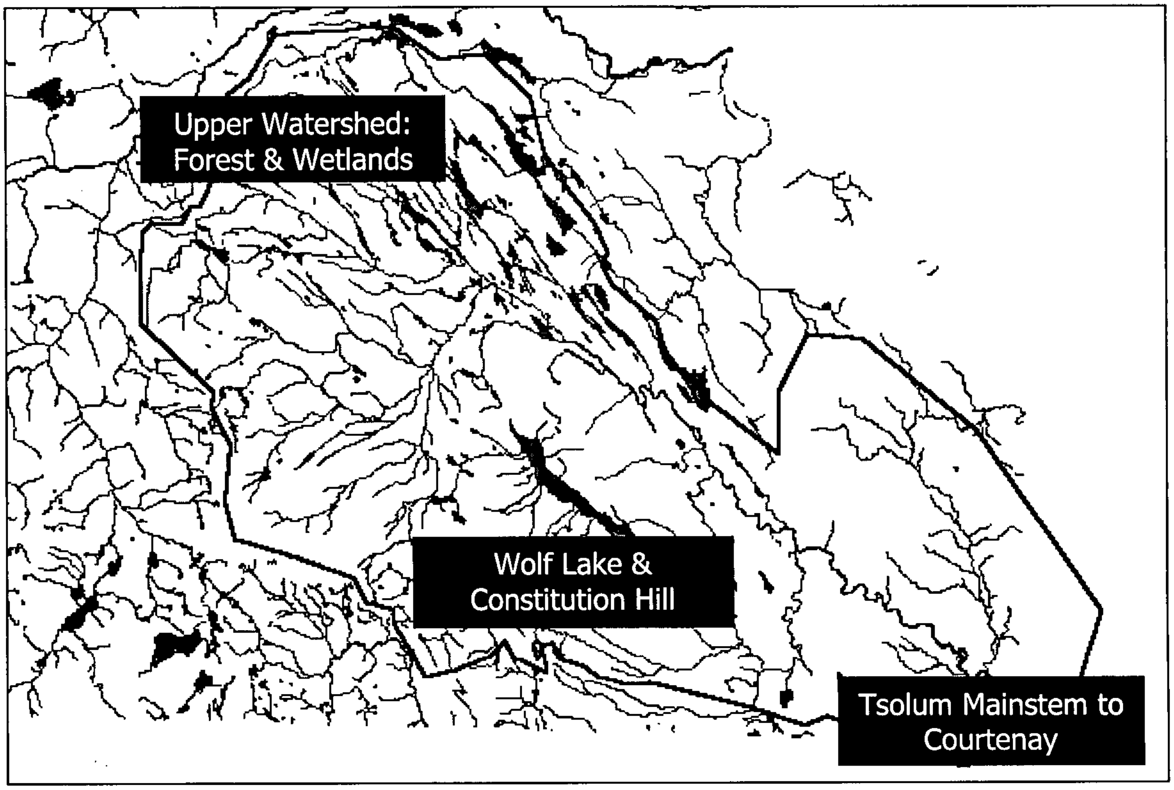

Figure 3. 2 The Tsolum River Watershed, Vancouver Island

Historical Context: Tsolum River

Once the Tsolum River supported a substantial (100,000+) run of Pink salmon; Coho salmon and Steelhead trout were also abundant. Soon after the first European settlers came to the Comox Valley in 1862, fish habitat degradation occurred due to gravel dredging, and scouring caused by log transport. As clearcut logging intensified in the 1950's, maximum flows increased to double what they had been in 1916. Increased siltation smothered salmon redds (underwater gravel spawning nests) and reduced invertebrate populations, on which salmonids depend for food. At times of low flow in the summers, the water was very warm and low in dissolved oxygen.

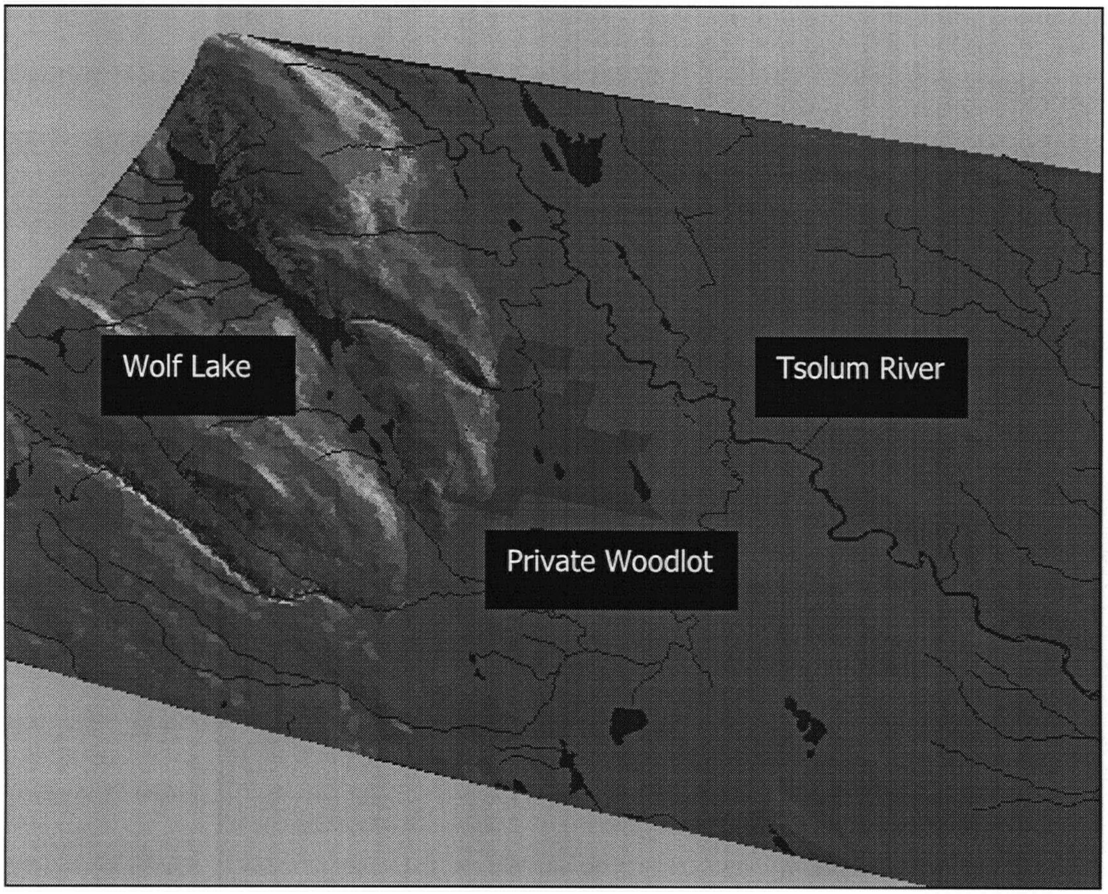

Figure 3. 3 Terrain Model of the Study Area

The Tsolum River is a source of water for domestic and agricultural use. Fourteen registered domestic and twenty-four irrigation licences on the Tsolum have contributed to very low base flows between July and October. Loss of riparian vegetation due to agriculture has also contributed to this problem. Acid mine drainage and heavy metal contamination from an abandoned mine on Mt. Washington continue to effect water quality adversely.

The Wolf Lake –Headquarters Creek Study Area

The study area (Figure 3.3) is located downstream of the Tsolum River's upper watershed, a forested area with numerous wetlands and a long history of logging activity. Wolf Lake's drainage into Headquarters Creek is controlled in order to augment low summer base flows. Much of the forest in the area is owned by TimberWest Forest Corporation, the largest owner of private forest lands in western Canada. However, a large private woodlot is located to the Southeast of Constitution Hill, and encompasses a significant portion of the study area. Headquarters Creek meets Joshua Creek before bending North and entering the Tsolum River.

A fish hatchery is located on Headquarters Creek, shortly before its confluence with the Tsolum. In recent years, Headquarters Creek has been stocked with Coho, Chum, & Pink salmon, as well as Cutthroat trout and Steelhead. Small–scale habitat enhancement and restoration projects have contributed to the population recovery process. Dove Creek and Pup Creek, the Tsolum's other tributaries in the study area, also support salmon populations.

4. Planning Process and Results

As stated in the introduction, the Tsolum River Restoration Society had expressed an interest in developing an interpretive trail system, based at an ecology-centre facility, to link their salmon habitat enhancement and restoration sites and explain them to the public. From this idea, the project's scope was expanded by the author, based on the rationale that the trail planning should encompass a broader program. Public trail development opportunities are rare, so the system should achieve the Society's goals, while providing an enjoyable recreational experience; accessing outstanding cultural and natural features; linking to other routes or trails; and providing an aesthetic experience.

This latter goal encompasses not only scenic opportunities (such as views to mountains), but the ecological aesthetic experience, as described above. Utilitarian land uses in the study area include industrial forestry, a massive electric power corridor, and most recently, a major highway. It was felt that attention should be drawn to the area's ecology, not only for aesthetic appreciation, but to help ensure its future health in the context of multiple competing land uses. In order to ensure that the trail planning could achieve all of these objectives, a detailed study of area's ecology was required. Suitability analysis (described below) was the method chosen in order to organize and analyze all of the data.

Background: Suitability Analysis

Suitability analysis assumes that "the ability of the landscape to support a particular land use varies according to the physical, biological, and cultural resources that are distributed over a geographical area" (Ndubisi 2002). By understanding the distribution and interactions of these resources, it is possible to determine the optimal locations for a given land use, while minimizing environmental impacts of development. "The output of a land suitability analysis is a set of maps, one for each land use, showing which level of suitability characterizes each parcel of land. This output requirement leads directly to two necessary components of any method: 1) a procedure for identifying parcels of land that are homogenous and 2) a procedure for rating these parcels with respect to suitability for each land use" (Hopkins, as cited in Ndubisi 2002).

Landscape – Unit and Landscape classification methods

Hills argued that ecosystems should be the basic unit for understanding and analyzing landscapes: "In landscape [ecological] planning, it is useful to conceive of ecosystems as 'production systems' whether the production is biological from farm, forest or fishery ecosystems, or physiographic from mine, aquifer or energy developing ecosystems or societal cultural ecosystems" (Hills 1974, as cited in Ndubisi 2002). "Hills proposed that the basic unit for understanding landscapes is the site type, derived from the congruence of those features of the landscape that in their interactions control production" (Ndubisi 2002). The biotic site type – biotic communities of plants and animals – is one form of this basic unit. The biotic site type, as determined based on mapping of dominant plant communities, is the method used in this project to define ecological land units.

Process Overview

The study area, loosely described as the middle watershed of the Tsolum River, was selected based on a procedure described by Hellemund (1993). Part of the proposed trail's purpose is to access various destinations or "nodes" in the area. Hellemund's method calls for the mapping of nodes and the study area's landscape structure – matrix, patches and corridors – and assessment of the resulting map for greenway suitability. This basic idea was refined, resulting in the division of the study area into ecological land units, based on ecosystem type. An aesthetic assessment, based on

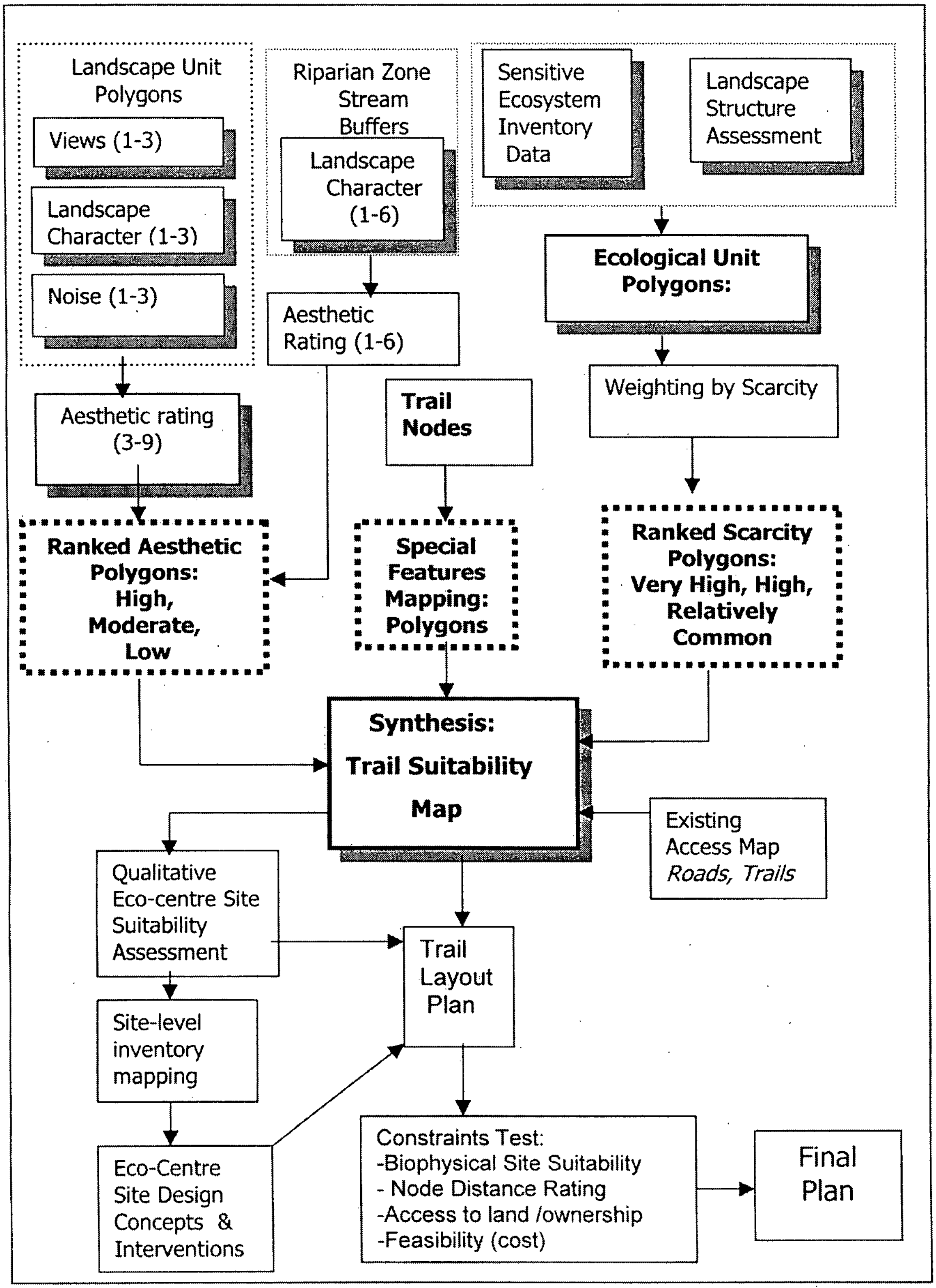

Figure 4. 1 Process Flowchart

criteria specific to recreational trail development was also conducted, resulting in aesthetic unit mapping and rating for trail suitability. This suitability analysis incorporated existing inventory data as well as original (primary) data.

These three factors - nodes, aesthetic units, and ecological land units – are the basic units considered essential to the planning process for trail siting and eco-centre location. Other possible factors, such as cost, feasibility, and risks to environmentally sensitive areas, are site-specific and require detailed assessment beyond the scope of this study. It was felt that a broad, conceptual approach to planning was first required, elements of which could be evaluated in a methodical, phased way, upon their acceptance by the stakeholders.

Finally the suitability analysis results were synthesised with the help of the GIS, in order to determine the best trail layout and eco-centre location. The planning process is summarized in Figure 4.1; each step is discussed below.

Process: Study Area Delineation

Node and Trail Programming

Nodes formed the basis for delineation of the study area. Identification of possible nodes began with site visits and discussions with Jack Minard of the Tsolum River Restoration Society. The proposed key uses of these nodes are the interpretation of natural and cultural history, and wildlife observation (including salmon, bears, birds of prey, beavers, mink, and more).

A number of criteria were established for determining possible nodes:

- Educational opportunities (both ecological and cultural)
- Experiential quality
- Views to external features
- Landscape Character: Coherence/ Legibility/ Complexity/ Mystery
- Political / ownership constraints and opportunities
- Linkages to parks, trails, roads
- Infrastructure constraints/opportunities

Discussions with Jack Minard also contributed to the program of intended activities and associated requirements for these nodes, and for the trail that would connect them:

Program: Enhancement Sites and Nodes of Interest

- Revealing and explaining habitat enhancement and restoration work
- Revealing and explaining the ecological value and condition of the sites
- Interpretation of cultural/historical interest
- Viewing of migrating / spawning salmon (seasonal)

Program: Trails

- Hiking, bicycling, horse access
- Exploration, from the eco-centre base
- Educational opportunities (both ecological and cultural)
- Views; sensory engagement

- Signage, way finding: posted maps
- Bridging of watercourses
- Boardwalk when wet areas are unavoidable
- Access to fish habitat enhancement sites and other nodes
- Links to Tsolum Spirit Park (at the confluence of Dove Creek & the Tsolum River), and the proposed "One-spot Trail" (the historic Comox Railway Bed, east of the Tsolum River)

A GIS database was assembled showing the location of the nodes, overlaid on a base map of 20-metre T.R.I.M. contour data. Black & White 1m-pixel orthophotographs of the area, taken in 1999, were added to the database. Nodes were mapped using the above programming criteria.

Once the possible nodes were mapped, other distinct landscape elements that were potentially suitable for or relevant to trail development were identified. These included linear landscape elements such as corridors, and areas already protected or used for recreation. To identify a potential study area, a generous boundary was drawn around the attractive areas, extending out to a topographic feature or other landscape element that formed a significant barrier. Areas were eliminated from consideration as part of the study area if it was felt they presented significant constraints, and no opportunities for a trail with the given goals. In this case, the Tsolum River and its tributary Dove Creek formed the eastern and southern boundaries of the area. The barrier formed by Highway 19 represented the western boundary, defining the study area in a roughly triangular form over 1,000 hectares in size (Figure 4.2).

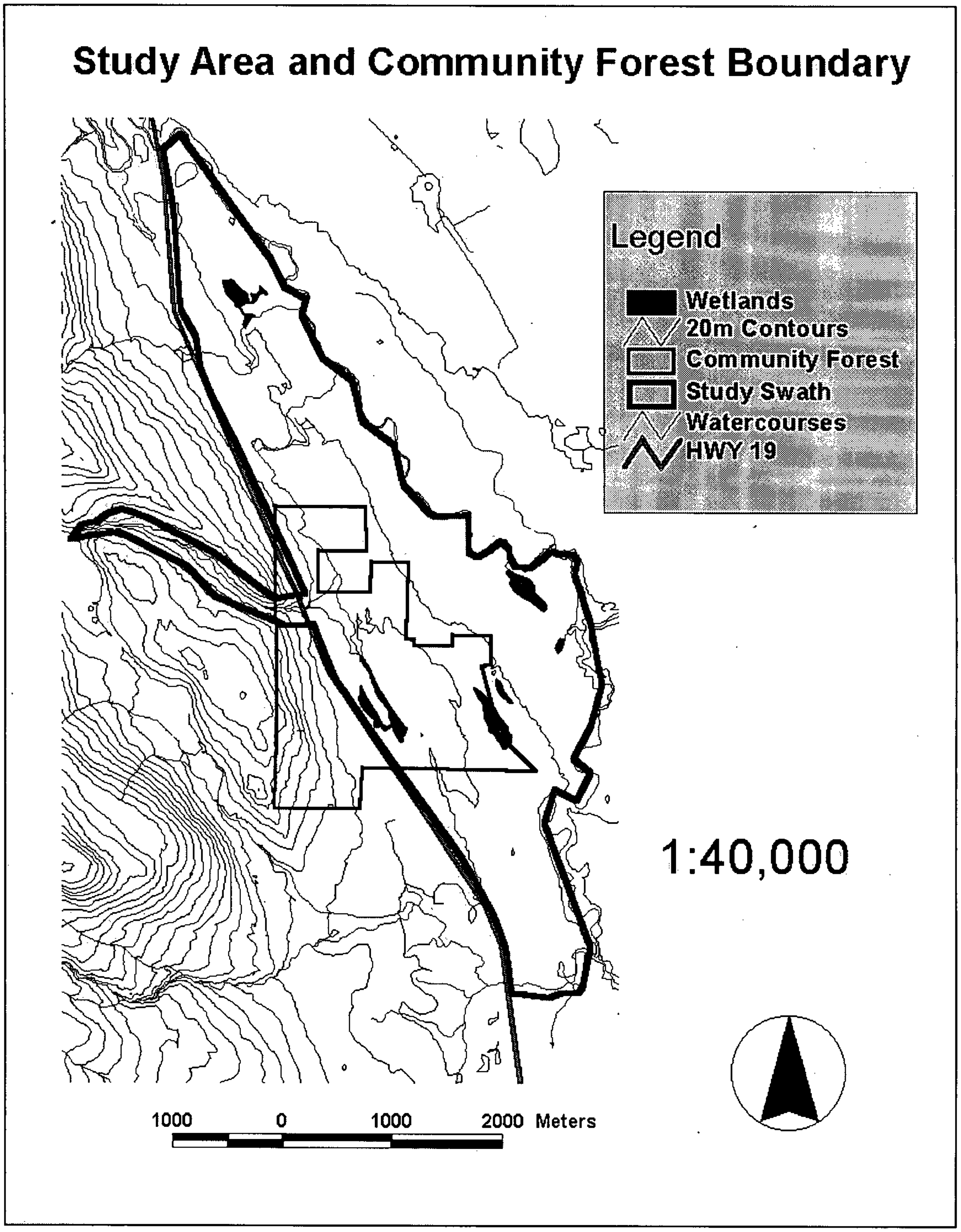

Figure 4. 2 Study Area Boundary

Since the highway corridor can be traversed on foot by walking beneath the Headquarters Creek bridge, and the Wolf Lake Dam represents a major node, the study area was extended under the bridge and up the creek corridor to the Wolf Lake Dam node. "Gateways", or entry points to the study area, were also identified based on orthophoto and map interpretation, and field visits. These represent key intersections where the study area can be accessed by existing roads and trails, as well as bridges over watercourses that form study area boundaries.

Node Descriptions

- Milman Wetland. A restoration project of the Tsolum River Restoraton Society. Beaver damming had recently been breached, draining the wetland. The breach has been repaired and a fry passage weir added, restoring the wetland as habitat for salmon, as well as a wide variety of wildlife species.

- Wolf Lake Dam. Wolf Lake, a fishing and informal camping destination, has long been dammed to aid a log sort operation. In recent years the dam has been improved, and Wolf Lake serves a valuable function as a reservoir, augmenting summer low flows in the Tsolum River. It was chosen as a node due to its wildland character, its scenic beauty, and historic remnant log sort pilings. The dam node links the trail system to existing logging roads, leading to the visually impressive slopes of Constitution Hill.

- Pup Creek beaver ponds. Beaver damming has created ponds, ideal for salmon rearing. This area can be easily accessed by exiting roads and trails through the hydro corridor. There is a small existing bridge over Pup Creek, and an outstanding view of Constitution Hill.

- Headquarters Creek / Joshua Creek confluence site. This diverse area was chosen as the preferred eco-centre site. It is discussed in detail in the Site Inventory section.

- Low-flow rearing channel. A salmon habitat enhancement project by the Tsolum River Restoration Society, located in the BC Hydro access. A winding channel was created in a wet shrubby area, and a fry passage weir and Large Organic Debris were added. Good opportunities exist for birding in this open area.

- Waterfall on Headquarters Creek. A scenic waterfall about twenty minutes' hike upstream from the Highway 19 bridge.

- Old Sawmill ruin and existing trail. On Farnham Road, at the bridge over the Tsolum River, is the shell of a former sawmill built in the early 1900's. The building has an interesting history in that it was part of the former town of Headquarters, and was fully equipped but never used. Starting at the sawmill, an existing trail winds along the Tsolum mainstem and connects to Headquarters Road.

- Fish Hatchery & Headquarters Creek Access Trail. The hatchery has a small existing building and fish rearing structures. A short trail leads to Headquarters Creek, where the water can be accessed and salmon migration observed at a fish passage structure.

Process: Ecological Land Unit Inventory

The orthophotos were interpreted to define ecological land units, later refined through selective field ground-truthing. Units were defined based on the dominant type of vegetation and its generalized ecological stage. These units were digitized and displayed as polygons using Arcview GIS. The units were divided into the following categories:

- Clearcut - recently harvested, very young regenerating forest
- Forest 20-60 years old – includes both coniferous, deciduous and mixed forests
- Rural / residential – large and small farms, areas of low-density settlement
- Open cleared corridor - BC Hydro Right-of-Way, shrub and grass vegetation
- Tree plantation – a young deciduous plantation in rows
- "Scrub" area – open, shrubby vegetation, likely seasonally inundated, but differentiated from wetland ecosystems
- Young conifer forest – estimated age less than 20 years
- Young cottonwood forest – estimated age less than 20 years

Sensitive Ecosystem Inventory polygon data was obtained from the Canadian Wildlife Service. "The Sensitive Ecosystems Inventory (SEI) refers to the relatively unmodified, rare and fragile terrestrial ecosystem types identified for the [SEI] project...Sensitive ecosystems provide, within developed landscapes, patches of natural areas that have intrinsic value and are critical to the survival of many species" (McPhee et al. 2000.). Five types of sensitive ecosystems were identified in the study area; they are described in Table 4.1. The SEI polygon data was combined with the ecological land units discussed above, to result in a refined Ecological Land Units map (Figure 4.3).

Ecosystems	Ecosystem Description
Terrestrial Herbaceous	Mosaics of rare coastal grassland and/or moss-covered rock outcrops; typically occur as openings in forested areas.
Wetland	Wet soil and moisture-dependent plants; includes marsh, swamps, shallow water, wet meadow
Riparian	Floodplain vegetation in varying stages
Older Forest	Older than 100 years; coniferous, or mixed with broadleaf species
Older Second Growth Forest*	Larger stands of 60-100 year old forest; coniferous, or mixed with broadleaf component

*Not considered sensitive, but recognized as important due to biodiversity value

Table 4. 1 Sensitive Ecosystems identified in the study area

Process: Aesthetic Quality Inventory

Using the ecological units and site reconnaissance photography as a reference, polygons representing units of similar aesthetic and experiential quality were digitized. The following aesthetic quality criteria were used to define these landscape units:

- Views - to external mountain features, or observer-superior (elevated) views of surrounding landscape elements
- Landscape character - a gestalt assessment based on such elements as boundary definition; enclosure; land form; vegetation patterns; and human impacts (Litton 1974).
- Highway noise level - in general, this measurement is directly proportional to distance from the highway. At polygons bordering the highway, one experiences high noise levels; highway noise decreases gradually but is still audible at

polygons located 500-600m away. Further away than this, the noise is not audible.

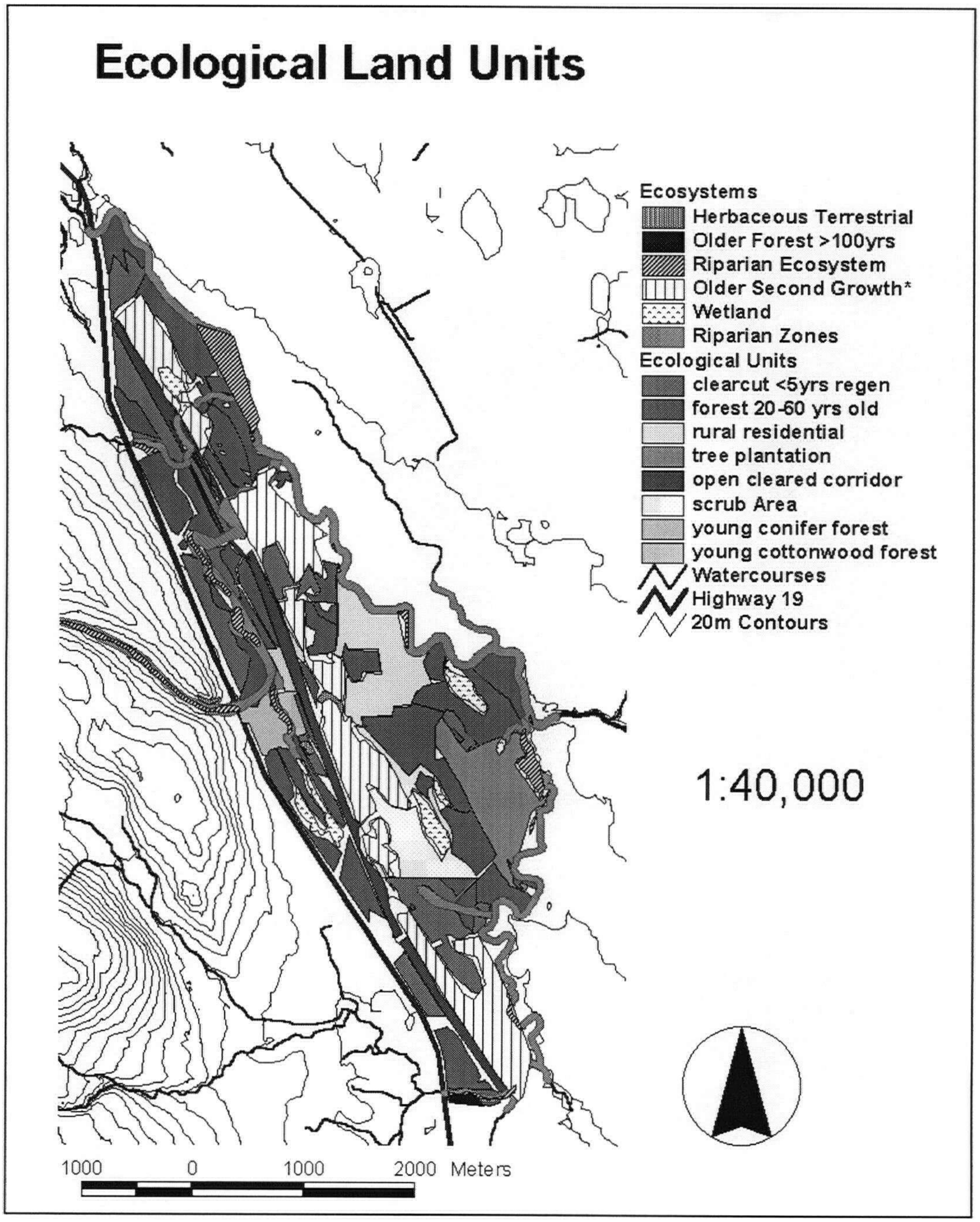

Figure 4. 3 Ecological Land Units

Each Landscape Unit was rated with a score of 1-3 for each of the above three criteria (1 = Low Suitability, 2 = Moderate Suitability, 3 = High Suitability). These three scores were added together, to result in one total aesthetic suitability score per unit, ranging from three to nine (3-5 = Low; 6-8 = Moderate; 7-9 =High). The results of this method, known as Ordinal Combination, represent the rating of each unit for aesthetic suitability for trail development.

Given their distinct character and central importance to the trail layout and eco-centre location, riparian zones were mapped by buffering all major watercourses with a 30-metre setback on both sides of the channel. The 30-metre figure was based on orthophoto assessment, which revealed that much of the existing streamside vegetation had already been limited to this width through adjacent clearing. A field-based, qualitative, gestalt assessment of overall aesthetic suitability for trail development was conducted for these riparian zones, based on the following criteria:

- Enclosure – trees and shore-edge plants form the major space definition, sometimes in combination with high, steep banks
- Spatial expression – sinuosity represents variety and higher quality
- Water movement – an exciting and vivid quality in faster flowing streams
- Water appearance – a composite factor of its visual interest, clarity and colour, and its capacity to reflect light, or other features

The above criteria were based on a study by Litton (1974). The riparian unit rating for aesthetic quality ranged from 1 (lowest suitability) to 6 (highest suitability). When displayed in a GIS environment, the scores were classified as follows:

1-2 = Low Suitability;

3-4 = Moderate Suitability;

5-6 = High Suitability

Despite the fact that the maximum riparian unit quality score is six (as opposed to the landscape unit maximum score of nine), this does not imply that the riparian units are of lesser quality. The classifications (low/medium/high) are used as the ultimate rating of aesthetic quality, and these appear on the resulting map (Figure 4.4) using the same colour scheme for both types of aesthetic rating. In general, overlap between the two aesthetic systems has been avoided, but in areas of minor overlap, the rating for the riparian zone dominates the underlying unit.

Process: Ecosystem Scarcity Index

Because interpretation of regional and local ecology is such a central theme of the trail system, it was felt that the trail should afford opportunities for experiencing rare or locally significant ecosystems whenever possible. For this reason, the relative scarcity of ecological unit polygons in the study area was determined, and used as criterion to be noted in the trail planning process. This helped to ensure that the trail system could encounter the maximum diversity of habitats. The final results of the scarcity index were displayed on the synthesis map (Figure 4.5) and used in a qualitative way to guide the trail layout.

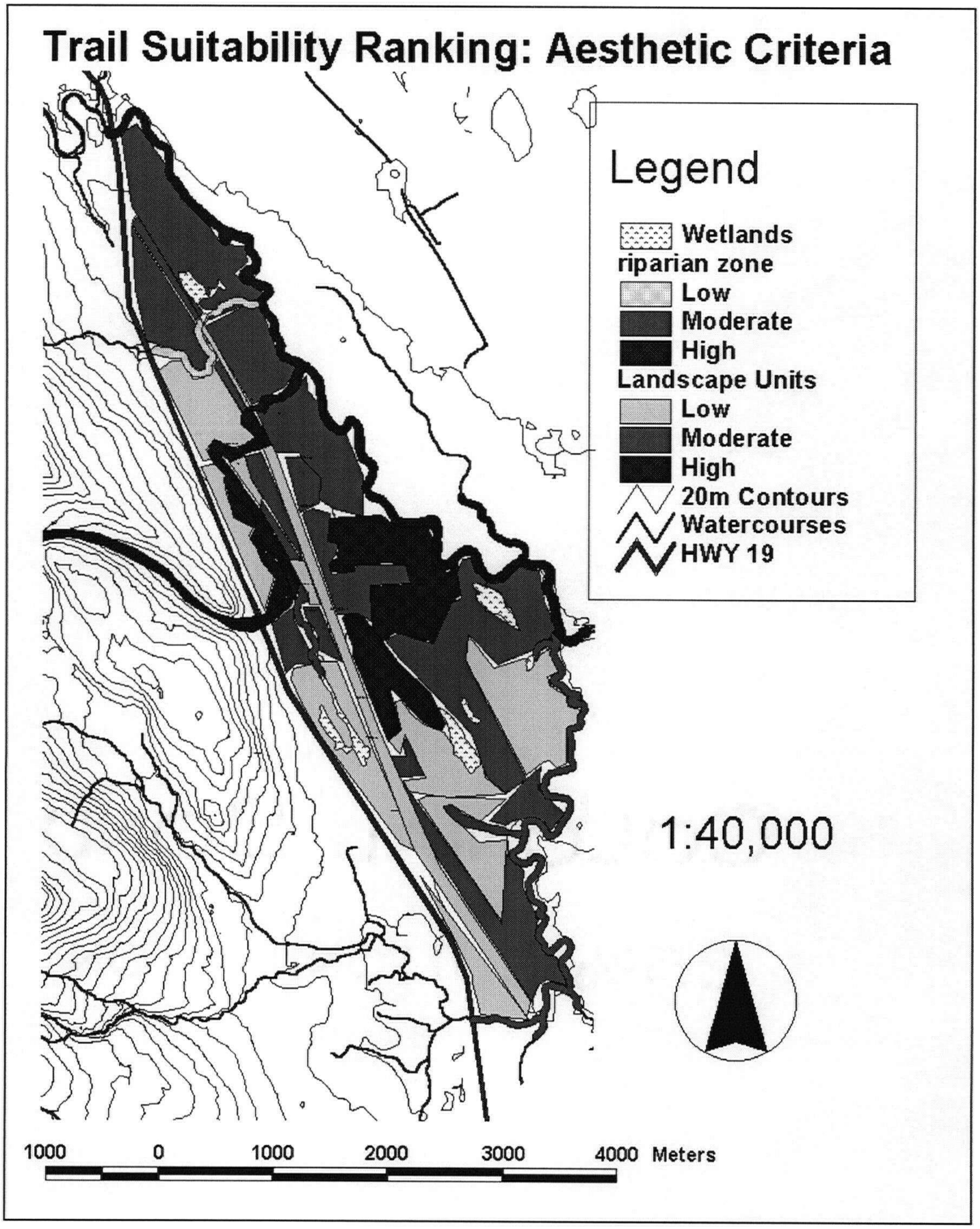

Figure 4. 4 Trail Suitability Ranking: Aesthetic Criteria

The areas of individual Sensitive Ecosystem Inventory polygons in the study area were calculated using Arcview. The total area of each sensitive ecosystem polygon type (e.g.

Wetland) was then determined. It was found that each of the ecosystem types (excluding Older Second Growth) individually amounted to less than 5% of the study area, and some totalled less than 3% of the study area. The same procedure was followed for the other types of Ecological Land Unit polygons, excluding only "Clearcut" and "Forest 20-60 yrs" (types that obviously totalled far more than 5% of the study area based on visual inspection of the size and frequency of polygons).

Based on the above procedure, all of the ecological unit types were rated and displayed in the following way:

- <3% of Study Area: Very High Scarcity
- 3-5% of Study Area: High Scarcity
- >5% of Study Area: Relatively Common

Process: Land Unit Synthesis

A synthesis map was prepared, using Arcview GIS to overlay the results of the Aesthetic Suitability Analysis with the Ecosystem Scarcity results, in order to visually identify the highest priority areas for trail location. The overlay is summarized in the following relationship:

Ecosystem Scarcity (Very High & High) + Aesthetic Suitability Ranking = Overall Priority. Those ecosystem polygons rated Very High and High [scarcity] were given coloured borders so they would be visible without obscuring the aesthetic rating's colour-coding. The resulting map (Figure 4.5) provided a data synthesis, useful for the design of possible trail layouts, and for determining the eco-centre site location.

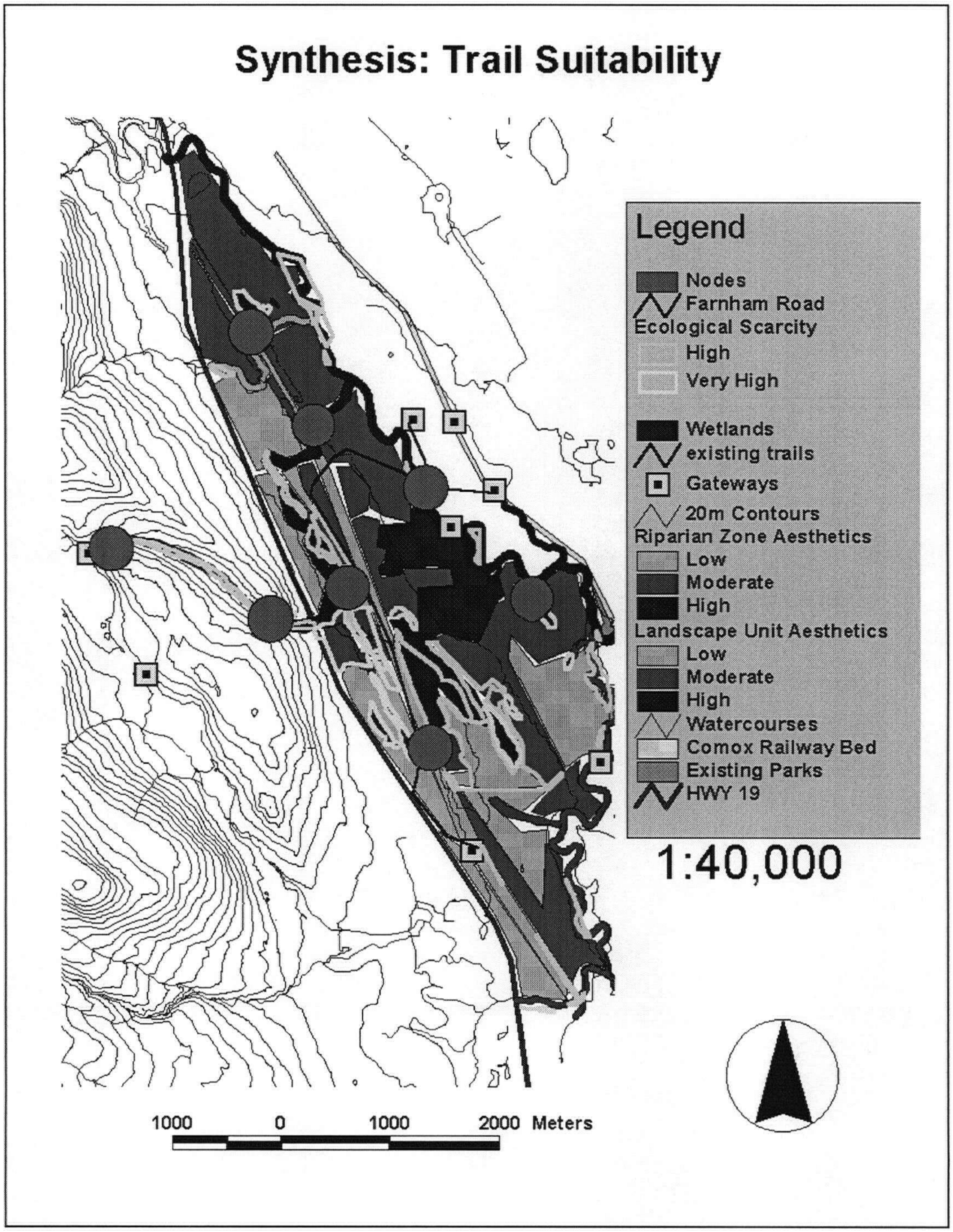

Figure 4. 5 Synthesis: Trail Suitability

The map provides the means to view the spatial relationship between the nodes, in the context of the aesthetic and ecological scarcity ratings. This made it possible to connect the nodes by trail, using the most suitable land units – those that had the highest aesthetic rating, and/or ecosystem scarcity.

A candidate site for the eco-centre (the Headquarters Creek – Joshua Creek confluence) was already being considered, and visual inspection of the synthesis map confirms the suitability of that location. The criteria for the selection of this site are as follows:

- Proximity to interesting / sensitive ecosystems including Joshua Creek and Headquarters Creek riparian areas; herbaceous terrestrial zones; older second growth; wetlands; Cottonwood forest; young conifer forest.
- High aesthetic quality and experiential quality due to numerous creek channels, forest diversity, wildland character
- Central location relative to other nodes
- One of two sites recommended by Jack Minard of the Tsolum Restoration society. The other, near the hatchery on Headquarters Creek, was investigated and, while also potentially suitable, is scheduled for clearcut logging in the near future.
- Numerous salmon spawning habitats, as identified by S.H.I.M. (Sensitive Habitat Inventory Mapping), providing viewing opportunities.
- Additional wildlife viewing opportunities: bears, eagles, mink, beaver, & riparian bird species.
- Ease of access: close to Farnham road; link to Highway 19 is only about 1km away.

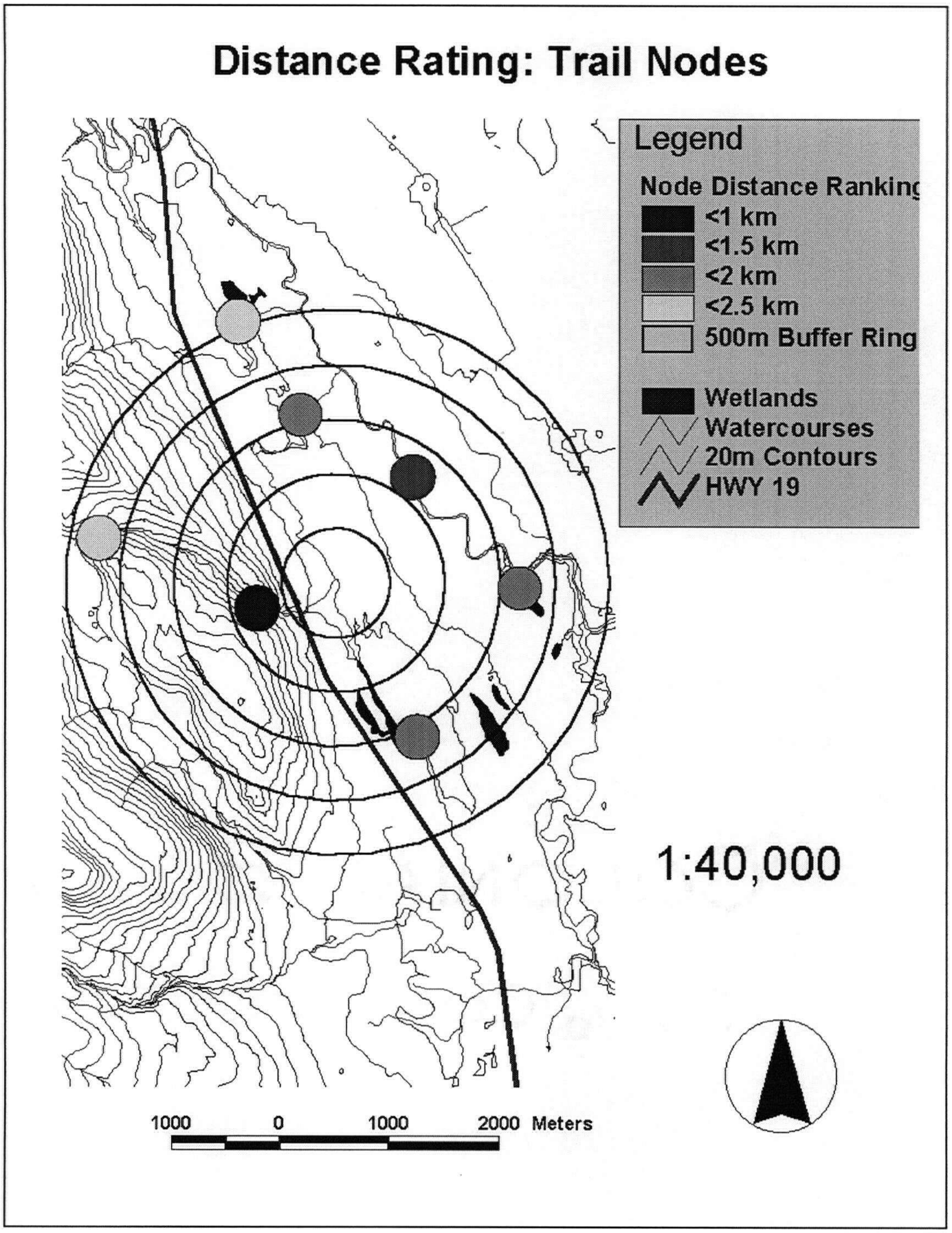

Figure 4. 6 Node Distance Rating

Process: Node Distance Rating

In order to further assess the suitability of the eco-centre location, the approximate distance from each node to the confluence site was measured using ArcView GIS. Lusk (2001) states that on a 3-10 km greenway, the number of preferred destinations is 3 to 4. If the predominant users are walkers, the destinations could be between 1 to 3.2 km apart. The node distance rating (Figure 4.6) shows that all of the nodes are within 2.5 km (measuring "as the crow flies") of the eco-centre site.

Process: Trail layout

Once the synthesis map had been created, a trail layout was digitized in Arcview by connecting the nodes to the eco-centre site and to each other, via the highest-rated suitability polygons (Figure 4.7). The layout also accesses those polygons with high / very high ecological scarcity. Several loop trails are possible, connecting to multiple nodes; the shortest of these loops is about 3.5 km long; there are several possible loops in the 5 km range. A loop encompassing most of the study area is possible; the distance is over 12 km. Some of these trails would be suitable for mountain-biking and horseback riding, however these uses are not encouraged on the core "eco-centre" area trails. The potential for conflict with other trail users in this area is high, and there is a significant amount of sensitive riparian and spawning habitat that could be in danger without controls. In addition, the trail to Wolf Lake Dam is probably not suitable for horses, due to its elevation gain. Motorized vehicles are not suitable for this trail system, due to the sensitivity of many of the ecosystems, and the potential for conflict with other users.

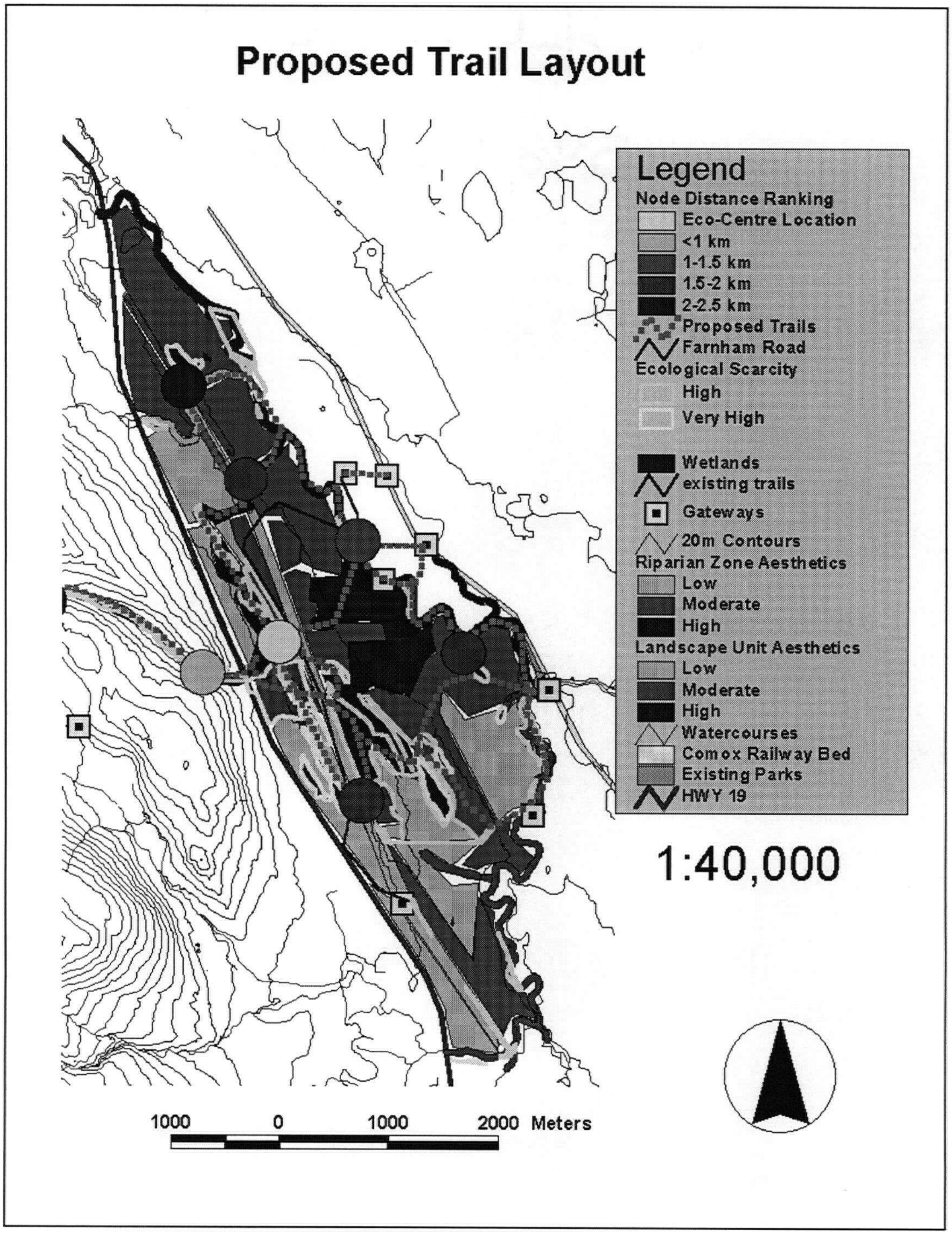

Figure 4. 7 Proposed Trail Layout

Links to existing trails and roads are achieved in the following locations (Gateways on Figure 4.7):

- "Headquarters Sawmill Trail" - a node location, described above
- Proposed "One-spot Trail" – utilizing the former Comox Railway Bed
- Existing "Tsolum Spirit" Park – at confluence of the Tsolum River and Dove Creek
- Existing Bridge over Dove Creek – on Dove Creek Road
- Wolf Lake Logging Road Access – roads can be accessed at the dam, linking the trail user to a long network of roads leading into the upper Tsolum watershed

5. Eco-Centre Design Process and Results

This section describes the design process leading to master planning and design details for the proposed eco-centre.

Site Inventory

Sensitive Habitat Inventory Mapping (S.H.I.M.), done in 1999, was accessed using an online G.I.S. system available through the S.H.I.M. website. This data consisted of numerous cross section points on Headquarters Creek and Joshua Creek. Each cross-section describes: the dominant vegetation type for 50 meters in either direction from the channel; channel wetted width and depth; bank slopes; and substrate material. Special features such as beaver dams, log jams, and side channels are also noted. This data was extremely valuable in understanding the site's ecology and the nature of the two channels and their tributaries.

The numerical S.H.I.M. cross-section data was combined with orthophoto interpretation, SEI data (Riparian), and G.I.S. base information to construct a hand-rendered graphic site inventory (Figure 5.1). The Sensitive Ecosystems Inventory classifies Riparian ecosystems into seven structural stages of vegetation based on age and structure of dominant vegetation. The inventory revealed a mature riparian ecosystem at Joshua Creek (SEI Riparian stage 6: mature coniferous-deciduous forest). The dominant tree species appears to be red alder, with conifers such as western redcedar in canopy gaps.

From this inventory, candidate areas for nature interpretation, the precise eco- centre location, parking, and possible creek crossings were determined and overlaid on a Conceptual Diagram (Figure 5.2). The inventory results, in combination with the site program (described next) and overall project goals, informed the site master plan (Figure 5.3).

Design Program: Eco-centre

The design program is intended to meet the following requirements:

- Learning about the natural history of the site and the surrounding watershed (in the spirit of the Ecological Aesthetic)
- Site exploration by trail: engagement of the senses, and immersion into the site's wildland character
- A starting point for longer hikes into the surrounding landscape
- Wooden, roofed shelter structure: A gathering place for education, meetings, presentations; seating for approximately 30
- Interpretive signage

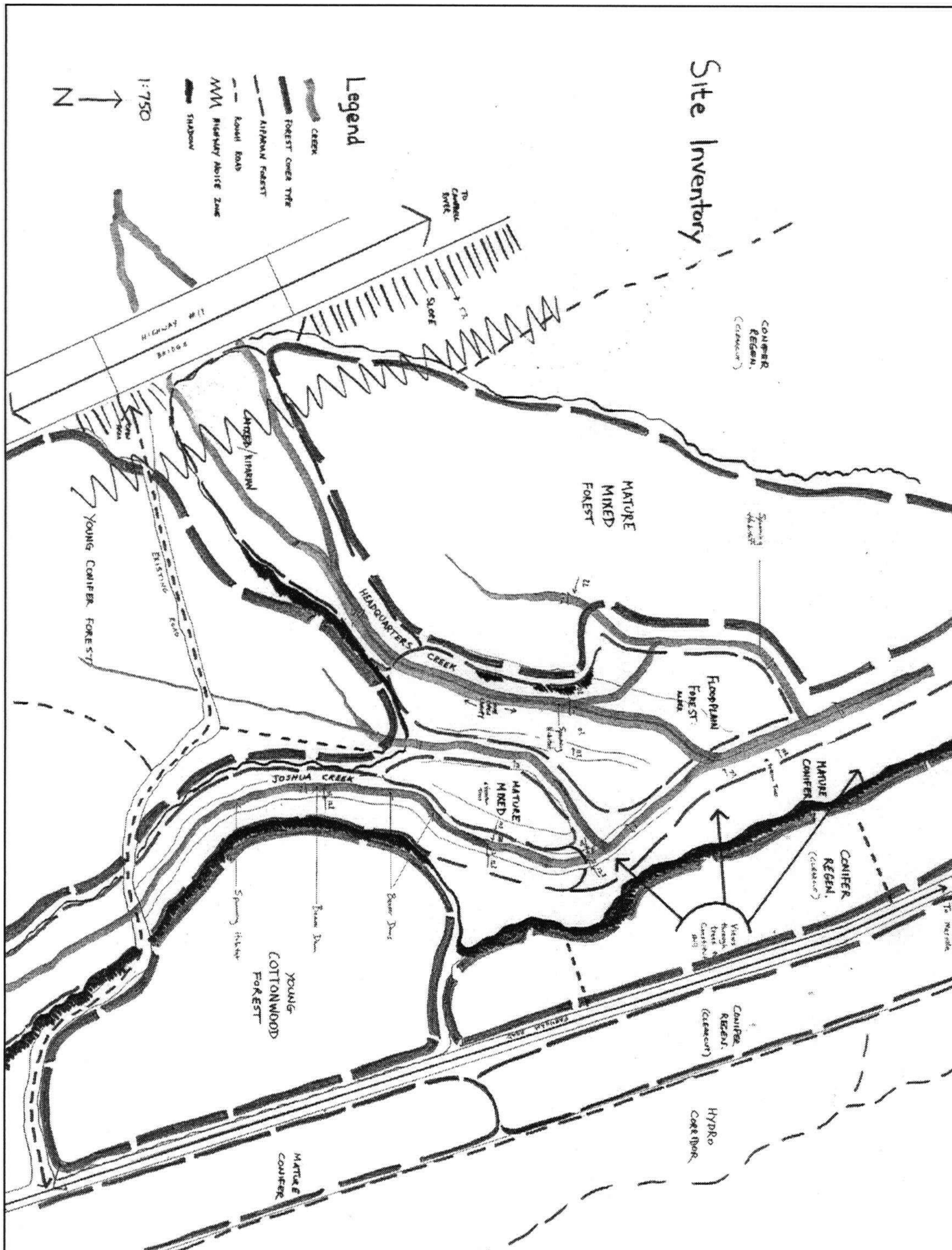

Figure 5. 1 Site Inventory

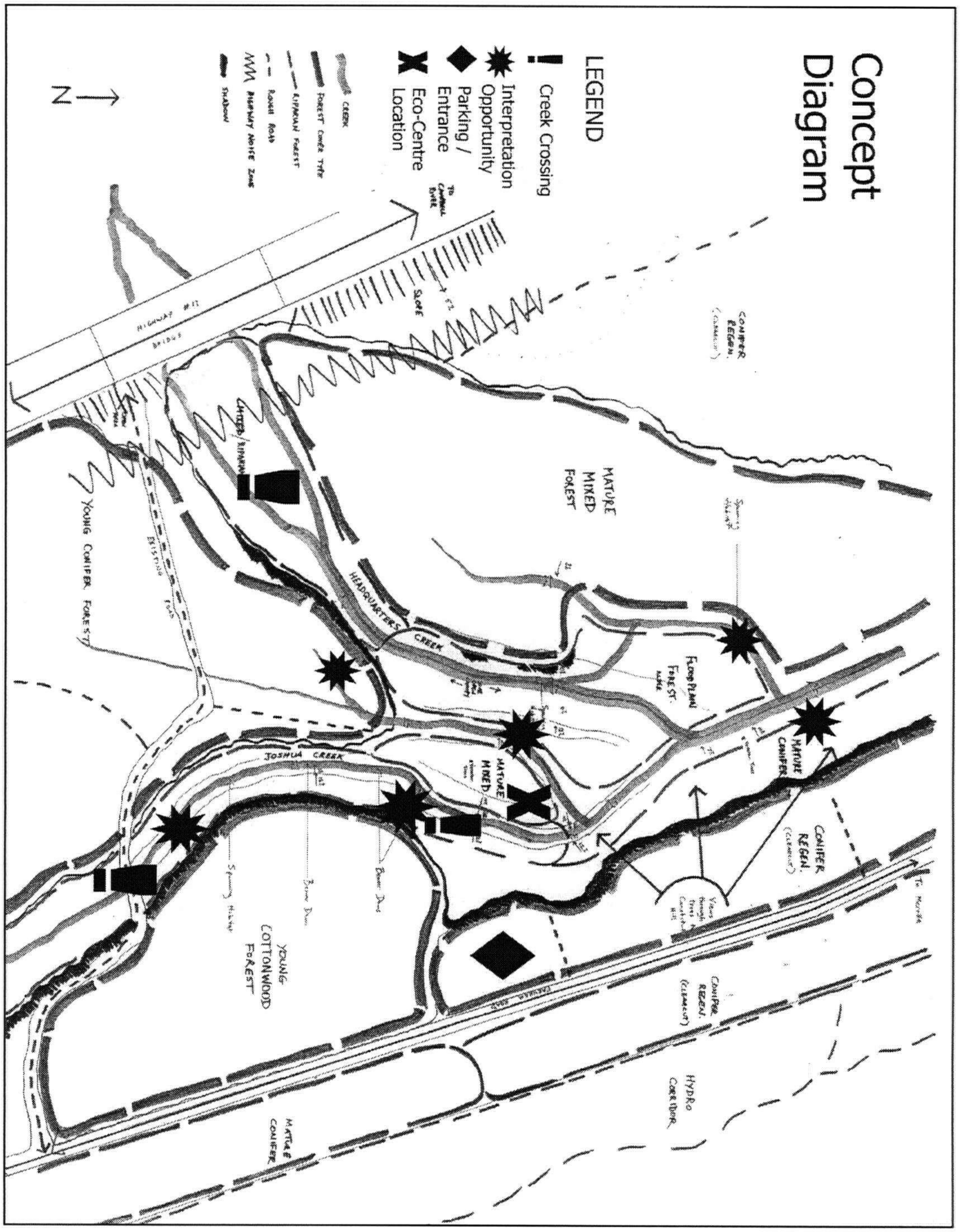

Figure 5. 2 Site Concept Diagram

- Facilities for river observation and seasonal observation of spawning salmon
- Wildlife viewing
- Restrooms / pit toilets
- Parking for 20 cars
- Service vehicle access

The proposed eco-centre is located on the point of land between Joshua Creek and Headquarters Creek (Figure 5.1). The rationale for siting the eco-centre in its position on the plan is as follows:

1. Overlooking the confluence of two channels, there are good creek viewing opportunities due to the relatively open canopy.
2. The location is a stable, upland area; the Headquarters Creek floodplain (to the west) is too low-lying, unstable and sensitive.
3. The forest character - a mature mixed forest with veteran trees – provides opportunities for wildlife viewing, and is aesthetically appealing.
4. A short hike, with creek crossing, is required to get to the centre from the parking lot. This provides a sense of entrance, and experiential quality, before arrival, without entailing major expense.

Design Description

The master plan (Figure 5.2) contains a series of design elements (described next), which in combination provide the appropriate range of visitor experiences and user

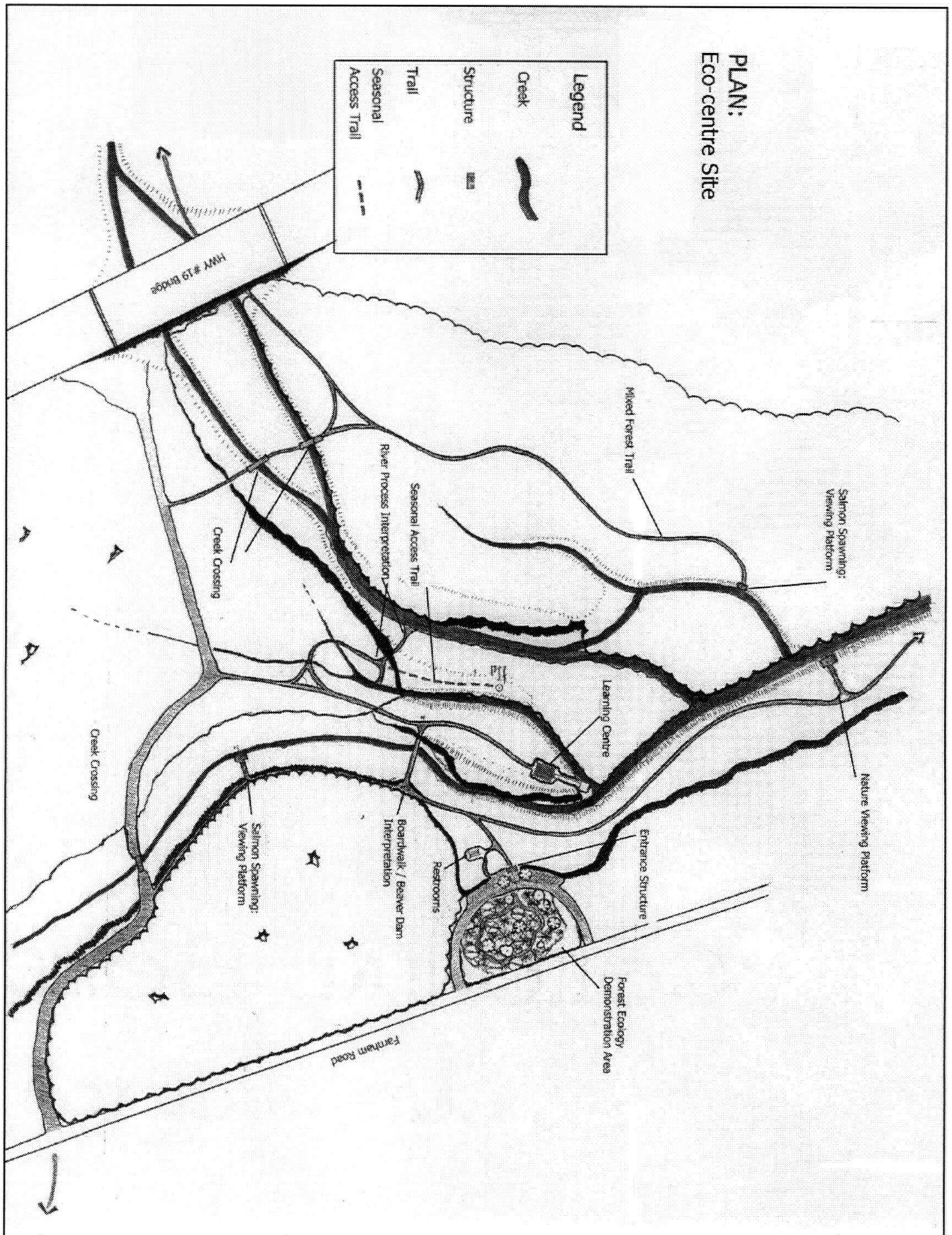

Figure 5. 3 Site Master Plan

needs. Figure 5.4 provides a more detailed plan of the central area, and Figure 5.5 diagrams the critical sequence and hierarchy of experiences and views encountered by users in the journey from the site entry to the eco-centre itself.

a) Site Access and Parking

The parking loop would be primarily entered from the south on Farnham Road, adjacent to the cottonwood forest. The crushed gravel road curves gradually to the parking areas, located at the base of a stand of mature Douglas fir trees. There is space for twenty vehicles in two separate pull-off parking areas. Restrooms are accessible directly from the parking area.

b) Entrance

The entrance structure is located between the two parking areas, set back to the border of the fir stand (Figure 5.6). The walk-through wood frame structure provides a clearly visible entrance to trail system and the whole site experience. There are also detailed way-finding maps and introductory interpretive information posted on the shelter.

c) Forest Ecology Demonstration Area

Immediately across from the entrance structure is the entrance to the Forest Ecology Demonstration Area. The vegetation in this area will grow and evolve over time, providing an opportunity to learn about forest ecology and succession. The area will re-establish the site's former forest association through varying stages of management. A trail winds through the young forest, with self-interpretive signs explaining the various stages of succession.

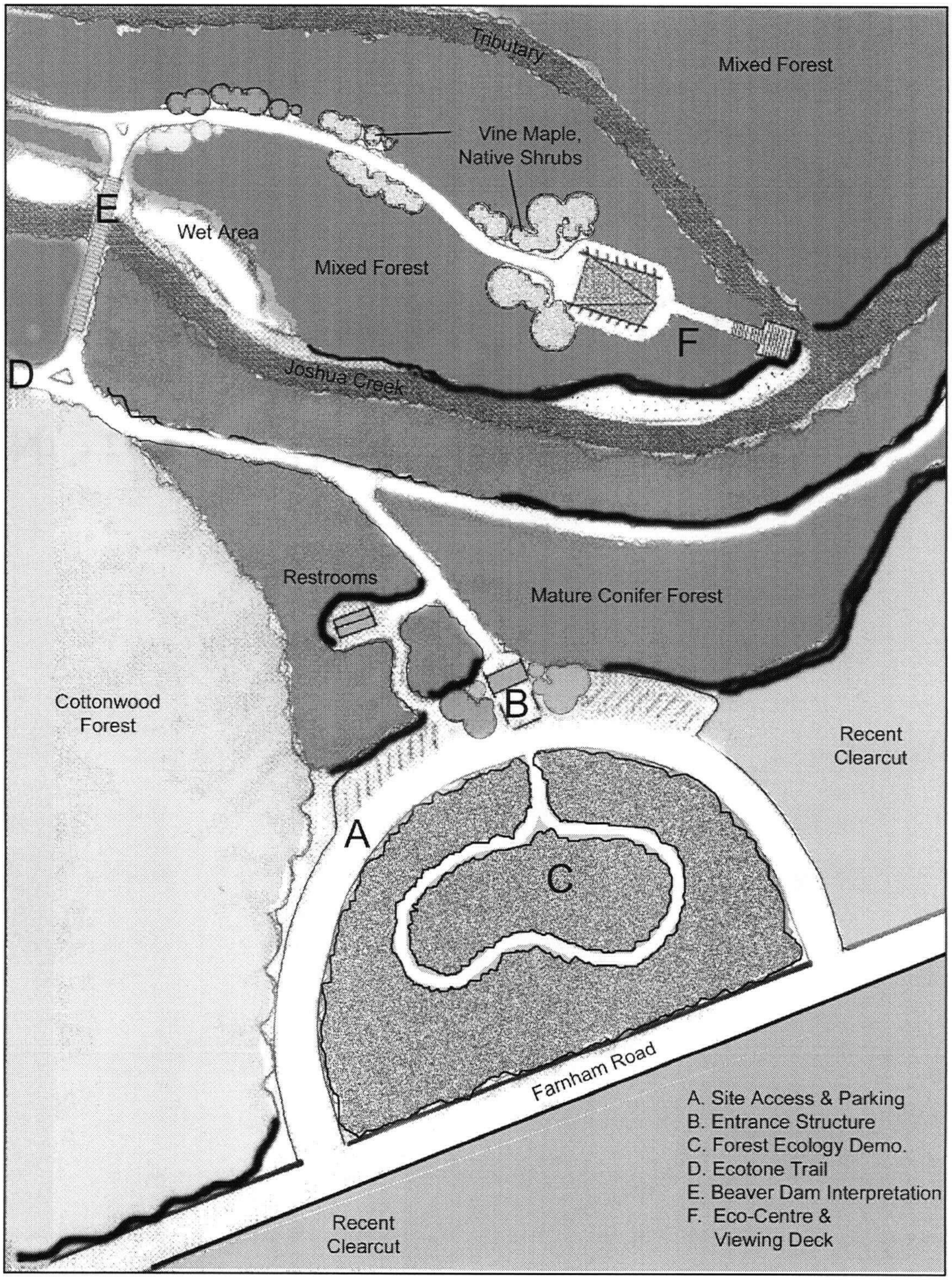

Figure 5. 4 Site Plan: Main Area

d) Cottonwood / Riparian Ecotone Trail

The main trail winds south through the Douglas fir stand and into an ecotone between the young Cottonwood stand and Joshua Creek's riparian forest. Shortly the boardwalk and bridge leading into the beaver dam interpretation area appears on the right as an option; though the trail also continues further south. Filtered views to the main destination of the eco-centre are maintained through the trees.

e) Beaver Dam Interpretation

The boardwalk crosses the wet, shallow-sloped riparian forest around Joshua Creek (Figure 5.7). Beaver dams and evidence of beaver activity are explained by interpretive signage with graphics. In this area the forest changes significantly due to the water levels; the canopy opens due the number of drowned trees.

f) Eco-centre & Viewing Deck

After crossing the boardwalk, the trail bends north and enters an older mixed forest stand, interspersed with veteran trees. A short hike through this mature forest leads to the open-sided, roofed learning centre structure (Figure 5.8). Inside are interpretive displays explaining the ecology of the site, with special attention to the role of the salmon as a keystone species in the ecosystem. Bench seating in the structure can accommodate groups of twenty or more (Figure 5.9). The structure is surrounded by forest, but opens up on the north side to a short trail leading to an elevated wooden viewing deck near the confluence of Joshua Creek and a tributary (Figure 5.10). The relatively open canopy here allows viewing of both streams and the surrounding alder forest, including Constitution Hill, just visible through the trees.

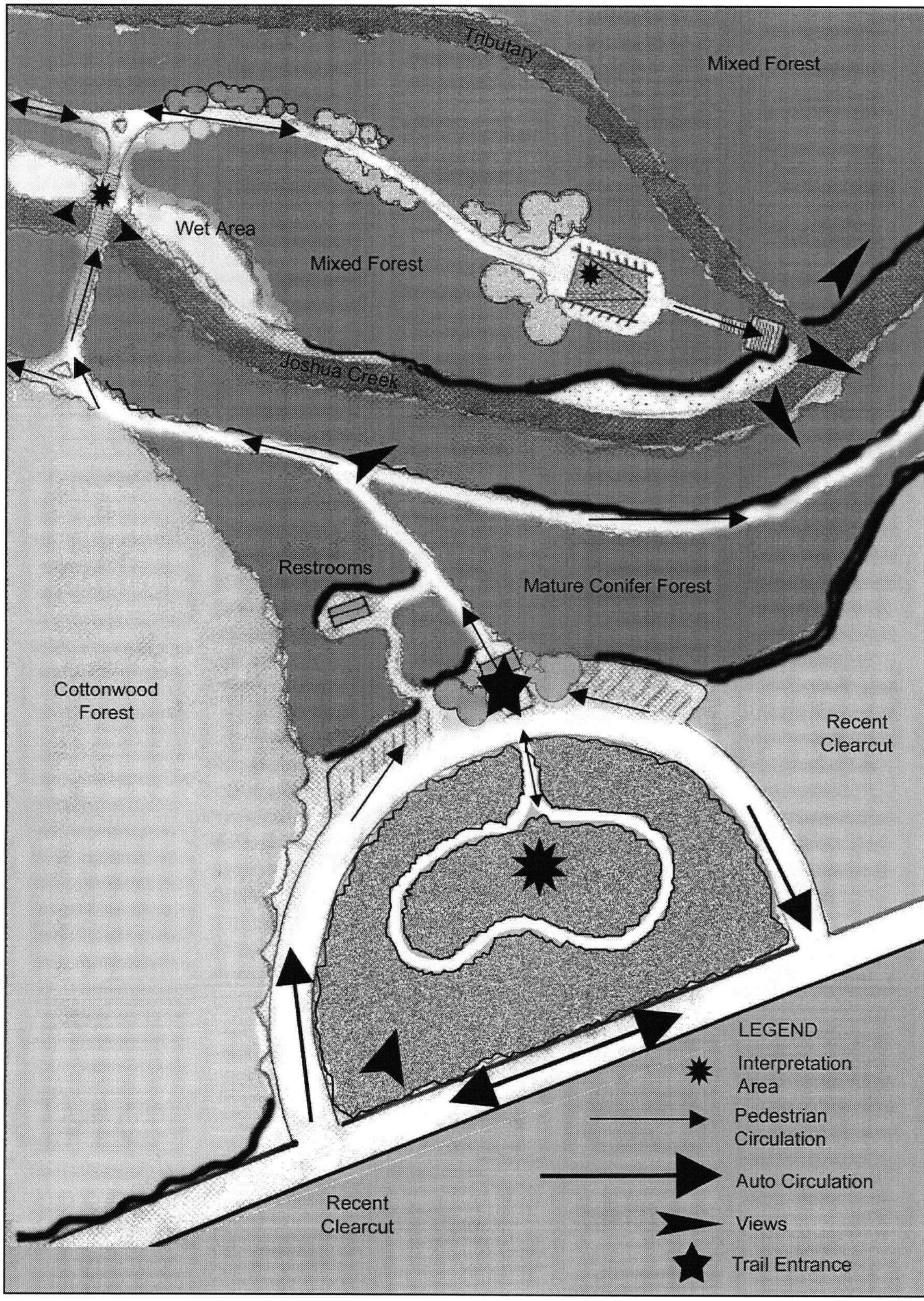

Figure 5. 5 Concept Diagram of Site Main Area

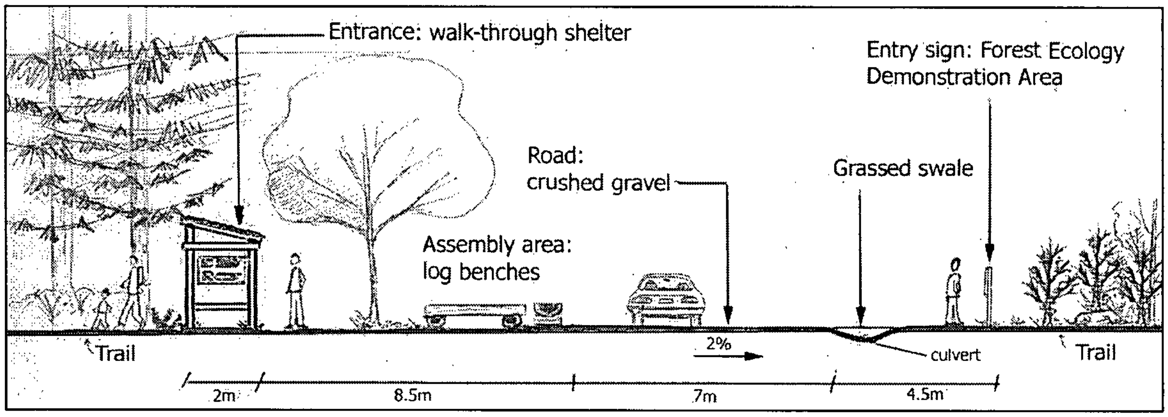

Figure 5. 6 Site Entrance North Elevation. Scale 1:200

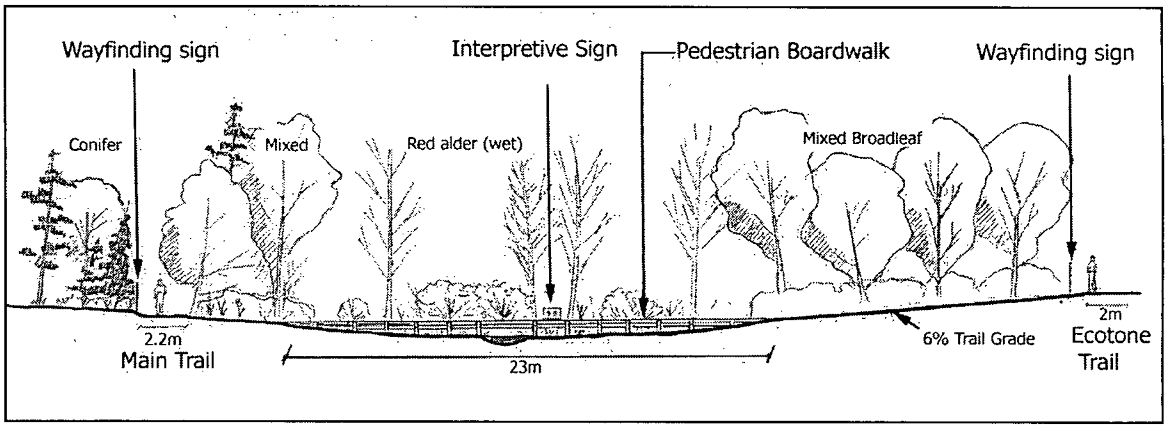

Figure 5. 7 Beaver Dam Interpretation Area North Elevation. Scale 1:400

g) Salmon Spawning Viewing Platforms

The trail enters the Joshua Creek riparian zone, a mature mixed forest with red alder and western redcedar. An open wood viewing deck (Figure 5.11) allows stream viewing and is the first opportunity to view the spawning salmon, and the wildlife that depend on the salmon carcasses.

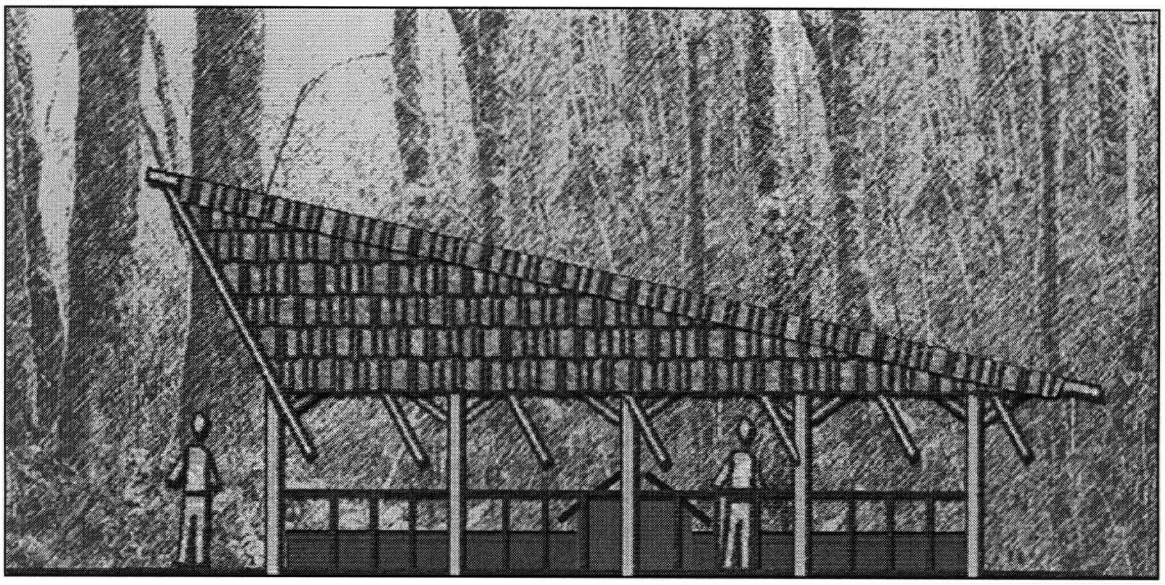

Figure 5. 8 Eco Centre East Elevation. Scale 1:125

h) North Viewing Platform

While most of the visitors are drawn to the southern points of interest upon arrival, an opportunity for quiet solitude exists to the north. A viewing platform on Headquarters Creek looks out over the water and into the serene floodplain red alder forest. The platform offers the chance to rest and enjoy the subtle beauty of the site, before continuing on the north trail towards other destinations, or returning to the entry area.

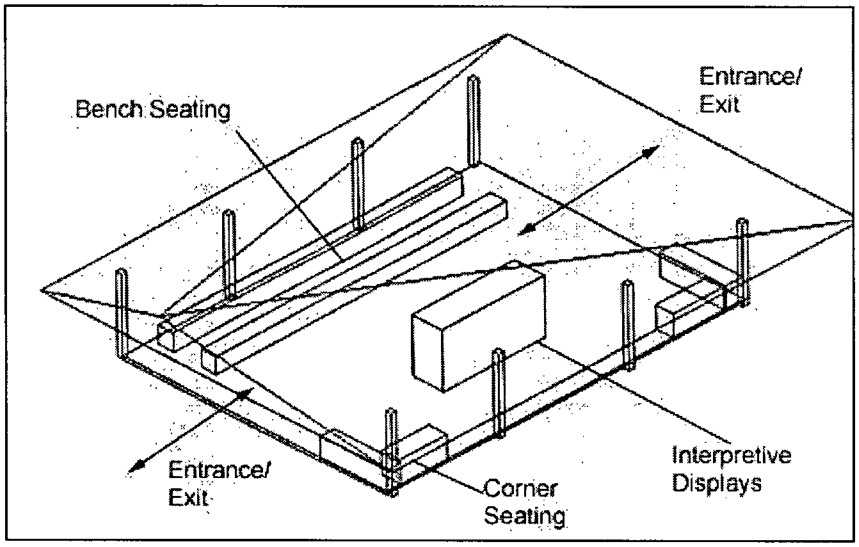

Figure 5. 9 Eco-Centre Axonometric Diagram. Scale 1:200

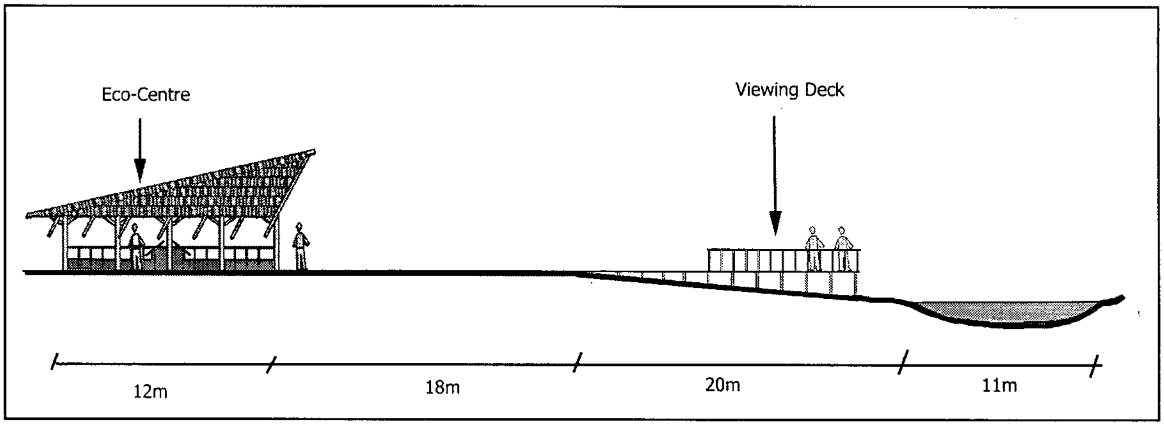

Figure 5. 10 Eco Centre and Viewing Deck East Elevation. Scale 1:400

i) "Logging Road Trail" and Connections

Further south, the trail meets an overgrown former logging road that winds west to Headquarters Creek through a young fir forest. After entering the creek's riparian zone, two separate crossings traverse the split channel. Then the trail forks, leading through the mixed forest to more spawning habitat to the north; or under the huge span of the Highway 19 bridge to head upstream. The trail gains elevation as it parallels the creek, stopping at a waterfall before reaching Wolf Lake.

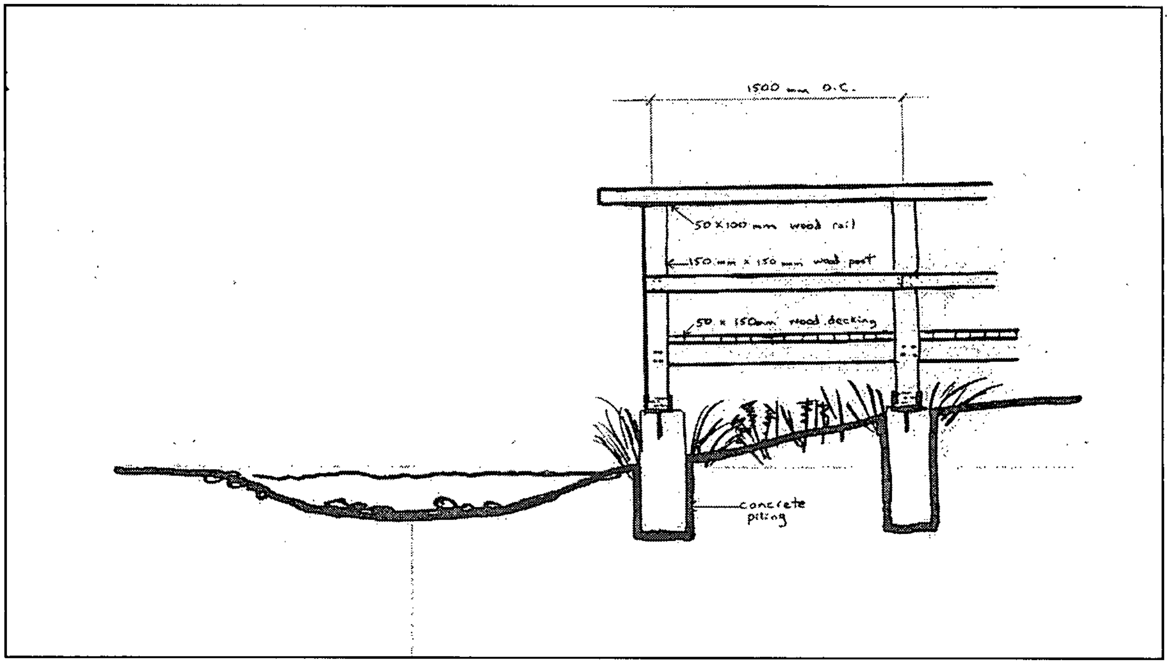

Figure 5. 11 Joshua Creek Viewing Platform Detail. Scale 1:50

6. Conclusion

This project took the seed of an idea planted by the Tsolum River Restoration Society and cultivated it, rooted firmly in the Ecological Aesthetic. The plan achieves the society's goals while augmenting them in ways that will be outlined below.

In terms of process, the project has benefited from the suitability analysis method. Landscape inventory has been critical to the process, and has directly influenced major planning and design decisions. The Geographic Information System has been of significant benefit to the suitability analysis process, facilitating data storage, manipulation, combination and synthesis. The analysis has complemented more intuitive design approaches also applied throughout, but especially at the site design scale.

The proposed site plan creates opportunities to see and experience the landscape while learning about it – key components in the aesthetic appreciation of natural ecosystems. The proposed eco-centre site and much of the proposed trail area are currently difficult to access due to factors like dense forest growth, and therefore their experience is limited to a few.

Visual and functional enhancements like structures contribute to a sense of stewardship while facilitating the visitor's comfort and overall experience. The eco-centre structure provides shelter, but remains open-sided, immersing the visitor in the forested setting. Care has been taken to provide an appropriate design, using locally available wood.

Over time, the cedar shake roof will grow mossy and its "fit" into the setting will grow with the forest. Similarly the viewing platforms facilitate controlled access in sensitive riparian areas, but remain open and rustic, emphasizing the experience of place.

By accessing the salmon habitat enhancement nodes, the Society's efforts become visible to the public and are explained. The forest ecology demonstration area goes beyond the Society's aquatic habitat enhancement goals to demonstrate visible forest stewardship and terrestrial restoration ecology. By intentionally accessing and describing sensitive and locally rare ecosystems in a responsible way, the trail contributes to habitat conservation for a variety of plant and animal species.

The proposed trail layout includes the experience of natural ecosystems alternating with human landscapes such as the hydro corridor and rural-residential area. This spatial configuration results in contrast and diversity for the trail user, as a rhythm between landscape types is experienced. Cultural history is explored at nodes like the Wolf Lake Dam and the Sawmill site, promoting heritage awareness and conservation.

Views to surrounding features like Constitution Hill and Mount Washington, accessed at nodes and while on the trail, connect the visitor to the larger landscape. At the site scale, filtered views of the proposed eco-centre, as well as views from the facility, are considered as part of the visitor's experience. The holistic approach of the Ecological Aesthetic considers the visual and ecological simultaneously, unlike traditional approaches like the Scenic Aesthetic.

Each proposed node along the trail is unique, and study limitations have prevented the development of creative interpretation and design interventions at each destination. Similarly, the study area is large, and all possible nodes have likely not been discovered, along with numerous places along the trail whose unique character creates experiential and learning opportunities. It is hoped that these will be discovered as the trail system expands incrementally. Ultimately it is hoped that, as the eco-centre and trail system become established in the local culture, they will be protected. Enhancements based in landscape ecology can expand the trail's role into a greenway with habitat corridor values.

Implementation of a trail system at the scale of this project will likely be a long-term process that is best carried out in phases. Development of the eco-centre site is an important first step in the process, providing a vital base from which the system can expand incrementally. It is hoped that the land at this site can be acquired, or agreements reached promptly with stakeholders, in order to establish the eco-centre. The trail to Wolf Lake is also a priority, as it connects the trail user to the upper watershed, and a diverse world that adds significant depth to the overall experience of the place.

The trail from the eco-centre downstream along Headquarters Creek is another priority, in that it links the visitor to the Tsolum River mainstem. This is an important connection, in consideration of the project's goal of helping the public to understand the area's ecology. Watching tributaries form and come together at the eco-centre, then following the creek downstream to its confluence with the watershed's main channel, is an important experiential step in this understanding.

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