Durrell Creek Integrated Watershed Management Plan

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ACKNOWLEDGEMENTS

This report was prepared by Pottinger Gaherty Environmental Consultants Ltd. (PGL) and northwest hydraulic consultants ltd., with significant input and assistance from the Durrell Creek Watershed Management Committee. The members of the Committee were:

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The Committee's deliberations were facilitated by Craig Darling, Accord Canada.

The consulting team that supported the Committee consisted of Pottinger Gaherty Environmental Consultants Ltd. (PGL) and northwest hydraulic consultants ltd. (nhc). The team members were Aynslie Ogden, Bruce Nidle, Lana MacDonald, Ian Blandford, and Susan Wilkins at PGL; and Ken Rood and Des Goold at nhc. Ian Robertson, Karen Golinski, Darrell Zbeetnoff, and Howard Paish were subconsultants to the team.

Kathy Wood, Municipality of Saanich was very helpful with communications and logistics.

EXECUTIVE SUMMARY

In 1997, Saanich invited a broad spectrum of stakeholders to form a steering committee, the Durrell Creek Watershed Management Committee (the Committee), to participate in preparation of an Integrated Watershed Management Plan (IWMP). The Committee consisted of representatives from:

- Department of Fisheries and Oceans
- Ministry of Agriculture and Food
- Agricultural Land Commission
- Ministry of Environment, Lands and Parks
- District of Saanich (Project Manager/Engineering, Planning, Environmental Management, Parks Department)
- Camosun College
- Local Community Associations (Strawberry Vale Ratepayers' Association, First Trestle Valley Ratepayers and Residents' Association)
- Local Environmental Groups (SWANS)
- Community Members
- Peninsula Agricultural Committee

The Committee has been meeting on a regular basis over the past several years. This has included several all-day meetings with the consulting team, representing considerable volunteer time and effort! Saanich Council gave the Committee the mandate to generate an IWMP that encompasses a wide variety of interests within the Durrell Creek catchment lands including agriculture, fish and wildlife habitat, ecology, recreation and existing land uses.

The Committee was supported by a facilitator whose primary role was to assist the parties in reaching consensus on the IWMP. The Committee was assisted by a consulting team, Pottinger Gaherty Environmental Consultants Ltd. with the assistance of northwest hydraulic consultants ltd. The consulting assignment consisted of hydrological modelling, biological and land use mapping, development of options, and preparation of the IWMP report. Neither the facilitator nor the consultants made decisions, passed judgements or imposed solutions on the Committee.

The following graphic illustrates the major chapters of the report and their content.

Executive Summary
* condensed summary of the IWMP*

1. Introduction
goals and framework for the study

2. Study Methodology

3. Watershed Description
summary physical, biological, and cultural features of the watershed

4. Issues and Options
summary of issues raised, options to resolve, and refinement of preferred options

5. Integrated Watershed Management Scenarios
*description of the 4 scenarios and their development

6. Committee Recommendations
criteria for selection, recommended scenario and justification

7. Plan Implementation and Monitoring
scheduling, funding and other implementation details

References
references cited in the report as well as consulted during the study

Glossary
technical terms and acronyms

Appendices
A – Terms of Reference
B – Steering Committee Process Agreement
C – Hydrologic and Hydraulic Modelling
D – Inventory Maps
E – Public Consultation
F – Response to Municipal Questions

DESCRIPTION OF THE WATERSHED

Physical Resources

LANDSCAPE

The Durrell Creek watershed, approximately 530 ha in size, is located within the political boundaries of the Municipality of Saanich. The topography of the area consists of low rolling hills and low gradient small catchments. The height of land in the watershed is about 125m in the northwest to less than 9m near the confluence of Durrell Creek and the Colquitz River. Many small lakes and bogs are commonly perched on the shallow bedrock surface. In the Durrell watershed, the bedrock uplands and the valley flats form two distinctly different physiographic types. The deep organic deposits beneath much of the flat lying valley floor are indicative of persistent wetlands prior to land clearing and drainage.

CLIMATE

The mean daily temperature ranges from 5.8° C to 13.4° C, with an annual mean of 9.6°C. The mean annual rainfall is 835mm, based on an 82 year period of record. The highest year on record was 1186mm recorded in 1990 and the lowest year on record was 1929, with 511mm of rain. The cyclic nature of rainfall with a period of 10 - 15 years is evident from a plot of long term mean annual rainfall.

HYDROLOGY

As Durrell Creek has not been gauged, a simulation model was used to generate a synthetic hydrograph (see Appendix C for details). Mean daily flows for existing conditions in Durrell Creek was completed for a 22-year modelling period. The results indicate:

- Average flow throughout the growing season (May - Sep) - 0.07 m^3/s
- Average flow throughout the dormant season (Oct - Mar) - 0.21 m^3/s
- Maximum monthly average flow (Nov) - 0.28 m^3/s
- Minimum monthly average flow (Jul) - 0.05 m^3/s
- Average annual flow - 0.14 m^3/s

There has been considerable manipulation of the Durrell watercourse, including ditching, culverting and diversions. The effect of all these changes on the resulting flow regime is assessed.

SOILS

Five soil types, Metchosin, Tagner, Saanichton, Somenos, and Sprucebark, occur in the watershed. The first three soil types can be improved to agricultural capabilities of class 2 or 3, which are good quality for local agriculture. As a result much of the valley flat is within the Agricultural Land Reserve. The Metchosin soils, found in the valley bottom, are primarily organic and derive from historic wetlands in the area.

Biological Resources

VEGETATION

The watershed is approximately 25% forested, while the remainder of the watershed has been disturbed over time by logging, agriculture, grazing, urban development, and invasion of non-native plants. The Durrell Creek watershed lies within the Coastal Douglas Fir biogeoclimatic zone. Some old growth Douglas fir forest exists in Francis King Park with trees up to 500 years old, and a number of Garry oak meadow ecosystems and second growth Douglas fir ecosystems exist. There are eight wetlands in the watershed, several of which have relatively natural vegetation communities.

WILDLIFE

The Durrell Creek watershed provides considerable habitat for upland and wetland wildlife in spite of human settlement. Waterfowl primarily uses the watershed in winter, when they congregate in key wetlands, particularly Hastings and Courtland Flats. Some early breeding species such as Canada geese and mallard also use the flats. Thirteen species of waterfowl have been recorded during the Christmas and Spring bird counts. The number of birds counted ranges from 1000 to 2,500, depending on the year. The timing of winter waterfowl use is dependent on date of flooding of fields and the seasonal timing of waterfowl migration. Canada geese are less dependent on open water habitat than ducks.

FISH

There appear to be no significant barriers to fish migration (e.g. falls, high gradients or debris dams) in the Durrell Creek watershed. Some culverts under roads in the area affect flow regimes, but do not appear to present a barrier to fish movement. For much of the summer season, Durrell Creek and its tributaries are dry or have very low flows and therefore provide poor or no in-situ fish habitat. However, Durrell Creek is tributary to the Colquitz River, which is a known salmonid bearing system. Streamkeepers data collected since 1998 confirm the presence of sticklebacks, sunfish and sculpins but no salmonids were observed. In February 1999 one juvenile cutthroat trout was captured in Durrell Creek close to its confluence with the Colquitz River.

FISH HABITAT

Much of the riparian zone along Durrell Creek has been impacted by agricultural and/or residential activity. The disturbed nature of the riparian zone adjacent to most of Durrell Creek, with its lack of mature deciduous and coniferous trees, results in little or no shading of the watercourse. A peak summer water temperature of 26°C – lethal to most salmonids – was recorded in Durrell Creek by Streamkeepers in 1998. Small shrubs dominate the riparian zone in some areas, but do not provide suitable cover for fish. Limited riparian vegetation also restricts the number of food sources (e.g. insect drop and leaf litter) for salmonids and other aquatic organisms. For the majority of Durrell Creek and its tributaries, there is a lack of gravel for spawning. A substantial percentage of the watercourses lack large substrate (cobbles and boulders) and are dominated by fines and organics, resulting in poor water quality. A significant portion of Durrell Creek has been dredged and channelized, drastically reducing habitat complexity. Limited water flow, lack of riffle areas and naturally occurring large woody debris, along with a high number of stagnant pool areas all contribute to the relatively low salmonid habitat quality of Durrell Creek.

ECOSYSTEM MAPPING

There have been two studies of the significant ecosystems of the Durrell Creek watershed; one at the regional scale and one at the local level. Several stands of significant native vegetation have been identified in the Durrell Creek Watershed. Francis King Park contains a large area which is characterized by an older (> 100 years) coniferous forest and some mix of broadleaf trees. Wetlands and open woodlands including stands of Garry oaks are also present throughout the watershed, often located on private land, and have important ecosystem values.

Community Profile

HISTORY

The Durrell watershed has a long history of human use. It has evolved from a hunting territory to an agricultural area to rural-urban fringe. The land was likely logged and recognized for its agricultural potential by the mid-1800's. The lowland areas of the Durrell Creek watershed have been farmed since the late 1800's. In 1908, the BC Electric Railway was built between Victoria and Sidney; including the placement of three railway bridges close together. The bridge nearest to Victoria at what is now Interurban Road became known as First Trestle. In 1925, the tracks were taken up and fill with culverts was used to lay the present road bed. In 1931, Saanich removed a culvert under the former BC Electric right-of-way at the request of local residents due to problems with drainage. In 1960, the bridge at Interurban Road/Charlton Road was removed and replaced with a concrete culvert. In 1985, the culvert under Wilkinson Road was replaced. The lowland areas of the Durrell Creek watershed historically flooded every year during winter months. Floodwaters on Hastings Street reached elevations of three feet above the road in the fall of 1948 after a heavy rainfall (Daily Colonist, January 12, 1975).

POPULATION

The Durrell Creek watershed is located within the Municipality of Saanich, a suburban/rural community that is part of the Capital Regional District. The Capital Regional District has a population in excess of 300 000 people, 51% of Vancouver Island's total population. Saanich has 32% of the population of the Capital Regional District. Saanich had a population of 105,393 in 1996, which is projected to increase to 109 200 by 2001. Population growth is expected to place pressure on all forms of urban services, including water, sewerage and solid waste disposal, transportation and housing. Pressure for expansion is expected to challenge traditional patterns of residential development, threaten agricultural land, and deplete environmental resources.

LAND USE

Changes in land use over the past 50 years were examined using aerial photography. The results indicate a small decrease in forested and grassed land, a gradual decrease in agricultural land, a decrease in low density residential and an increase in medium density (smaller lots) residential. The effective impervious area more than doubled from 4.7% in 1956 to 11.3% in 1999. The most common land uses in the Durrell watershed are agricultural and rural residential. In addition, some land has been developed as urban residential and a small portion is commercial/industrial and institutional. Institutional uses include Camosun College, a BC Hydro substation, Wilkinson Road Jail, and Strawberry Vale School. Parks include Francis-King and Strawberry Knoll.

AGRICULTURE

Agriculture is a dominant land use within the Durrell watershed. The extent and variety of agricultural land uses has diminished over time in Saanich, but it is still an important contributor to the economy and lifestyle in rural Saanich. The current agricultural practices in the watershed were mapped, using zoning maps, the results of the land owner survey and other published information as sources. Vegetable crops, horse/equestrian, and mixed use dominate, with smaller amounts of livestock, hobby farms and nursery operations.

PLANNING

The Durrell watershed is governed by the Saanich Official Community Plan (OCP) and the more detailed Local Area Plan for Rural Saanich. The OCP's general policies of maintaining rural land uses and protecting the environment are compatible with the goals of the IWMP. The Urban Containment Boundary and Sewer Enterprise Boundary are important measures to control urban expansion. Designation of land in the Agricultural Land Reserve is also important in the protection of land suitable for agricultural production. The Courtland-Hastings flats are designated as a Development Permit Area, which requires a development permit prior to any subdivision or building. The Fill Prohibition Bylaw is an important tool in the protection of floodplain areas from filling. The boundary is currently based at an elevation of 12.71m, and encompasses the Courtland-Hastings flats. It is intended to provide natural flood storage, rather than having to provide a man-made stormwater management system. This policy is in keeping with both the Agricultural Land Reserve restrictions on filling agricultural land and the recent trend to minimizing the environmental effects of diversion of runoff to stormwater systems.

Public Concerns

LOCAL GROUPS

The residents of the Durrell watershed do not identify themselves with that name; they are generally considered Saanich residents. The Courtland-Hastings flats and Strawberry Vale areas have distinctive character and are referred to as such. The name First Trestle Valley, which referred to a feature of the BC Electric Railway, is also used by some recently to refer to the same geographic area. While it has no single identity, the Durrell watershed is considered an attractive area to live in, and the residents take considerable interest in their community. There is a strong desire to preserve the agricultural character of the area, as well as protection and enhancement of environmental and recreational features. Several interest groups have formed to represent these interests: Courtland-Hastings Agricultural Preservation Society (CHAPS), the Strawberry Vale Wetlands and Agricultural Lands Nature Stewardship Project (SWANS) and the First Trestle Valley Ratepayers and Residents Association. The Strawberry Vale Ratepayers Association, formed in 1987, is also interested in the area. Downstream implications of the Durrell drainage problem is only one of their broader interests.

CONSULTATION

As an integral part of this study, public consultation was conducted to solicit input to the issues and solutions for watershed management. Two open houses and a landowner survey were the main tools used to obtain public feedback. It was also assumed that the local residents on the Committee provided ongoing input regarding local concerns. Copies of the consultation materials including the landowner survey, the survey results and open house handouts and questionnaires are all included. In the last few years, there has been renewed interest in both the environment and recreation in the watershed. There are also concerns over gradual habitat loss and the need to maintain and improve the environment from a fish and wildlife habitat perspective. Simultaneously, the need to provide opportunities for passive recreation has been raised in the community. Landowners have complained that their land has been periodically flooded beyond the normal winter conditions and, on occasion, they have been unable to harvest crops. In relation to water flows in Durrell Creek, there has been a claim that natural flows from an adjacent catchment area may have been diverted to this creek resulting in higher than normal flood conditions. There are claims that the installation of the Interurban/Charlton Road culvert and the surrounding road base resulted in restrictions and limitations to the natural drainage capabilities and detention of water on the valley floor. Many of the Gillie Road lots are subject to flooding and under current conditions unable to be used for single family use.

ISSUES AND OPTIONS

The following list of 17 issues under the five headings, which roughly group the concerns by subject area, were addressed by the IWMP.

Water Management
• Flooding of agricultural land and valley flat of Durrell Creek
• Improvement or replacement of local drainage structures
• Lack of stormwater detention and treatment
• Non-structural options for water management
Agriculture
• Risk of crop loss/shortened growing season on Courtland-Hastings flats
• Desire to promote agricultural practices that are consistent with environmental guidelines
• Desire to improve returns from agricultural production
• Desire to prevent loss of land base /encroachment on farm land
Environment
• Water quality below acceptable standards
• Gradual habitat loss/loss of biodiversity
Recreation
• Lack of adequate opportunities for passive recreation
• Desire to maintain or improve aesthetic values/liveability of watershed
Land Use
• Underutilized undeveloped road rights of way
• Lack of resolution of long term use of Gillie Road lots
• Desire for healthier environment through land development/land use guidelines
• Long term infrastructure requirements to satisfy expanding population

For each of the issues identified above, a range of options to resolve that issue was developed. An original list of 108 options was reviewed and refined at a series of Committee workshops. An explanation was given for all the options considered and then eliminated. Assessment of the compatibility of individual options and the possible effects of each proposed option was also reviewed. The refined list of approximately 30 options was advanced to the next step of developing the IWMP.

WATERSHED MANAGEMENT SCENARIOS

The two driving issues in development of the plan were flooding of the valley and drainage of adjacent agricultural land. Four scenarios were developed to address these issues, and recommendations on other concerns were made within this framework. The scenarios differ in the extent to which they manage water levels and control flooding upstream of Interurban Road, and the extent to which they meet standard agricultural criteria for growing season and dormant season drainage.

	Scenario	Increasing Amount of Flow Control	Increasing Agricultural Drainage	Increasing Value of Agricultural Production
#1a	Improve growing season drainage by lowering Interurban culvert			
#1b	Improve growing season drainage by pumping/flapgate			
#2	Ensure growing season drainage by lowering/enlarging culvert and pumping/flapgate/stoplogs			
#3	Manage year round drainage with Lowering/enlarging culvert and larger pump/flapgate			

For each scenario the proposed measures and the pros and cons of each were described (attached table). The measures that were common to all scenarios were then outlined.

Watershed Management Scenarios - Pros and Cons

Scenario #1a - Improvement of Growing Season Water Levels by Lowering Interurban Culvert	Scenario #1b - Improvement of Growing Season Water Levels by Flapgate/Small Pump	Scenario #2 - Management of growing season water levels	Scenario #3 - Management of water levels throughout the year
Water Management			
Lower Interurban culvert by 0.8m to 8.8m invert level, set culvert flat, add flapgate	Add flapgate and small pumping station to existing Interurban culvert	Lower and replace Interurban culvert with larger capacity floodbox, add flapgate, add pump (500-1000 l/s)	Lower and replace Interurban culvert with larger capacity floodbox, add flapgate, add pump (1000-2000 l/s)
Not economic to install on farm drainage	Not economic to install on farm drainage	Improve local and on farm drainage structures.	Water levels can be controlled year round
Extreme (winter) water levels unchanged	Extreme (winter) water levels unchanged	Extreme (winter) water levels unchanged	Lower stream water levels from Apr-Oct
		Eliminate overbank flooding in summer	Winter water levels depend on pump operation
Reduce summer flooding by approx. 30%	Summer flooding not affected	Summer flooding almost eliminated	Summer flooding almost eliminated
Summer soil drainage freeboard 0.9m most of season	Summer soil drainage freeboard 0.9m	Summer soil drainage freeboard 0.9m	Year round soil drainage freeboard 1.2m
Water levels in the Colquitz not affected	Water levels in the Colquitz not affected	Winter flows to the Colquitz not affected	Potential increase winter levels in Colquitz by 15cm
Agriculture			
Reliable growing season estimated 4.5 months	Same as Scenario #1a	Growing season up to 8 months	Year round and double cropping possible, crop flexibility
Doesn't meet all ARDSA summer criteria		Will meet ARDSA summer criteria	Meet full ARDSA criteria
Decreases risk of crop loss		Decrease risk of crop loss due to flooding	Minimize risk of flooding and crop loss
Small increase in return		Double cropping and cropping flexibility	Long term soil capability enhanced
Soil erosion/soil degradation/lost productivity		Same as Scenario #1a	Use of winter cover crops enhanced
Winter cover cropping not possible		Use of winter cover crops possible	
Environment			
Summer flooding and any associated habitat would be reduced	Same as Scenario #1a	Same as Scenario #1a	Same as Scenario #1a
Winter use of seasonally flooded fields reduced	No chance in winter use of seasonally flooded fields	Stoplogs maintain winter water levels	Some winter use of seasonally flooded fields may be affected
	Pumping would not affect fish habitat		
Improved protection of ESAs			Winter water levels on seasonally flooded field depends on pumping
Channel maintenance combined with riparian enhancement	Same as Scenario #1a		Winter use of fields by waterfowl will be affected if fields drained
Decreased soil loss/sedimentation			Cover crops provide habitat
Improved water quality			Species mix altered
Recreation			
Improved trail network, better connections	Same as scenario #1a	Same as scenario #1a	Same as scenario #1a
Improved bird watching stations and parking	Same as Scenario #1a		Bird watching opportunities will be altered in winter
Improved education re: agriculture and environment			Some mitigation of impacts to waterfowl if cover crops used
Some trail use would be seasonal due to flooding	Same as Scenario #1a		
Land Use			
Flooding of Gillie Road lots not changed	Same as scenario #1a	Same as scenario #1a	Flooding of Gillie Road lots reduced but not eliminated

Watershed Management Measures – Common to all Scenarios

Water Management

- Recommend a water management study on the Colquitz system
- Adjust Durrell Creek channel from Interurban to Hastings, grading from 8.3m to 8.7m
- Lower Hastings Street culvert by 0.6m to 9.0m; replace Granville Avenue culvert
- Adjust Durrell Creek channel across Hastings Flat
- Recommend drainage management/operating procedures

Agriculture

- Recommend land development guidelines to minimize impacts of other land use on agriculture
- Encourage observance of codes of agricultural practice
- Recommend stewardship guidelines for riparian/farm environmental planning

Environment

- Continue water quality and septic field testing/cross connection upgrade where necessary
- Encourage landowners to undertake private land stewardship for terrestrial ESAs
- Encourage revegetation of riparian ESAs on private land, especially behind the Wilkinson Road jail
- Encourage municipality to undertake stewardship on municipal ESAs, particularly the reach of Durrell Creek upstream of Interurban Road
- Encourage general environmental stewardship and identify desirable practices

Recreation

- Implement recreational opportunities plan, including trails, bird viewing stations, retain existing ROW, develop educational component

Land Development

- Amend OCP to include all agricultural land in a Development Permit Area
- Encourage agricultural use of Gillie Road lots

COMMITTEE RECOMMENDATIONS

The overall goal of the Committee was to select a scenario that contributes most to realizing an appropriate balance of social, economic and environmental values for the study area. The specific criteria for selection identified were:

- Maximize environmental benefits
- Support farming in the area
- Comply with public policy
- Propose an acceptable outcome
- Maximize potential benefits to private property owners
- Enhance community livability
- Do no harm downstream
- Maximize value for the money
- Integrate public feedback

The four scenarios were compared using the above criteria, and Scenario #2 was recommended by the Committee as the best compromise for the Durrell Creek watershed.

The details of implementation of the IWMP are as follows:

- A three phase implementation schedule is recommended, commencing in 2001, as approvals allow
- funding partners should be sought
- a monitoring plan using the Committee's support is recommended

Phase I

- ➢ Replace Interurban culvert with larger culvert at lower elevation (including provision for stoplogs or wier)
- ➢ Replace Granville Avenue culvert
- ➢ Carry out channel regrading and planting of riparian vegetation along Durrell Creek in the Charleton right-of-way west of Interurban Road
- ➢ Construct parking and wildlife viewing area near Interurban at Charleton
- ➢ commence environmental stewardship program as staff and funding permits

- continue water quality testing program as conditions dictate
- commence negotiations with Correctional Institute for access and approval of planned enhancements in phase II

Phase II

- Construct wet well and pump on upstream side of new Interurban culvert (subject to review of existing operation)
- Carry out environmental enhancements in area between Interurban Road and Wilkinson road
- Construct Roy Road parking and trail access
- Construct trail along Durrell Creek between Wilkinson and Interurban

Phase III

- All remaining aspects of the plan into the official planning documents of the municipality and work will proceed as funding and staffing permit

The challenge of how to achieve the best balance for the Durrell Creek watershed was met by a lot of hard work by the community and agency members of the Committee, utilizing the tools provided to them. In the end, a solution was found that all interests could live with. The following quote probably best captures the essence of the solution:

> "A garden in the summer, a lake in the winter. Why not?"
> Ron Burnham, The Daily Colonist, Jan 12/75

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LIST OF ATTACHMENTS

Chapter 1 – Introduction

This report describes both the process and the results of development of an IWMP. A consulting team, consisting of Pottinger Gaherty Environmental Consultants Ltd. (PGL) and northwest hydraulic consultants ltd. (nhc), were retained in March, 1999 to conduct studies to support development of the IWMP. A stakeholder/agency committee (the Durrell Creek Watershed Management Committee) were involved extensively in the development of this plan, and hence are co-authors of this report.

1.1 Study Purpose

The Durrell Creek watershed, approximately 530ha in size, is a tributary of the Colquitz River which drains approximately 60% of the Municipality of Saanich. The majority of land use within the watershed is agricultural, approximately 25% of the catchment area is forested, though some urban residential and commercial/industrial/institutional land development exists. Agricultural viability, flood control and stormwater management, protection and enhancement of fish and wildlife habitat, and recreational opportunities are important issues to this community at the rural-urban fringe.

The watershed has many competing and often conflicting land use demands. Consequently, the Municipality of Saanich (Saanich) decided to proactively plan for the future use of land and resources in this watershed. A community-based steering committee, the Durrell Creek Watershed Management Committee (Committee) was appointed to guide the development of an Integrated Watershed Management Plan (IWMP). The purpose of this IWMP was to inventory the Durrell Creek watershed, identify resource management issues, and outline a practical and realistic implementation strategy that integrates the needs of all resources. The IWMP involved consultation with all stakeholders concerned with resource management in the watershed, allowing for the development of options that are based on the needs of the local community.

1.2 Background

Long standing concerns about drainage of lowland areas in the Durrell Creek valley were the primary impetus for this study. The area was cleared and farmed before the turn of the century, and flooding of the lowland areas has occurred periodically. Urban development, including single family housing, Camosun College and a BC Hydro substation, has occurred in the eastern portion of the watershed since the 1950's. Much of the Durrell Creek watercourse has been altered over time, including a possible diversion of part of the headwaters from an adjacent stream and culverting under Interurban, Granville, Wilkinson and Hastings streets.

The perception that flooding of lowland areas in the watershed has increased and varying opinions as to the cause of the flooding has led to considerable controversy between local residents and Saanich officials. Several studies of the hydrology of the study area have been commissioned by local residents, and various legal remedies have been sought. The Municipality proactively undertook this cooperative planning exercise in 1997 to research and resolve the issues with community involvement.

1.3 Durrell Creek Watershed Management Committee Role

In 1997, Saanich invited a broad spectrum of stakeholders to form a steering committee (Durrell Creek Watershed Management Committee) and participate in preparation of the IWMP. The Committee was given the task of reaching consensus on recommendations to Saanich Council aimed at supporting agriculture and providing ecologically sensitive guidelines for land use in the Durrell Creek watershed. In particular, Saanich required that the IWMP address storm water management, flooding, water storage, water quality, drainage, sustainable farming, alternative land uses, recreation, wildlife, fish habitat and other ecological issues that were dividing the community.

The Committee consists of representatives from:

- Department of Fisheries and Oceans
- Ministry of Agriculture and Food
- Agricultural Land Commission
- Ministry of Environment, Lands and Parks
- District of Saanich (Project Manager/Engineering, Planning, Environmental Management, Parks Department)
- Camosun College
- Local Community Associations (Strawberry Vale Ratepayers' Association, First Trestle Valley Ratepayers and Residents' Association)
- Local Environmental Groups (SWANS)
- Community Members
- Peninsula Agricultural Committee

Throughout 1998, the Committee met regularly to develop Terms of Reference for the IWMP (Appendix A). Early in 1999, the Committee addressed concerns about its structure, responsibilities and ability to reach consensus by adopting a process and procedure agreement (See Appendix B) and appointing a facilitator.

In February, 1999, following a comprehensive tendering process and on the recommendation of the Committee, Saanich Council appointed Pottinger Gaherty Environmental Consultants Ltd. (PGL) to gather information, conduct research and prepare the IWMP pursuant to the terms of reference. PGL was assisted by northwest hydraulic consultants ltd. (nhc). The consulting assignment included:

- hydrological modelling, biological and land use mapping
- regularly interacting with the Committee and reporting on progress
- developing options and potential scenarios for the consideration of the Committee
- supporting the scenario selection process
- preparing the IWMP report

The PGL team's role was to work closely with the Committee to provide the data and analyses required to build the IWMP step by step. Because this IWMP was a community-based document developed through consultation, the PGL team primarily served the role of technical support to the Committee, with the aim of producing a joint-authored end product.

At the end of several stages of the work, the Committee with the assistance of PGL, reported progress to Saanich Council. Saanich appointed a staff member as Project Manager who was responsible for overseeing PGL's work and ensuring that communication was maintained between the PGL and the Committee.

Neither the facilitator nor the consultants made decisions, passed judgements or imposed solutions on the Committee.

1.4 Goals and Objectives

One of the critical steps in integrated watershed management planning is to define specific goals for the planning area - expressions of what is wanted in the future for the lands, resources, and communities in the planning area. General plan goals are the primary basis for evaluating management alternatives. Therefore, prior to any evaluations of management options, consensus was reached on the watershed management goals. The goals identified by the Committee include:

1.4.1 Goals

The goal of this study is to develop an Integrated Watershed Management Plan for the Durrell Creek watershed that is based on inventory, consultation, and detailed options analysis. Continuance of viable agricultural operations and protection for environmentally significant areas are key elements to be incorporated in the IWMP.

1.4.2 Desired Outcomes

The desired outcomes of the IWMP, as determined by the Committee at the outset of the planning process, were as follows:

<u>Drainage</u>

- Flood control
- Stormwater management facilities that provide drainage systems that meet the needs of agriculture and the natural environment
- Drainage maintenance programs that are compatible with BCMAF, MOELP and DFO requirements

<u>Agriculture</u>

- Maintenance and improvement of agriculture viability by providing sufficient drainage during normal growing season
- Farming practices near the stream in the lower valley that are in accordance with existing guidelines
- Identify farming opportunities

<u>Environmental Management</u>

- Water quality that meets provincial guidelines
- Protection and enhancement of biodiversity and ESAs
- Maintenance and improvement of wildlife habitat
- Maintenance and possible regeneration of fish habitat (rearing, overwintering)
- Determine potential habitat improvement areas, net gain areas

Recreation

- Provision of passive recreational opportunities

Land Development

- Land development guidelines
- Determine long term use of Gillie Road Lots
- Determine long term use of undeveloped rights of way
- Long term infrastructure development plan

1.5 Guiding Principles

The following guiding principles were developed to assist the Committee in the successful development, assessment, and refinement of management options for the Durrell Creek Watershed. Wherever possible, the plan should:

Be consistent with regional planning goals. The options we develop will reinforce and promote the official community plan goals and other regional policies.

Be a living document. The IWMP is intended to evolve and be revised over time and adopt adaptive management principles based on monitoring and evaluation of plan results.

Be based on community involvement. The selection of options will be based in part on watershed management objectives defined by the community-based steering committee, public open houses, interviews with affected property owners, and results of a landowner survey.

Be practical and feasible. The management options will strike a balance between short and long term planning goals. Special attention will be paid to minimizing maintenance requirements.

Deliver on relevant government policy direction. Regulations, guidelines, and regional policies will serve as the parameters within which the options-development process will operate.

Consider supply/demand relationships. Management options will account for expected demand for various land uses, as well as the supply of land to accommodate those uses.

Conform with ecosystem-based management concepts. The fundamental basis to watershed management planning is the need to maintain the long-term integrity of the watershed and to consider the watershed in its entirety when selecting management scenarios.

Recognize uncertainty. Due to the inherent uncertainty involved in managing natural processes within a watershed, low-risk or adaptive management options may be recommended where appropriate.

Ensure equitible distribution of benefits and costs. Ideally, watershed management options will reflect a rough equity in the distribution of benefits and costs – geographically, between land use sectors, and within land use sectors. As not all land uses will be compatible, evaluating trade-offs between various land use scenarios will be an integral component of the decision making process.

Recognize existing land uses and legal rights. Historic and existing land uses, investments and legal commitments will be recognized throughout the options development process. Private property will be respected.

Implement best management practices. Where possible, options will be based on best management practices.

1.6 Regulatory Framework

As indicated above, one of the guiding principles in the development of the IWMP was to comply with existing legislation and government policy to the greatest extent possible. The following legislation and policies have already affected development within the Durrell Creek Watershed, and continue to guide exercises such as development of the Durrell Creek IWMP.

1. Urban Containment Boundary (UCB) Policy - In the early 1960's, the UCB was established, to ensure the provision of sewer service to urban areas of Saanich and ensure that sanitary sewer services would not be extended to rural Saanich. This is one of the key tools of the Saanich Growth Management Program. Other than minor amendments, extension of the UCB will not be considered until all growth options within Saanich have been evaluated in the next review of the OCP.
2. Subdivision Minimum - In the late 1960's, the subdivision minimum lot size in rural Saanich was increased from 0.65 ha (1.6 acres) to 2 ha (5 acres) to reduce the amount of subdivision of rural land and thus eliminate the possible need for servicing isolated pockets of development in the future.
3. Agriculture Land Reserve (ALR) - In 1974, the land designated as ALR is subject to the Agricultural Land Commission Act which restricts land use and subdivision.
4. Deposit of Fill Bylaw - In1984, a bylaw was passed to regulate or prohibit the deposit of fill on lands within Saanich.

Some of the relevant legislation and guidelines are as follows:

Federal

Fisheries Act

Migratory Waterfowl Act

Provincial

<u>BCMAF</u>

Environmental Guidelines for Producers in British Columbia: Field Vegetable, Beef, Dairy, Hog, Mushroom and Poultry Producers, Horse Owners, Greenhouse Growers, Nursery & Turf Industry, Tree Fruit and Grape Producers

BC Agriculture Drainage Manual – ARDSA Criteria

Agricultural Land Commission Act

Farm Practices Protection Act

Soil Conservation Act

<u>MOELP</u>

Water Quality Standards

Municipal Act

Waste Management Act

Water Act

Health Act

Ditch Guidelines

<u>DFO</u>

DFO/MOELP Land Development Guidelines for the Protection of Aquatic Habitat

DFO Stewardship Series

Municipal/Regional

Saanich Official Community Plan and Local Area Plans (Rural Saanich, Carey)

Municipal Bylaws and Policies (Fill Prohibition Bylaw, Urban Containment Boundary)

Agriculture Strategy for the Saanich Peninsula

Environmentally Significant Areas study

Chapter 2 – Study Methodology

This chapter briefly describes the methods used to conduct this study. The work is described under the headings of hydrologic and hydraulic modelling, biological mapping, land use mapping, public consultation, issue identification and refinement, assessment and refinement of options, watershed management scenarios, and development of the watershed management plan. In most instances, the consulting team conducted the primary data collection and analysis, while the Committee met to consider the results and make decisions.

2.1 Hydrologic and Hydraulic Modelling

A complete description of the hydrologic and hydraulic models and the results is provided in Appendix C.

Saanich and the Committee presented the consultant with the following list of key issues and objectives for the hydrologic modelling study:

- Determine whether flooding has increased in the Durrell Creek Valley floodplain over the last 50 years in terms of height of floodwaters and duration of water on the land and, if it has, state the reasons why.
- Estimate water levels and provide floodplain mapping for the 10-, 25-, and 200-yr instantaneous discharges in Durrell Creek. This information is provided for the existing watershed boundary as well as for those boundaries that existed prior to diversion(s), if any.
- Define existing summer and winter base flow elevations adjacent to agricultural lands in the watershed. Also, determine the duration of flooding over specific field levels for the current watershed, with and without diversions.
- Determine and evaluate what, if any, hydrologic or hydraulic improvements may be required in order to meet freeboard requirements over base flow water levels for agricultural drainage. Specifically, determine the effect of culvert modifications at Interurban Road and Wilkinson Road on water levels for specific return periods (10-, 25-, and 200-yr) and on the duration of flooding over specific field levels.

The primary task of the modelling was to develop linked hydrologic and hydraulic models of the Durrell Creek watershed. The hydrologic model predicts flows from the climate data; the hydraulic model predicts the water levels associated with those flows. The two models were used to predict the effects of climate change, urbanization, drainage diversions and the Interurban Road culvert on flows and water levels.

The hydrologic model used for this project was the U.S. Environmental Protection Agency's (EPA) Hydrologic Simulation Program – FORTRAN (HSPF) model, version 11.0. HSPF is a conceptual deterministic hydrologic model, capable of providing continuous simulation of streamflow and other hydrologic processes from climate data. ROUTE, a proprietary storage analysis model was used to predict water levels from the flow data.

For the purpose of this project, the Durrell Creek watershed was divided into 8 sub-basins. The sub-basin boundaries were drawn to coincide with the confluence of tributaries, existing storm drainage boundaries, major road crossings or other watershed features. Delineation and verification of the sub-basin boundaries was based on the following:

- Existing boundaries of Durrell Creek by the District of Saanich and by Hoel Engineering.
- Storm drainage maps provided by the District of Saanich (scale 1; 5,300)
- Topographic maps for the area provided by the District of Saanich (UTM scale 1: 5,000)
- Field verification by nhc staff
- Discussions with Saanich staff and PGL staff

Durrell Creek was surveyed on April 29-30, 1999. Channel and floodplain elevations were surveyed at 15 cross-sections, starting near the Wilkinson Road culvert and ending near the Granville Avenue culvert above Hastings flats. The survey covered a total distance of roughly 1.4km. In addition to the cross-sections, individual elevation points were surveyed within and around the perimeter of the agricultural fields, along the inverts of secondary field drainage ditches, along the tops of major roadways and at the inverts of culverts located along the principal drainage path.

Long-term model simulations were performed for seven separate scenarios, developed for the purpose of examining the effect of land use changes, drainage diversions, and drainage improvements on discharges and water levels. Each simulation was run for the climate and Colquitz River levels over the 22-year period from January 1976 through December 1997, at an hourly time-step.

2.2 Biological Mapping

Within the Durrell Creek watershed, several areas are reported to be natural habitat or have ecological significance. The biological mapping overview provided an identification of these areas, a summary of available biological inventory data, and an assessment of the data in the context of developing an IWMP for the Durrell Creek watershed. The goal of the biological mapping overview was to develop maps to be used as tools in later stages of the project. Individual map layers were stored within a GIS mapping program (Appendix D).

2.2.1 Streams, Riparian Zones, Fish and Fish Habitat

Important natural fish habitat and areas of ecological significance within the watershed were identified and evaluated for preservation and/or protection possibilities. With respect to streams, riparian zones, fish and fish habitat, this task consisted of a review and summary of available (existing) data including:

- information obtained from aerial photographs;
- information obtained from 1:2500 scale maps (provided by Saanich);
- the Riparian Inventory Report (Saanich, September 1996);
- DFO's Fisheries Information Summary System (FISS);
- MOELP studies and reports;
- CHAPS/Streamkeepers (fish/fry trapping results); and
- other consultant's reports.

Once all potential sources of information were examined, field work was carried out to fill information gaps in the database. A site visit by our fisheries biologist was conducted in April/99 to review available data and assess habitat conditions. The mainstem of Durrell Creek was walked, as well as several of the major tributaries.

2.2.2 Surface Water Quality

Saanich provided surface water quality test results from another study (Good Environmental, 1999). These data were evaluated to determine the location and source of point or non-point pollution. Using existing water quality data, we evaluated streams within the watershed to determine the presence of point and non-point sources of pollution. The analysis of water quality data involved a review and summary of data from:

- 1997 aerial photographs;
- FISS;
- CHAPS/Streamkeepers;
- MOELP; and
- other water quality reports.

The most recent BC Water Quality Guidelines released in August 1998 by MOELP -- which includes guidelines for drinking water, irrigation, livestock watering, aesthetic and recreational water uses -- were used to determine problem areas within the watershed.

2.2.3 Wetlands

Wetland areas of ecological significance within the watershed were identified and evaluated for preservation and/or enhancement possibilities. The classification and mapping of wetlands involved a review and summary of existing data including:

- Review of historical and current aerial photographs.
- Review of existing wetland mapping data held by Saanich.
- Review of pertinent student projects from Camosun College and the University of Victoria.

Field work was conducted to confirm and or modify existing wetland data.

2.2.4 Vegetation

Vegetation communities were identified and evaluated for preservation, and/or enhancement possibilities. This task consisted of a review and summary of available data including:

- 1997 aerial photographs
- Records registered with the Conservation Data Centre
- Information obtained from MOELP, Ministry of Forests, and other regulatory agencies
- 1:2400 scale mapping of vegetation communities in the Landscape and Habitat Survey Atlas
- Francis-King Park inventory data

From these sources, preliminary boundaries and characteristics of the vegetation communities were established. Field work was carried out to fill information gaps in the database.

2.2.5 Wildlife

Wildlife, specifically amphibians, reptiles, mammals, and birds are an important component of the Durrell Creek watershed. It was important to define the specific location and temporal attributes of these species and habitats so that management proposals for the watershed can be as beneficial as possible for wildlife. This task consisted of a review and summary of existing information including:

- Existing wildlife information in the watershed, and where appropriate, areas immediately adjacent.
- Records registered with the Conservation Data Centre to confirm red and blue listed species in the study area.
- Christmas Bird Count records.

We also interviewed local naturalists familiar with the area to obtain additional information. Owners of major properties in the watershed were contacted to determine the approximate annual timing of significant wildlife concentrations on their own or neighbouring properties. From these sources, we plotted the location of species and habitats important to birds, mammals, amphibians and reptiles. Field surveys of the site were conducted using a combination of census techniques. Maps of key wildlife observations, known concentrations, habitats, environmentally sensitive areas with special emphasis on rare and endangered species were completed. The focus was to determine habitat suitability for black-tailed deer, a species considered indicative of other larger mammals in the watershed and habitat capability for waterfowl.

2.2.6 Aesthetics

Scenic areas, including areas that are visually sensitive, scenic and pastoral landscapes, were identified. An assessment of the aesthetic quality of each of these areas was made. Some parts of the watershed provide a unique opportunity for the public to see local food production, and environmental and agricultural stewardship working together. As this is a very subjective attribute, we relied upon Committee input on this issue.

2.2.7 Impact of Human Activity

An assessment was made on the impact of human activity in recent history on animal and plant habitat. The assessment was based on a review of historical aerial photographs, interviews with members of the community, and the results of the data collected above. The photographs and statements that are available from 'old timers' concerning the conditions of the land during the earlier part of the century were an important source of information to assess human impact on the watershed. Maps, depicting stream channel and land use change over time, were used to present these results (Appendix C).

2.2.8 Map Production

Results of the inventory were mapped using the 1:2500 scale on cadastral base maps provided by Saanich. These maps provided an important working tool for later stages of the project. Maps were stored within a GIS database, a planning and decision support tool that can capture, store, manipulate, analyze, and display information to help understand relationships among resource values and uses. Each map was stored as a separate layer within the database allowing for easy access to the particular characteristics of a geographic location. All maps will be fitted (registered) to the base map. By overlaying these layers of information, current land use, land use suitability, and future land use scenarios are more easily assessed. The following maps (Appendix D) were provided to summarize information gathered during this stage of the project:

- Waterfowl Habitat Capability Classification
- Fish and Water Quality
- Vegetation Communities
- Black-tailed Deer Habitat Suitability Classification and Wildlife Sightings
- Environmentally Significant Areas

The maps will also be provided to the Municipality as full size sheets as well as digital files for their future use.

2.3 Land Use Mapping

An inventory and mapping of land uses within the Durrell Creek watershed was conducted. A review and assessment of the opportunities and constraints of different land uses within the watershed, including agriculture, recreation, and development will be conducted based on the review of existing data, and field work. The goal of this stage was to develop maps that will be used as tools in later stages of the project. Maps will be stored as layers within a GIS and overlaying these maps to identify land use suitability, assess current land use, assess potential land use conflicts, and develop and evaluate potential management options.

2.3.1 Land Use Inventory and Assessment

Agriculture is an important land use within the Durrell Creek watershed. The type and viability of farming in the watershed depends on many variables including water management, flood prevention, summer irrigation, and subsurface drainage. This stage involved inventorying current and historic farming methods and production within the watershed, including mapping of soils and agricultural capability. Existing information was reviewed including:

- Soil maps
- Agriculture capability maps
- Saanich's Agriculture Plan

- Surficial geology mapping at 1:2400 scale in the Landscape and Habitat Survey Atlas
- Recent and historical aerial photos

Agencies and community groups such as BC Ministry of Agriculture and Food, the Agriculture Land Commission, Saanich Peninsula Agricultural Strategy Committee, and the Courtland Hastings Agricultural Preservation Society, were contacted to obtain information on current and historic agricultural production, established farming practices, and restrictions on local production. We also contacted individual farmers in the watershed to obtain information on the potential for different crops and their restrictions to economic production. Data was collected from BC Assessment and a landowner survey regarding agricultural practices in the watershed.

Once all potential sources of information were examined, a field confirmation program was carried out to map current agricultural practices, confirm or modify soil unit boundaries, and assess agricultural capability with and without water management improvements. The field program focused on land zoned for agricultural use ('A') in the watershed. The following maps (Appendix D) were prepared:

- Land Use
- Zoning
- Agricultural Practices
- Soils
- Floodplain
- Wetland Classification
- Agriculture Capability
- Recreation Opportunities

A cost benefit analysis of the net agricultural benefit arising from improvements to agricultural capability and crop potentials due to implementation of a regional drainage strategy was conducted. This information was to make an assessment regarding the net agricultural benefits from regional drainage improvements in terms of crop potentials and yield benefits to determine if regional drainage improvement expenditures are justified.

2.3.2 Recreational Land Use Inventory and Assessment

Passive recreational land use opportunities and constraints were assessed for the watershed, with the objective of outlining opportunities that are diverse and low-impact. This task involved a review all published information on passive recreational use for the study area.

2.4 Public Consultation/Landowner Survey

As part of this assignment, a survey of landowners in the study area was conducted. We wanted to ensure that the concerns and opinions of the residents of the watershed were available to the Committee and the consulting team at the early stages in the planning process. The landowner survey was mailed out to all residents of the watershed in June, 1999, and the results were compiled and distributed to the Committee in November, 1999. A total of 60 residents responded, out of approximately 600 surveys that were mailed out, giving a response rate of 10%. A summary is given for all respondents, and where interesting trends were observed, results were also summarized for the three geographical areas (sub-areas) identified in the survey namely residents within the Urban Containment Boundary, residents of rural lots within the ALR, and residents of rural lots outside the ALR.

Because feedback from the community is essential, two public open houses were scheduled during the planning process. The first public open house gave the public an opportunity to provide early feedback on the findings of the inventory phase. The second public open house was held after the draft Watershed Management Plan was prepared.

The goal of the public consultation sessions was to facilitate the exchange of information between the consultant, the Committee, the municipality, and those interested in or affected by the planning process. Technical information was clearly presented in a manner that is understandable to a wide audience. To facilitate dissemination of information to the public, we prepared summary documents that were suitable to a wide audience. The actions taken to accommodate public concerns that arose during the public open house were documented.

2.5 Assessment of Issues and Options

Options for addressing watershed management issues were assessed in terms of public support, implementation costs, and potential impacts (positive and negative). Practical recommendations were made regarding suitable management strategies to resolve issues in each of five main categories: drainage, agriculture, environment, recreation and land use. Recommendations were in accordance with existing regulations wherever possible, but some modifications to municipal policy were also made.

This activity was primarily conducted by the Committee at a series of working meetings, with support from the consulting team as required. A long list of issues was developed and reduced/refined by Committee discussion. A long list of options was developed by the consulting team, and reviewed by the Committee. By process of elimination, a short list of acceptable options was recommended for consideration in the development of watershed management scenarios.

2.5.1 Determination of Major Issues in the Watershed

This task involved analysis of inventory and modelling results, including the use of GIS as a tool to overlay maps, and team working sessions. Based on an integration of the results of hydrological modelling, biological inventory, and land use mapping stages, issues were identified that may prevent or limit the watershed management goals from being achieved. Consultation with the Committee was undertaken to obtain additional information on issues within the watershed that are important to the community. Conflicting land uses were clearly laid out for review and resolution through the subsequent steps of the process.

2.5.2 Development of Options and Recommendations

Management options relating to water management, agriculture, environment, recreation, and land use were developed for the Durrell Creek watershed. Overlays of map information produced during the previous stages of the project in a Geographic Information System (GIS) were a valuable tool to identify potential land use conflicts within the watershed. Only options that were in agreement with existing regulatory guidelines were considered. Particular attention was paid to developing options that are in accordance with existing guidelines, and are environmentally sustainable, practical and implementable, compatible with other land uses in the watershed, and require minimal maintenance.

Based on cost benefit analysis, regulatory constraints, and results of the landowner interviews, recommendations were developed regarding the most suitable management options for the watershed. A working session was held with the Committee where our recommendations, along with the various options, were reviewed and discussed. The focus of the workshop was to ensure that the proposed options were properly integrated, compatible, and sustainable. Compatibility between options proved to be an important criterion in determining the short list of options. Various assessment tools were used at Committee workshops to identify preferred options.

2.6 Watershed Management Scenarios

To provide structure to the watershed management plan and to achieve integration of the various proposals, four watershed management scenarios were developed by the consulting team. They were based on different solutions to resolve the central issues of water management at Interurban Road and agricultural use of the Courtland – Hastings flats. The options to address other issues such as recreation, environment and land use were all presented within the framework of the drainage scenarios. Each scenario was presented with details of the proposed measures and the effects of the measures, as well as the cost implications.

The four watershed management scenarios were presented to the Committee for their review and consideration. Various aspects of the proposed measures under each scenario were discussed further by subcommittees and the findings reported back to the main table. The subcommittees which met outside of the main Committee looked at: recreation opportunities, effects of other land use on agriculture, environmentally significant areas, and agency mandates. The scenarios were refined by the consulting team and returned to the Committee for their further consideration.

2.7 Development of Watershed Management Plan

The decision as to which scenario to recommend to Saanich Council was made by the Committee, after detailed consideration and review of the draft report. Criteria were developed by the Committee to guide the selection of a preferred scenario. At the request of the Committee, the agency subcommittee met and provided their preliminary feedback on scenario selection from the viewpoint of their respective agency mandate. This advice was circulated to the Committee and an all day workshop was held to review and finalize scenario selection. Based on the Committee's advice, and the feedback from the second public open house, the Watershed Management Plan was finalized.

Chapter 3 – Watershed Inventory

The Durrell Creek Watershed, approximately 530 ha in size, is located within the political boundaries of the Municipality of Saanich. This chapter briefly describes:

- Physical resources including geology and physiology, climate and hydrology, soils
- Biological resources including vegetation communities, wetlands, wildlife and wildlife habitat, fish and fish habitat, and environmentally significant areas.
- Land use, including historical and current land use, municipal plans and zoning
- Community Profile including socioeconomic setting and public concerns

3.1 Physical Resources

The physical resources of the study area can be briefly described, including the geology climate, hydrology and soils of the study area. Base maps of the floodplain and soils of the study area are included in Appendix D. A more detailed description of the hydrology of Durrell Creek is included in Appendix C.

3.1.1 Geology and Physiography

The regional bedrock underlying the Saanich Peninsula consists of metamorphic gneiss, quartzite and metavolcanics, with argillites and greenstones fractured by faulting. The low rolling bedrock plain is covered with a thin veneer of glacial and marine deposits. These range from gravel and sand morainal deposits to clay, with pockets of organic soils and peat in the poorly drained low lying areas.

The Durrell Creek watershed consists of low rolling hills and flat lying small catchments. The height of land in the watershed is about 125m in the northwest, while the low point is less than 9m near the confluence of Durrell Creek and the Colquitz River. Small lakes and bogs are commonly found perched on the shallow bedrock surface. In the Durrell watershed, the bedrock uplands and the valley flats form two distinctly different physiographic types. The deep organic deposits beneath much of the flat lying valley floor are indicative of persistent wetlands (likely peat bog) prior to land clearing and drainage.

3.1.2 Climate and Hydrology

The closest operating Atmospheric Environment Service climate station to Durrell Creek with a long term record is Saanichton CDA. Based on the 30 years from 1951 to 1980, the mean daily temperature ranges from 5.8 C° to 13.4°C, with an annual mean of 9.6° C. Mean annual precipitation is 835mm, based on the entire 82 year period of record. The highest precipitation on record is 1186mm recorded in 1990; the lowest recorded annual total occurred in 1929, with 511mm of rain. Most precipitation falls from November to February, with average monthly totals ranging from 93 to 152mm. The driest months are July and August, with monthly averages of 19 and 25mm. Snowfall accounts for 4.5% of the total annual precipitation.

Inspection of the annual precipitation recorded at Saanichton CDA shows a long term trend to increased totals, as well as periods of unusually high precipitation that are often ten to fifteen years apart (Figure 3; Appendix C). The past ten to fifteen years have been unusually wet, contributing to increased flooding in Durrell Creek, both by raising water levels in the Colquitz River and by greater flows from Durrell Creek. At the same time, the precipitation falling in April and May has greatly increased, resulting in high water levels in the Colquitz River, poor field drainage and a late start for agriculture (Figures 4 and 5; Appendix C).

Hydrology

Durrell Creek is a tributary of the Colquitz River, which drains approximately 60% of the municipality's 150 square kilometres. The Durrell catchment area is roughly 5.3km^2 , so Durrell drains 3% of the municipality. Durrell Creek has never been gauged, but a station has been operated on the Colquitz River just downstream of the Durrell confluence. The Colquitz River at Durrell has about 24 years of record, as described more fully in Appendix C. The average mean annual daily discharge is 0.36m^3/s, with monthly averages ranging from 1.03m^3/s in January to 0.04m^3/s in August and September. The highest mean daily flow of 16.7 m^3/s occurred on November 23, 1990.

Water levels in the Colquitz River are very important to flooding in the Durrell Creek valley. During the winter season, flooding in the Durrell valley results from backwater from the Colquitz River. The backwater may flood as far upstream as the fields above Granville Avenue, and in extreme cases may result in flow reversals in Durrell Creek.

As Durrell Creek has not been gauged, a simulation model was used to generate a synthetic hydrograph (see Appendix C for details). Mean daily flows for existing conditions in Durrell Creek based on 22-years of climate and Colquitz River levels. The results indicate:

Average flow throughout the growing season (May - Sep) - 0.07 m^3/s

Average flow throughout the dormant season (Oct - Mar) - 0.21 m^3/s

Maximum monthly average flow (Nov) - 0.28 m^3/s

Minimum monthly average flow (Jul) - 0.05 m^3/s

Average annual flow - 0.14 m^3/s

Predicted annual peak instantaneous flows for Durrell Creek range from a maximum of 3.1 m^3/s, which occurred in 1990 to a minimum of 1.09 m^3/s, which occurred in 1994.

Mean daily water levels associated with the discharges are:

Courtland Flats

Average water level throughout the growing season (May – Sep) – El. 9.5 m

Average water level throughout the dormant season (Oct – Mar) – El. 9.7 m

Maximum monthly average water level (Nov) – El. 9.8 m

Minimum monthly average water level (Jul-Aug) – El. 9.5 m

Average annual water level – El. 9.6 m

Hastings Flats

Average water level throughout the growing season (May – Sep) – El. 9.7 m

Average water level throughout the dormant season (Oct – Mar) – El. 9.9 m

Maximum monthly average water level (Nov) – El. 10.0 m

Minimum monthly average water level (Jun – Sep) – El. 9.7 m

Average annual water level – El. 9.8 m

During extreme floods, water levels are assumed to be constant throughout the valley floor, therefore no distinction is made between Courtland and Hastings flats. The two predicted extremes are a maximum of 11.6 m, which occurred in 1990 and a minimum of 10.3 m, which occurred several times.

A frequency analysis was performed on the set of annual maximum water levels. Estimated water levels for 2-, 10-, 25-, 50-, 100- and 200-year returns were predicted. Selected peak flow estimates are as follows:

- 10-year – 11.3 m
- 25-year – 11.5 m
- 200-year – 12.1 m

Floodplain boundaries for existing conditions showing the area flooded during various sized storms are included in Appendix D. Land use, diversion or lowering the Interurban Road culvert have no effect on the floodplain boundaries and no maps were prepared for these different scenarios. The historic floodplain, prior to 1976, could not be calculated due to the lack of historic water levels on the Colquitz River.

Diversions

A number of drainage diversions either have occurred or are rumoured to have occurred in Durrell watershed over the years. Hoel Engineering Ltd (1996) and Santos (1998) report that a diversion of Porters (Francis King) Creek took place in the early 1960's. According to these accounts, the creek originally flowed south along the Charlton road alignment, under Burnside Road, eventually discharging into Portage Inlet. Porters Creek, which has a drainage area of about 1.1 km^2, accounts for roughly 1/5 of the existing watershed area. The date when the diversion occurred is unclear. Old airphotos from 1946 show a connection from Porters Creek to Durrell Creek.

In addition to Porters Creek, there are a number of other areas adjacent to the valley from which water is said to have been diverted, including the areas about BC Hydro's Goward Sub-Station, near Strawberry Vale School and along Hector Road west of Interurban Road.

Diversion of Porters Creek out of the watershed would cause a steady reduction of about 0.2 m^3/s in peak flows with a return period of 2 years or more (Appendix C; Table 9). Frequent flows would be reduced by an ever-increasing amount up to a maximum of about 0.5 m^3/sec (about a 50% reduction) for the 1-year flow. The 1-year flow represents a common event that is expected to be exceeded at least once a year. Re-diversion of Porters Creek would cause a reduction of about 0.1 m in water levels with a return period of 25-years or less. At greater return periods, the effect of the diversion is negligible.

Diversion of Porters Creek out of the watershed would slightly reduce the duration of flooding on Courtland flats. The time that water levels exceed 9.6m each year would be reduced from 150 days to 128 days, on average. The re-diversion would have a similar effect on the duration of flooding on Hastings flat.

Culverts

The Interurban Road culvert is a circular concrete culvert with a diameter of 1.65 m (65 in.). The culverts upstream invert elevation is 9.44m, which is 0.3 m above the ditch invert immediately upstream and more than 1.2 m above the deepened ditch on the west side of Courtland flats. The Interurban Road culvert controls drainage of upstream fields during the growing season.

The Wilkinson Road culvert is a 1.5 m by 3.0 m, concrete box culvert, located roughly 250 m upstream of the Colquitz River confluence. The upstream and downstream inverts of the culvert are 8.66 m and 8.55 m respectively. The cross-sectional area of the culvert is roughly twice that of the upstream channel, which would indicate that the structure has little effect on flood conditions upstream.

The culvert at Hastings St. controls drainage throughout the southern portion of Hastings Flats. The bottom of the culvert is at an elevation of about El. 9.6 m, which is about the same as the average ditch invert elevation in the area. During the site inspection, the entrance of the culvert appeared to be at least partially clogged with vegetation and silt.

There are several smaller culverts designed to provide drainage throughout the valley floor that are either collapsed, poorly positioned or overgrown with vegetation. The regular inspection and maintenance of all of these culverts should be thought of as a key component of flood control in the valley and drainage improvement on agricultural lands.

The hydrologic and hydraulic models show that the lowering the Interurban culvert actually causes a slight increase of about 0.1 m^3/s in annual peak flows from return periods from 2 to 200 years. This occurs because, for a given water level at Interurban Road (imposed by the Colquitz River), the lower culvert is able to pass more flow due to the increased headwater depth. Lowering the culvert also slightly reduced water levels with return periods of 2-years or less, lowering them by 0.1 to 0.2 m.

Lowering the Interurban culvert has a large effect in the duration of flooding on Courtland flats. The time that water levels exceed 9.6m each year would be reduced from 150 days to 37 days, on average. At Hastings flat, lowering the Interurban Road culvert provides a much smaller reduction in the duration of flooding. Lowering of the Hastings Street culvert and drainage improvements on the Hastings flat and Durrell Creek would be required to achieve the full benefit of lowering the Interurban Road culvert.

ARDSA Drainage Criteria

The analysis of flooding of agricultural land can be done in a quantitative context, using the ARDSA (Agricultural and Rural Development Subsidiary Agreement) drainage criteria. These criteria were developed to precisely describe how much drainage is needed to allow agricultural production to occur.

According to the 1999 field surveys, field elevations at Courtland flats range from 9.6 m to 9.9 m, with an average of about 9.7 m. At Hastings flats, field elevations range from 10.0 m to 10.4 m and average about 10.2 m. Base flow elevations are compared to field elevations in the following table.

	Field Level	Base Flow Elevation	
		Growing Season	Dormant Season
Courtland Flats	9.7m	9.5m	9.7m
Hastings Flats	10.2m	9.7m	9.9m

Note that freeboard over summer base levels under existing conditions is about 0.2 m on Courtland flats and about 0.5 m on Hastings flats. Both are well below the recommended minimum freeboard of 1.2 m, indicating that field drainage is impeded for the existing conditions in the Durrell Creek Valley. Lowering of the culverts under the Interurban Road and Hastings Street would be required to meet minimum freeboard elevations of 0.9 m.

The 10-year, 2-day rainfall total was estimated from a frequency analysis of daily precipitation at the Saanichton CDA climate station (see Appendix C). For existing conditions at Courtland flats, water levels rise over the minimum field elevation of 9.7 m rapidly to about 10.3 m, and then remain above the minimum field elevation for about 4 days. Elevations decline slowly to base flows over an additional two days. The two-day drainage criteria for the summer storm are not met.

At Courtland flats, diverting Porters Creek out of the watershed reduces the peak water level to an elevation of 10.2 m and reduces the duration of water levels above minimum field elevation by about 12 hours. Lowering of the Interurban Road culvert dramatically reduces the duration of flooding. Water levels rise to a lower peak, drop below minimum field elevations within 2 days, then continue to decline to the new lower base flow elevation set by the lowered culvert invert. The lowered culvert meets the two-day drainage criteria for summer storms.

For existing conditions at Hastings flats, water levels rise over the minimum field elevation rapidly, reaching a maximum water level of over 10.4 m. Elevations decline reasonably rapidly, dropping below the minimum field elevation in about 2.33 days. They then return to base flows over about two days. Hastings flats nearly meets the two-day summer drainage criteria. Diverting Porters Creek out of the watershed slightly reduces the peak water level and reduces the duration of water levels exceeding minimum field elevations to about 1.75 days. The diversion of Porters Creek would significantly reduce the runoff entering Hastings flats, resulting in reduced flood levels and flood duration.

The water level hydrograph, if the Interurban Road culvert is lowered, is similar to that for diverting Porters Creek, however water levels return to base flow elevations quicker. Lowering of the Hastings Street culvert and improvements to Durrell Creek, in conjunction with lowering the Interurban Road culvert, would further reduce the duration of summer flooding on Hastings flat.

The 10-year, 5-day storm at Saanichton CDA was estimated to be 124.0 mm (see Appendix C). For existing conditions at Courtland flats, water levels rise above minimum field elevations at the start of the storm, rise to a peak elevation of 10.9 m, and remain above minimum field elevations eight days after the start of the storm. The main volume of runoff associated with the event appears to be removed in about 5 days. However, water levels remain above field elevations because of high water levels on the Colquitz River. Therefore, the drainage requirement is not met.

At Courtland flats, the diversion of Porters Creek has little effect on the water level hydrograph, reducing water levels from a few cm to about 20 cm at the peak. Water levels still remain above field elevations. With the lowered culvert, water levels are below minimum field elevations for the first part of the storm, rise rapidly to 10.8 and then decline to about minimum field elevations within five days. Water levels remain at about field elevations because of high water levels on the Colquitz River, preventing field drainage.

For existing conditions at Hastings flats, water levels rise to just below minimum field elevations just after the start of the storm, rise to a peak elevation of about 11.0 m, and return to minimum field elevations after four days. Water levels near minimum elevations prevent field drainage. The diversion of Porters Creek would reduce flood levels by 10 cm throughout the storm, but it does not affect the duration of flooding. Lowering the culvert at Interurban Road has little or no effect on flood levels at Hastings flats. Lowering of the Hastings Street culvert and deepening of Durrell Creek, in conjunction with lowering the Interurban Road culvert, would be required to reduce the duration of winter flooding on Hastings flat.

The above results are for a particular combination of summer or winter storm precipitation and water levels on Colquitz Creek. The same storms, with different tailwater levels, may produce entirely different patterns of flooding.

3.1.3 Water Quality

Water quality in Durrell Creek has been an ongoing concern, with both human and animal wastes contributing to the problem.

In a study commissioned by Saanich, the water quality of Durrell Creek was tested over a four-month period from October 1998 to January 1999 (Good Environmental, 1999). Results of this sampling are summarized on the Fish and Water Quality map in Appendix D. Although a limited amount of sampling was done, the suspected water quality problems were evident. Several samples exceeded the British Columbia Water Quality Standards for Livestock for total suspended solids (100mg/L), phosphates (0.2mg/L and 200ug/L) and fecal coliforms (100 CFU/100ml). Because of the short sampling period, patterns in water quality were not established but leaking septic systems and cross-connections were both suspected.

During October/98, the station upstream of Interurban Road showed an unusually high amount of total suspended solids (620 mg/L). This happened once in four months. The field notes indicate that the water was shallow and murky at time of sampling, and the lab also noted that the sample contained a large amount of fine sediment. This and a nearby station had significant levels of phosphates. Several stations had elevated fecal coliform counts. November/98 saw a large increase in the amount of rainfall as compared to October. One station recorded levels of phosphate that were above the allowable limits. Another station had a slight slick on the surface at the time of sampling, and testing showed a small amount of oil and grease present. Four stations had elevated fecal coliform counts. December/98 was also a wet month and water levels were high. Fecal counts were elevated at three stations. Two stations had a slick on the surface and smelled of diesel. These findings are typical of road runoff introduced through the storm drainage network. Results were positive for oil and grease in the water and soil samples - levels were higher in the soil than in the water. Three stations had elevated fecal coliform counts. January, 1999 had less rain and lower water levels. One station had elevated levels of phosphates. Another station had a slight diesel smell and small slicks could be seen percolating up to the surface. The same three stations had elevated fecal coliform counts.

These results clearly indicated that there were water quality issues with Durrell Creek. The Capital Regional Health Board was notified and additional testing is ongoing to determine if leaking septic systems and/or sewer cross connections are the source of the elevated coliform counts.

3.1.4 Soils/Agricultural Capability

The soils found in the Durrell Creek Watershed are the result of complex geological and geomorphological events and processes that have occurred throughout geologic time. However, relatively recent periods of glacial and interglacial erosion and deposition over shallow bedrock have given the region much of its distinctive character. The majority of the area is occupied by unconsolidated surficial materials of relatively recent age. These sediments were deposited by glacial, fluvial and marine processes during the last 40,000 years. Five soil types, Metchosin, Tagner, Saanichton, Somenos, and Sprucebark, occur in the watershed. A detailed soils map was compiled from several published sources and field checked (Appendix D). An agricultural capability map based on the soils mapping was also compiled from existing sources and field checked (Appendix D).

Metchosin soils developed from very strongly to strongly acid organic deposits derived from mosses, sedges and other hydrophytic vegetation. These organic soils are well decomposed, 40-160 cm deep, occupy depressional areas, level slopes, and are very poorly drained. These soils are classified as Terric Humisols. These soils have an unimproved agriculture capability rating of Class 3 capable of producing a fairly wide range of crops, with the primary limitations being inundation (flooding) and excess groundwater. These soils can be improved to Class 2.

Tagner soils developed in deep, silty and/or clayey marine deposits that occupy depressional areas. Slopes are normally level to gently sloping. These soils are poorly drained and are generally free of coarse fragments. Dense compact subsoil layers restrict perviousness. These soils are classified as Humic Luvic Gleysols. These soils have an unimproved agriculture capability rating of Class 5 with the major limitations to agriculture being inundation (flooding)/ excess groundwater, and undesirable soil structure/low perviousness. These soils can be improved to Class 3.

Saanichton soils developed in deep, silty and/or clayey marine deposits that occupy level to gently sloping areas. These soils are well drained and are generally free of coarse fragments. Dense, compact subsoils can restrict perviousness. The usual taxonomic classification is Orthic Sombric Brunisol. These soils generally have an unimproved agriculture capability rating of Class 3 with the primary limitations to agriculture being undesirable soil structure/low imperviousness. Topography can also be a limitation, reducing the rating to Class 5. These soils can be improved to Class 2 (or 4, if topography is limiting).

Somenos soils developed from deep, gravelly sandy morainal deposits. These soils are well drained with 20-50% coarse fragments. The usual taxonomic classification is Duric Dystric Brunisol. These soils have an unimproved agriculture capability rating of Class 5 with limitations to agriculture being topography and shallow soils over bedrock. These soils can be improved to Class 4.

Sprucebark soils have developed in sandy bouldery and/or sandy rubbly colluvial or morainal deposits. These soils are less than 1m thick, overly intrusive bedrock, and are rapidly drained. The usual taxonomic classification is Orthic Dystric Brunisol. These soils have an agriculture capability rating of Class 7 with limitations to agriculture being topography and shallow soils over bedrock, and are unimprovable.

3.2 Biological Resources

Despite the long history of human occupation of the Durrell watershed, the area has a moderate amount of natural habitat. The watershed is approximately 25% forested, with the bulk of that forest cover located in the western end of the watershed in Francis King Park. This pattern is fairly typical of the rural-urban fringe around Victoria.

The description of the biological resources of the watershed can be subdivided into sections on vegetation communities, wildlife and wildlife habitat, fish and fish habitat, and environmentally significant areas.

3.2.1 Vegetation Communities

The Durrell Creek Watershed lies within the Coastal Douglas Fir biogeoclimatic zone. This zone covers a small area of BC's south coast, including a narrow band at low elevations along the southeastern coast of Vancouver Island. Sheltered by the rainshadow of Vancouver Island, the area experiences long dry summers and mild wet winters. In the past, Douglas-fir forests dominated this zone, but now only fragments of this rare ecosystem remain in an old-growth state. Nearly every type of old-growth Douglas-fir forest on this dry coastal plain is now rare or endangered, including the Garry oak meadow ecosystem, which is among the rarest in the province.

Most of the Durrell Creek watershed has been disturbed over time by logging, agriculture, grazing, urban development, and invasion of non-native plants. In the Durrell Creek watershed, only a small area of Douglas-fir forest within Francis-King Park remains in a relatively undisturbed old-growth state. However, a number of Garry oak meadow ecosystems and second growth Douglas-fir ecosystems exist (Appendix D).

Urban development is the major threat to these remaining forests, however urbanization is not the only threat. Fire suppression, overuse, and invasion by non-native plants such as Scotch broom, English ivy, Himalayan blackberry, and Eurasian spurge-laurel are also of concern. In addition, many of these sensitive ecosystems are on privately owned land. Active management, such as weeding, prescribed burning, and stewardship of older second-growth forest, will be required to maintain these ecosystems. Governments will need to take steps to create incentives for private landowners to preserve biodiversity on their land.

Wetlands

Eight wetlands along Durrell Creek and its tributaries were classified and mapped, according to the Canadian Wetland Classification System (Appendix D). The CWCS wetland classes reflect complex hydrological, chemical and biotic gradients. The five classes of wetlands recognized by the CWCS are bog, fen, swamp, marsh, and open shallow water. Wetland form is based on surface morphology and pattern, water quality, relationship to open water and morphology of the underlying mineral soil, as expressed by ecosystems that are established on the wetlands. Finally, wetland type is based on vegetation physiognomy (Zoltai and Vitt, 1995).

The field assessment of eight wetlands in the Durrell Creek watershed focused on vegetation composition and physiognomy, as well as on the hydrotopographic position of each wetland within the surrounding landscape. In the resulting classification, most wetlands were identified as various types of basin swamp. Characteristic vegetation in swamps includes a well-developed shrub or tree layer, while the bryophyte ground layer is poorly developed or lacking. Seasonal water level fluctuations and relatively strong water flow also characterize swamps, facilitating high levels of production and decomposition. It is the low water levels in summer months that permit the establishment of a well-developed tree or shrub layer (Zoltai and Vitt, 1995).

Throughout the Saanich Peninsula, swamps typically develop due to constraining topographic features. Water accumulates in depressions during winter months and is lost through evapotranspiration during warmer periods. More extensive wetlands, including seven large bogs once occurred on the Saanich Peninsula (McMinn et al. 1976), but most were drained and converted to agricultural use.

The Hastings and Courtland flats are difficult to classify, as most classification systems emphasize unmodified vegetation composition and physiognomy. As natural vegetation is absent, we can only speculate what class of wetland would have occurred prior to disturbance, or what class of wetland would develop if successional processes were to resume.

Wetland 1: The tall shrub basin swamp located between Densmore Avenue and Interurban Road north of the power station, is dominated by Pacific willow (Salix lucida), Hooker's willow (S. hookeriana), and red-osier dogwood (Cornus stolonifera). Sitka spruce (Picea sitchensis) occurs immediately to the west, while red alder (Alnus rubra) is found along the east side. Stands of trembling aspen (Populus tremuloides) and black cottonwood (P. balsamifera ssp. trichocarpa) border Interurban Road. Other shrub vegetation includes hardhack (Spiraea douglasii), Pacific crabapple (Malus fusca), Suksdorf's hawthorn (Crataegus suskdorfii) and pacific ninebark (Physiocarpus capitatus). Herbaceous species such as western buttercup (Ranunculus occidentalis), Cooley's hedge-nettle (Stachys cooleyae), Pacific water-parsley (Oeananthe sarmentosa), small bedstraw (Galium trifidum), slough sedge (Carux obnupta), and American brooklime (Veronica americana) are found in wetter areas. Common rush (Juncus effusus), reed canary crass (Phalaris arundinacea) and Himalayan blackberry (Rubus discolor), and trembling aspen indicate disturbance.

Wetland 2: The flooded field along Liberto Road is a heavily grazed wet depression with some standing water. It appears to lack native vegetation cover.

Wetland 3: Hector Wetland is a low shrub basin swamp dominated by hardhack and reed canary grass. The extensive cover of reed canary grass indicates that this wetland was likely farmed in the past. Tall shrubs surrounding Hector Wetland include Pacific willow, Hooker's willow, Scouler's willow (S. scouleriana), red-osier dogwood, red alder, cascara (Rhamnus purshiana) and Suksdorf's hawthorn.

Wetland 4: Trevlac Wetland is located along Hector Road near Trevlac Place. It is a tall shrub basin swamp with some standing water. Tall shrub vegetation is dominated by willows including Pacific willow, Hooker's willow, Scouler's willow and red-osier dogwood. Low shrubs include hardhack and invasive Himalayan blackberry in drier areas. Another non-native species is the European weeping birch (Betula pendula). In wetter areas, reed canary grass, skunk cabbage (lysichiton americanum), and cattail (Typha latifolia). Duckweed (Lemna minor) is found in standing water. Near the edges of the swamp are Sitka spruce, shore pine (Pinus contorta var. contorta), Pacific crabapple, cascara, and red alder. Trevlac Wetland has been incorrectly identified as a pine bog in previous reports, possibly due to the presence of shore pine. The absence of peat moss (Sphagnum spp.) and other bog-associated plant species such as Labrador tea (Ledum groenlandicum), bog laurel (Kalmia occidentalis) and bog cranberry (Vaccinium oxycoccos), however, indicate that this wetland is definitely not a bog. In addition, pH measured from a point sample of water collected from this wetland on June 1 1999 measures pH 6.5. This value is within the range expected for swamps, but far exceeds values expected for bogs (pH usually <4.0) (Vitt, 1994).

Wetland 5: Courtland Flats are seasonally flooded fields, currently under agricultural production. Ditches surrounding the fields contain reed canary grass.

Wetland 6 : Hastings Flats are seasonally flooded fields, currently under agricultural production. Ditches along the margins of the fields contain reed canary grass. Nearby shrubs include Suksdorf's hawthorn and red-osier dogwood.

Wetland 7: The wetlands across from Porter's Pond, along a private driveway off Granville Avenue, are old fields dominated by reed canary grass, interspersed with clumps of hardhack. The surrounding vegetation includes red alder, willows (Salix spp.) and English hawthorn (Crataegus monogyna).

Wetland 8: The large wetland downslope from the Nature House in Francis King Regional Park is a tall shrub basin swamp dominated by Pacific and Hooker's willows, red-osier dogwood, Pacific crabapple, and hardhack. The north end of the swamp is surrounded by western redcedar (Thuja plicata), while a well-developed stand of red alder occurs along the east side. The rich herbaceous layer includes skunk cabbage and lady fern (Athyrium felix-femina) in one area, while Cooley's hedge-nettle, Pacific water parsley, slough sedge, American brooklime, small flowered bulrush (Scirpus microcarpus), and beaked sedge (Carex rostrata) occur in another.

3.2.2 Wildlife and Wildlife Habitat

The Durrell Creek watershed provides considerable habitat for upland and wetland wildlife in spite of human settlement, albeit at low densities. Information for this section was derived from previously gathered Christmas and spring bird counts of the Hastings-Courtland flats (David Pearce; Green and Wightman SWANS, 1996), riparian inventory study field notes (Saanich, 1999), naturalists contributions (such as from Liane Gustafson), interviews with staff from BC Environment and Capital Regional District Parks Department (Francis/King Regional Park), our own air photo interpretation of the watershed and two days in the field in early June, 1999.

Amphibians

The American bullfrog is found throughout the Durrell system (L. Gustafson, personal communication). Staff at Francis/King Regional Park (pers. comm. to I. Robertson) identified the following species as occurring in the park: rough-skinned newt, western red-backed salamander, clouded salamander, Pacific treefrog, and red-legged frog. Three other species were identified as possibly occurring in the watershed: long-toed salamander, Oregon salamander, and western toad (S.A. Orchard, pers. comm.). Although these species are adapted to natural wetlands, certain species might use the flooded parts of the Hastings and Courtland flats for breeding. If they do, any proposed draining should take place prior to the middle of March to avoid wasting reproductive effort.

Reptiles

Several species have been identified as occurring or likely to occur in the Durrell Creek watershed: painted turtle (blue listed), northern alligator lizard, sharptail snake (red listed), western garter snake, northwestern garter snake, and common garter snake (S.A. Orchard, pers. comm.).

Birds

Waterfowl: Waterfowl use of the Durrell Creek watershed is primarily in the winter, when they congregate in certain key wetlands, particularly the Hastings and Courtland flats. At this location, the average total of water associated birds recorded during 1987 - 1995 Christmas Bird counts was 1001, with maximum counts somewhat greater (see table below). The bulk of the birds were dabbling ducks and Canada geese.

A total of 13 waterfowl species was recorded during these counts. The prominent species were trumpeter swan, Canada goose, green-winged teal, mallard, northern pintail, American wigeon, and ring-necked duck. Other species observed were northern shoveler, gadwall, Eurasian wigeon, canvasback, redhead, and bufflehead.

Hastings and Courtland Flats: Summary of Christmas and Spring Bird Count Data				
Species/ Species Groups	Christmas (1987/95)		Spring (1991/95)	
	Mean	High	Mean	High
Trumpeter Swan	7	36	1	1
Canada Goose	156	412	52	110
Dabbling Ducks	668	1315	60	97
Diving Ducks	74	288	1	6
Raptors	8	16	5	9
Shorebirds	11	36	21	32
Other Birds	77	253	43	71

Source: (Green and Wightman, 1996)

The Hastings and Courtland flats area also provide habitat in the spring, based on surveys conducted in early May in the years 1991 through 1995 (see table above). These surveys probably capture a combination of early breeding species such as Canada geese and mallard, as well as later breeding migrants such as American wigeon which would likely breed elsewhere. Though spring numbers were only one-tenth that of winter numbers, the number of dabbling duck species was one greater with the arrival of a few blue-winged and cinnamon teal offsetting the absence of Eurasian wigeon. The only diving ducks were a few records of ring-necked duck.

The seasonal timing of winter waterfowl use of the Hastings and Courtland flats is probably dependent on a combination of factors: primarily, the timing when the fields become flooded, and the seasonal arrival time of waterfowl. In the absence of weekly or bi-weekly counts, the following estimated time is partly conjectural as it applies to this area. Waterfowl start arriving in the Georgia Basin before the end of August, but the full complement of ducks is usually recorded near the first week of November (Vermeer, 1994; Breault and Butler, 1992). Numbers fluctuate over the course of the winter, but the onset of the dispersal away from wintering grounds is usually recorded before the end of March. This pattern likely applies to the Hastings and Courtland flats.

Some discussion has already been made of birds recorded in early May. Certain waterfowl are resident, particularly Canada geese and mallard. On Porter's Pond two broods of Canada geese were recorded (June 1, 1999), estimated at 45 days old. Mallards were also observed but no broods; they were probably under cover.

In addition to the Hastings and Courtland flats, and Porter's Pond there are other small wetlands in the Durrell Creek watershed. These appear to support small numbers of geese and ducks. There are records of Canada geese throughout the watershed. A waterfowl capability map is presented in Appendix D.

Canada geese are found in most areas where they can graze on grass; they appear to be less dependent on open water and flooded fields than the ducks. For example, draining of the Hastings and Courtland flats occurred during the winter of 1993-1994 (Green and Wightman, 1996). The Christmas Bird count of 1993 showed significant declines in dabbling ducks – 115 compared to the 1987-1995 average of 668, and diving ducks – 26 compared to the average of 74. Canada geese that year showed a modest increase – 183 compared to the average of 156. There were increases in raptors and other birds, discussed below.

Raptors: This category includes eagles, hawks, and falcons, as well as owls. Christmas and spring bird count data confirm some of the key species regularly observed (Green and Wightman, 1996). These include bald eagle, sharp-shinned hawk (Christmas only), Cooper's hawk, red-tailed hawk, merlin, peregrine falcon (Christmas only). In addition, local naturalist Liane Gustafson (pers. comm., May, 1999; letter to PGL, June 23, 1999) has passed on records of the occasional winter sighting of i) rough-legged hawk, ii) osprey, which breed on nearby Prospect Lake, and feed in ponds within the Durrell Creek watershed, and iii) northern harrier.

An active bald eagle nest is situated above the Hastings and Courtland flats. Over the last 10 years, it has produced 14 fledged young (L. Gustafson, pers. comm.). The location of this nest has been plotted on the wildlife map in Appendix D. Red-tailed hawks were frequently observed during our June 1, 1999 field trip and nesting was suspected above Hector Bog, though no nest was observed.

Owls are easily overlooked, but great horned owl sightings (2) were made during late summer and autumn watershed surveys. L. Gustafson's notes also refer to barred owl and northern pygmy-owl sightings. The *swarthii* (Vancouver island) subspecies of the latter is blue listed.

The limited raptor count data may not be sufficient to show any strong effect with respect to drainage of the Hastings and Courtland Flats. However, over Christmas, 1993 the raptor count (16) was the highest during the 1987-1995 period, but it was a single event. In early May, there was an average of 2½ raptors in 1991 and 1992, before more aggressive drainage, and an average of 6 thereafter. Most of this difference was based on numerous sightings of red-tailed hawks from 1993 to 1995. Their increased numbers might be explained by the increased amount of drained areas within which to forage for rodents.

Upland Game: This term is used here to include pheasants, quail, and pigeons. Ring-necked pheasants are reported as common in the cultivated and pastoral parts of the Durrell Creek watershed (L. Gustafson, pers. comm.). California quail are common throughout the drainage. Band-tailed pigeons and mourning dove were recorded by L. Gustafson (pers. comm.).

Waders and Shorebirds: This section combines herons, rails and coots, plovers and sandpipers. Great blue herons were not recorded during Christmas and Spring Bird Counts in the Hastings and Courtland Flats, but Liane Gustafson (pers. comm.) has records from the area and there are limited records of this blue listed (i.e. vulnerable) species from elsewhere in this watershed (Appendix D).

American coots were recorded on four out of the nine years of Christmas Bird counts at the Hastings and Courtland Flats (Green and Wightman, 1996); they were absent from the area in spring. They require considerable emergent vegetation from which to construct floating nests, when drained there is insufficient habitat at the Flats. There appears to be appropriate habitat at Porter's Pond, but our team did not observe them there. Virginia rail (1) was recorded during one of the five Spring Bird Counts at the Hastings and Courtland Flats, but better habitat is located at Porter's Pond and Hector Bog.

As a group, shorebirds were recorded regularly at the Flats during Christmas and Spring Bird Counts; individual species, however, tended to be irregular in occurrence (Green and Wightman, 1996). For example, while a total of 55 killdeer were observed during the nine Christmas Bird Counts between 1987 and 1995, these numbers come from only five counts, they were not recorded during the other four counts. A similar pattern applies to common snipe and greater yellowlegs. Only three species were recorded at Christmas. A total of nine species were recorded in spring, five of these based on one record. Of these species, killdeer are assumed to be resident and breeding in the watershed; we recorded young killdeer at Liberto Pond off Hector Road on June 1, 1999. The other species - greater and lesser yellowlegs, solitary sandpiper, spotted sandpiper, western sandpiper, least sandpiper, short-billed dowitcher, and long-billed dowitcher - are assumed to be migrants. We suspect common snipe breed in the watershed.

Other Large Birds: Turkey vulture, common nighthawk northwestern crow, and common raven are included here. The first is a species regularly observed over the rocky hills of the Coastal Douglas-fir biogeoclimatic zone (Gulf Islands, southeastern Vancouver Island). A total of 14 were observed during the Spring Bird Counts from 1993 to 1995. Common nighthawk, northwestern crow and common raven have been regularly recorded (Liane Gustafson, pers. comm.).

Other Birds: In addition to the birds mentioned above, at least 45 additional species have been recorded. These include rufous and Anna's hummingbirds, belted kingfisher, woodpeckers (4), and red-shafted flickers and passerines (39). The latter includes the introduced Eurasian skylark, whose local population is now declining. The blue listed Hutton's vireo also likely occurs.

Mammals

Mammals are much more secretive, and many species require special techniques to enumerate. Our list of mammals is presented with this limitation in mind.

Small Mammals: Shrews and voles have been recorded (L. Gustafson, pers. comm.), but specific identifications have not been made. The voles, in particular, as well as mice are assumed to be important elements in the diet of hawks and owls.

Beaver and Muskrat: American beaver have not been observed in the area of the Hastings and Courtland flats (L. Gustafson, pers. comm.), though they have been seen in the adjacent watershed (Viaduct flats). In contrast, muskrat are regularly observed.

Carnivores: According to L. Gustafson (pers. comm.) and staff from Francis/King Regional Park cougar occur in the Durrell Creek watershed from time to time. There are also records of mink and river otters from the Flats (L. Gustafson, pers. comm.). Black bears are recorded occasionally at Francis/King Regional Park.

Deer: Columbia black-tailed deer have been reported from the grounds of the Wilkinson Road Correction facility in the eastern part of the watershed to Francis/King Regional Park and the Hector Bog at its western and northern limits. A habitat capability/suitability map was prepared, which shows the extensive area of moderate class habitat in the watershed (Appendix D).

3.2.3 Fish and Fish Habitat

Durrell Creek (also listed in the DFO records as Jail Creek) flows into the Colquitz River, which flows from Beaver Lake to Portage Inlet. Durrell Creek flows through low gradient lands (<5%) into the Colquitz River. There are two major tributaries to Durrell Creek: Arnason Brook and Porter's Creek. There appear to be no significant barriers to fish migration (e.g. falls, high gradients or debris dams) in the Durrell Creek watershed. Some culverts under roads in the area affect flow regimes, but do not appear to present a barrier to fish movement.

For much of the summer season, Durrell Creek and its tributaries are dry or have very low flows and therefore provide poor or no in-situ fish habitat. However, Durrell Creek is tributary to the Colquitz River, which is a known salmonid bearing system. Summer discharge from Elk and Beaver Lake springs (Burns & Falls 1977) allows coho and cutthroat trout to persist in the heavily impacted Colquitz River. There is potential for overwintering habitat in Durrell Creek, especially during high flows in the Colquitz River.

Fish

Increasing land use and human disturbances adjacent to the Durrell and Colquitz watercourses have reduced salmonid populations to small or non-existent. Coho were the most abundant species found, however numbers have been declining drastically since the late 1970's. As many as 400 coho were found in the Colquitz River in 1947, but only 25 were counted in 1978. Coho transplants were initiated by Department of Fisheries and Oceans Canada (DFO) in 1983. Historically, all salmonids spawned in Rithet Creek, a tributary to the Colquitz River upstream of its confluence with Durrell Creek (DFO 1988). Despite the impacted habitat, the Colquitz system continues to support salmonid populations. Records indicate the presence of steelhead, cutthroat trout, chum and coho salmon.

There are no DFO escapement data for Durrell Creek or its tributaries. Streamkeepers data collected since 1998 confirm the presence of sticklebacks, sunfish and sculpins but no salmonids. As referred in the Riparian Inventory Report (Corporation of the District of Saanich, 1996), a long-time guard at the Wilkinson Penitentiary reported that salmon fry utilized Durrell Creek behind the jail 10-20 years ago. More recent reports (Brian Tucker, personal communication) indicate that coho fry were observed in the system in 1994.

In February 1999 one juvenile cutthroat trout was captured in Durrell Creek close to its confluence with the Colquitz River. It is unknown whether or not this juvenile was anadromous. Although anadromous cutthroat utilize accessible stream habitats ranging from large, turbulent rivers to tiny trickles, they are typically inhabitants of the small stream environment (Burns & Falls 1977).

It should be noted that none of these sources provide conclusive data on the presence/absence of salmonids in the Durrell system.

A man-made pond approximately 5m deep at the northeast end of Charlton Road contained rainbow trout until 1996, by which time otter, osprey and eagles had fished the pond out (District of Saanich, 1996). This pond connected to Durrell Creek, but had a screened gate on the outlet to prevent escape of the trout.

Habitat Alteration

About 20 years ago, the Colquitz River was already in a vulnerable state. In 1977 the Colquitz system was considered to be "terminally ill" and a very strong program of care and rehabilitation was required to restore a reasonable level of health (Burns & Falls 1977). Much of the system was polluted and it had been severely altered by land clearing, ditching, channeling and stream burial, all of which seriously reduced its value as salmonid habitat (Burns & Falls 1977). There were common occurrences where riparian areas were dug out adjacent to watercourses. Burn and Falls (1977) reported that dredged material was dumped immediately beside Jail Creek.

Marshall et al. (1977-79) commented in 1952 that the Colquitz River was utilized in residential areas for sewage disposal. Heavy silting also occurred in the Colquitz River in 1964 to 1971 due to increasing agricultural activity (Marshall et al. 1977-79).

Most of the riparian zone along Durrell Creek has been impacted by agricultural and/or residential activity. Livestock have direct access to the creek, and it is littered with garbage in several places.

In recent years, several volunteer groups have been cleaning and restoring portions of the Colquitz and Durrell systems. In many cases, the groups consist of volunteers with environmental and agricultural backgrounds and interests, working together to improve stream habitats.

Fish Habitat Constraints

Due to the presence of dominant species such as sticklebacks and sculpins, which are highly adaptable to changing environments, Durrell Creek currently has very limited habitat to offer for the more sensitive salmonid species. A review of stream data collected since 1996, along with a recent field survey, confirms that basic characteristics of preferred salmon habitat (suitable substrate, water temperature and cover) are almost non-existent in Durrell Creek.

For the majority of Durrell Creek and its tributaries, there is a lack of gravel for spawning activities. A substantial percentage of the watercourses lack large substrate (cobbles and boulders) and are dominated by fines and organics, resulting in poor water quality. It appears that in the upper reaches of Durrell Creek above Charlton Road, large substrate dominates and a more natural watercourse is present. A section of Porter's Creek just upstream of Charlton Road had exceptionally good habitat with abundant gravel and mature deciduous trees in the riparian zone.

The disturbed nature of the riparian zone adjacent to most of Durrell Creek, with its lack of mature deciduous and coniferous trees, results in little or no shading of the watercourse. A peak summer water temperature of 26°C – lethal to most salmonids – was recorded in Durrell Creek by Streamkeepers in 1998. Small shrubs dominate the riparian zone in some areas, but do not provide suitable cover for fish. Limited riparian vegetation also restricts the number of food sources (e.g. insect drop and leaf litter) for salmonids and other aquatic organisms.

A significant portion of Durrell Creek has been dredged and channelized, drastically reducing habitat complexity. Limited water flow, lack of riffle areas and naturally occurring large woody debris, along with a high number of stagnant pool areas all contribute to the relatively low salmonid habitat quality of Durrell Creek.

Several reaches of Durrell Creek have been enhanced by volunteer initiatives (riparian planting) and the potential to improve water quality contributions to the Colquitz system is an ongoing initiative supported by DFO (Cindy Harlow, DFO, pers.comm.).

3.2.4 Environmentally Significant Areas

The identification of rare and endangered ecosystems is important in watershed planning. Such ecosystems are often interdependent and should be considered within the context of the overall landscape. Some partially modified and non-natural ecosystems also function as: reservoirs for biodiversity in otherwise developed and urbanized landscapes, act as buffers between developed areas and the more fragile ecosystems, and provide wildlife corridors and important habitat niches throughout developed areas. The growing recognition of and interest in, rare and endangered ecosystems and species is accompanied by the increasing realization that even these modified ecosystems are increasingly being threatened by development.

There have been two studies of the significant ecosystems of the Durrell Creek watershed; one at the regional scale and one at the local level. The maps prepared by the two studies were compared, and the results are quite similar. The terrestrial ecosystems were mapped by the regional scale study, and included as is in the municipal ESA atlas. The main difference lies in the mapping and classification of all watercourses and riparian areas by the local study.

The regional study, conducted by Environment Canada et al (1999), was a Sensitive Ecosystem Inventory of East Vancouver Island and Gulf Islands between 1993 and 1997. The primary objective of the project was to systematically identify, classify and map ecosystems and other habitats of high biodiversity. Some sensitive riparian ecosystems were identified by this study, but none in the Durrell watershed. The maps were prepared at a scale of 1:20 000. The local study outlined Environmentally Significant Areas (ESAs) and was completed in 1999 by Saanich, in partnership with MOELP, DFO and the Real Estate Foundation. This document includes an inventory focusing on detailed field-based assessments of environmental features including all streams, lakes, wetlands and riparian vegetation. The mapping was completed on an orthophoto base at a scale of 1:11 000. The ESA map (Appendix D) prepared for this study used the findings of the municipal atlas.

As illustrated on the Environmentally Significant Areas map (Appendix D), patches of significant native vegetation have been identified in the Durrell Creek watershed. Francis King Park contains a large area which is characterized by an older (> 100 years) coniferous forest and some mix of broadleaf trees. There are some large specimens, 350 - 500 years old, present in the park. Wetlands and open woodlands including stands of Garry oaks are also present throughout the watershed, often located on private land, and have important ecosystem values.

3.3 Land Use

The Durrell watershed has a long history of human use. It has evolved from a hunting territory to an agricultural area to rural-urban fringe. The history of land use will be briefly described, followed by a summary of the current land use and municipal zoning, and a brief description of the socioeconomic profile of the community.

3.3.1 History of Land Use

The watershed is in the traditional territory of the Songhees and Esquimalt people, who are Coast Salish. The Courtland and Hastings flats area was the property of the Kosampson family, one of the five Lekwungen Family Groups in the Greater Victoria area. The area was used as a living area by the Kosampson family, including hunting, fishing and plant collecting.

The land was likely logged and recognized for its agricultural potential by the mid-1800's. The lowland areas of the Durrell Creek watershed have been farmed since the early 1900's. Several pioneering families who first farmed the Courtland-Hastings flats still remain in the area. BC's Colony Farms farmed a portion of this area to produce food for the province's penal system between 1944-1975. In 1990, a flood event resulted in extensive damage to crops on the Courtland and Hastings flats.

In 1908, the BC Electric Railway was built between Victoria and Sidney; including the placement of three railway bridges close together. The bridge nearest to Victoria at what is now Interurban Road became known as First Trestle. In 1925, the tracks were taken up and fill with culverts was used to lay the present road bed. In 1960, the bridge at Interurban

Road/Charlton Road was removed and replaced with a concrete culvert. In 1985, the culvert under Wilkinson Road was replaced. The lowland areas of the Durrell Creek watershed historically flooded every year during winter months. Floodwaters on Hastings Street reached elevations of three feet above the road in the fall of 1948 after a heavy rainfall (Daily Colonist, January 12, 1975).

In the early 1900's, three 5 acre parcels owned by the Gillie, Case and Scott families, now known as the Gillie Road lots, were subdivided during a land "boom" to create small single family lots by the Agnew and Fadden Development Company. A few of these individual lots sold, however, the firm went bankrupt, the development plan was unsuccessful, and all remaining unsold lots reverted to the Gillie family. This plot was farmed until 1971. In 1971, these lots were sold at values ranging from $1750 to $3450 by Colony Realty Ltd. (Times Columnist, June 27, 1971). The sale price was consistent with the low values for small farm acreages at that time. Many of the lots were bought sight unseen by speculators awaiting another "land boom".

Changes in land use over the past 50 years were examined using aerial photography, to assist in the hydrologic modelling (Appendix C). The results indicate a small decrease in forested and grassed land, a gradual decrease in agricultural land, a decrease in low density residential and an increase in medium and high density residential. The effective impervious area more than doubled from 4.7% in 1956 to 11.3% in 1999.

3.3.2 Current Land Use

The most common land uses in the Durrell watershed is agricultural and rural residential. In addition, some land has been developed as urban residential and a small portion is commercial/industrial and institutional. Institutional uses include Camosun College, Wilkinson Road Jail, and Strawberry Vale School. Parks include Francis-King and Strawberry Knoll. Approximately 25% of the area is forested with mature Douglas-fir and associated species, including areas of ecological significance.

Agriculture is a dominant land use within the Durrell watershed. The extent and variety of agricultural land uses has diminished over time in Saanich, but it is still an important contributor to the economy and lifestyle in rural Saanich. The current agricultural practices in the watershed were mapped, using zoning maps, the results of the land owner survey and other published information as sources (Appendix D).

The Courtland and Hastings flats are described by the farmers who have worked them as extremely productive peat lands, provided that they can get on the land early enough in the season and are not subjected to summer flooding. They believe that those flats contain up to 120 to 150 feet of peat and clay, similar to nearby Panama and Blenkinsop flats. Typically, farmers are unable to get on the land until May. Panama and Blenkinsop flats, where flooding is controlled, can be farmed starting in March which sometimes allows double cropping.

The Courtland and Hastings flats are currently producing 18 tons of standard potatoes per acre, with up to 20 tons produced a few years ago (R. Galey, pers.comm.). The Galeys are farming 37.5 acres, leased from 6 landowners. There are an additional 2 -3 acres that could also be farmed. Based on their experience on Blenkinsop flats, Galey's have a good idea what they would grow on the Courtland – Hastings flats if flooding was controlled. They would be able to double crop with early potatoes, and carrots, lettuce, cauliflower and cabbage. Longer season crops such as corn and onions could also be considered.

3.3.3 Municipal Plans and Zoning

The Durrell watershed is governed by the Saanich Official Community Plan (OCP) and the more detailed Local Area Plan for Rural Saanich. The Carey Local Area Plan addresses the residential area immediately to the south of the Durrell watershed. The OCP's general policies of maintaining rural land uses and protecting the environment are compatible with the goals of the IWMP. The Urban Containment Boundary and Sewer Enterprise Boundary, as indicated on the Zoning map in Appendix D, are important measures to control urban expansion. Designation of land in the Agricultural Land Reserve is also important in the protection of land suitable for agricultural production. The Local Area Plan for Rural Saanich which includes the Durrell watershed acknowledges that some contradictions exist between agricultural and rural residential land uses. In general, the document protects agricultural land use and practices, and confirms that rural residential lots in the Durrell area should be a minimum of 2ha. The Courtland-Hastings flats is designated as a Development Permit Area, for the protection of the environment. A development permit is required prior to any subdivision or building.

The Fill Prohibition Bylaw is an important tool in the protection of floodplain areas from filling (see map in Appendix D). The boundary is currently based at an elevation of 12.71m, and encompasses the Courtland-Hastings flats. It is intended to provide natural flood storage, rather than having to provide a man-made stormwater management system. This policy is in keeping with both the Agricultural Land Reserve restrictions on filling agricultural land and the recent trend to minimizing the environmental effects of diversion of runoff to stormwater systems.

The municipal zoning for the Durrell Creek watershed area was taken from the current zoning bylaw, and is indicated on the Zoning map in Appendix D. Categories of land use in the Durrell watershed are indicated in the table below.

Zoning	Name	Land Uses Permitted
A-1	Rural Zone	Agricultural, single family dwelling, boarding, home occupation, accessory produce sales, and accessory buildings and structures
A-2	Rural Zone	Agricultural, single family dwelling, boarding, home occupation, accessory produce sales, and accessory buildings and structures (min. lot size for subdivision 4 ha.)
A-5	Rural Zone	Agricultural, single family dwelling, boarding, home occupation, accessory produce sales, landscape contractor business, and accessory buildings and structures (min. lot size for subdivision 2 ha.)
P-1	Assembly Zone	Art Gallery, astrological observatory, church, college, day care centre, community centre, horticultural centre, library, museum, school, theatre, recreation facility, university, accessory residential, accessory buildings and structures
P-2	Utility Zone	Ambulance hall, fire hall, motor vehicle inspection station, police station, public utility, public works and storage yard including accessory retail sales, pump station, reservoir, accessory unenclosed storage, accessory buildings and structures
P-3	Personal Care Zone	Hospital, nursing home, accessory buildings and structures, community residential facility, congregate housing
P-4	Recreation and Open Space Zone	Community centre, park, recreation facility, accessory residential, accessory buildings and structures, day-care and preschool licensed under the community care facility act
P-4N	Natural Park	Natural park, nature centre, accessory residential, accessory buildings and structures
P-11	Public Institution	Hospital, college, university, office, research, community residential facility
RD-1	Two Family Dwelling Zone	single family dwelling, two family dwelling, boarding, home occupation, and accessory buildings and structures
RS-6	Single Family Dwelling Zone	single family dwelling, boarding, home occupation, and accessory buildings and structures

3.4 Community Profile

The residents of the Durrell watershed do not identify themselves with that name; they are generally considered Saanich residents. The Courtland-Hastings flats and Strawberry Vale areas have distinctive character and are referred to as such. The name First Trestle Valley, which referred to a feature of the BC Electric Railway, is also by some used to refer to the same area. While it has no named identity, the Durrell watershed is considered an attractive area to live in, and the residents take considerable interest in their community. There is a strong desire to preserve the agricultural character of the area, as well as protection and enhancement of environmental and recreational features. Several community groups have either taken an interest in or been formed to address watershed issues:

- Courtland-Hastings Agricultural Preservation Society (CHAPS)
- Strawberry Vale Wetlands and Agricultural Lands Nature Stewardship Project (SWANS)
- First Trestle Valley Ratepayers and Residents Association
- Strawberry Vale Ratepayers and Residents Association.

3.4.1 Socioeconomic Setting

The Durrell Creek watershed is located within the Municipality of Saanich, a suburban/rural community that is part of the Capital Regional District. The Capital Regional District has a population in excess of 300 000 people, 51% of Vancouver Island's total population. Saanich has 32% of the population of the Capital Regional District. Saanich had a population of 105,393 in 1996, which is projected to increase further. Population growth is expected to place pressure on all forms of urban services, including water, sewerage and solid waste disposal, transportation and housing. Pressure for expansion is expected to challenge traditional patterns of residential development, threaten agricultural land, and deplete environmental resources. Regional initiatives, including the Regional Development Strategy, Regional Transportation Strategy, Planning for Regional Parks, CRD Healthy Atmosphere 2000, Healthy CRD 2000, Liquid Waste Management, Solid Waste Management, and Regional Values Goals and Priorities, demonstrate regional cooperative initiatives to tackle these challenges.

3.4.2 Public Concerns

As an integral part of this study, public consultation was conducted to solicit input to the issues and solutions for watershed management. Two open houses and a landowner survey were the main tools used to obtain public feedback. It was also assumed that the local residents on the Committee provided ongoing input regarding local concerns. Copies of the consultation materials including the landowner survey, the survey results and open house handouts and questionnaires are all included in Appendix E.

In the last few years, there has been renewed interest in both the environment and recreation in the watershed. There are also concerns over gradual habitat loss and the need to maintain and improving the environment from a fish and wildlife habitat perspective. Simultaneously, the need to provide opportunities for passive recreation has been raised in the community. In recent years, landowners have complained that their land has been flooded beyond the normal winter conditions and occasionally they have been unable to harvest crops. In relation to water flows in Durrell Creek, there has been a claim that natural flows from an adjacent catchment area may have been diverted to this creek resulting in higher than normal flood conditions. There are claims that the installation of the Interurban/Charlton Road culvert and the surrounding road base resulted in restrictions and limitations to the natural drainage capabilities and detention of water on the valley floor. Many of the Gillie Road lots are subject to flooding and under current conditions unable to be used for single family use.

Landowner concerns were also solicited during the open houses as part of this study, as well as the landowner survey distributed in June, 1999. The results of the survey are given in Appendix E.

Chapter 4 – Issues and Options

To help clarify the topics to be addressed by the IWMP, a list of specific issues was generated and reviewed with the Committee. The issues are largely based on the desired outcomes, as stated in chapter 1.4.2, that formed the terms of reference for this study. The list was refined and revisited throughout the process of proposing options and moving forward to the development of scenarios. Some of the working tools of the options assessment phase are included for reference in Appendix F.

4.1 Description of Issues

The following list of issues was developed, under the five headings which roughly group the concerns by subject area.

Water Management

- Flooding of agricultural land and valley flat of Durrell Creek
- Improvement or replacement of local drainage structures
- Lack of stormwater detention and treatment
- Non-structural options for water management

Agriculture

- Risk of crop loss/shortened growing season on Courtland-Hastings flats
- Desire to promote agricultural practices that are consistent with environmental guidelines
- Desire to improve returns from agricultural production
- Desire to prevent loss of land base /encroachment on farm land

Environment

- Water quality below acceptable standards
- Gradual habitat loss/loss of biodiversity

Recreation

- Lack of adequate opportunities for passive recreation
- Desire to maintain or improve aesthetic values/liveability of watershed

Land Use

- Underutilized undeveloped road rights of way
- Lack of resolution of long term use of Gillie Road lots
- Desire for healthier environment through land development/land use guidelines
- Long term infrastructure requirements to satisfy expanding population

This list was reviewed and refined periodically through consultation with the Committee, up to and including the scenario development phase. A number of the issues were dropped from further consideration. The issues dropped and the rationale for that decision are summarized below. The dropped issues were felt to be either of no concern to local residents or the solution was beyond the scope of this plan.

4.2 Identification of Options

For each of the issues identified in the previous section, a range of options was presented to the Committee for discussion at a full day workshop. A total of 108 options were developed by the consulting team and tabled for the Committee's consideration. The full list of possible options is included on a worksheet in Appendix F. Many of the options were based on concepts that had been proposed by various stakeholders or Committee members. All options were included in the long list, and given equal consideration. The goal was to systematically review all possible solutions to the issues raised and document the decisions as to their viability.

4.3 Options Assessment and Refinement

The Committee worked through an options assessment process in detail, considering the viability of individual options, the effects of the option and the compatibility with other options. A total of 70 of the 108 original options were dropped at a first workshop. Several subsequent meetings continued the process of refinement of the options and in particular, the compatibility of the proposed solutions.

For each of the issues, the following sections summarize the options considered, the Committee's recommendation, and some background on that recommendation.

4.3.1 Water Management Options

Issue: How can we reduce the risk of flooding of agricultural land and valley flat of Durrell Creek?

Potential Options	Committee Recommendations
Reduce water levels in Colquitz Creek	Not recommended for further consideration
Store water in Elk and Beaver Lakes	General Recommendation - additional study required that is outside scope of IWMP
Diversion of tributaries of Durrell Creek out of watershed	Not recommended for further consideration
Retention or detention storage in Durrell watershed - one large structure	Not recommended for further consideration
Develop retention storage ponds in tributaries of Durrell Creek	Recommended for further consideration in the context of stormwater treatment, fish habitat, waterfowl management, recreation, and aesthetic objectives
Convert Interurban Road to a dyke	Recommended for further consideration
Channel Maintenance of Durrell Creek/ maintain and enlarge local drainage ditches	Recommended for further consideration
Improvement or replacement of local drainage structures	Recommended for further consideration
Replace Interurban Road culvert	Recommended for further consideration
Replace culverts on Hastings and Granville	Recommended for further consideration
Raise elevation of Courtland-Hastings Flats	Not recommended for further consideration
Master Drainage Plans/Best Management Practices	General recommendation - further detailed study not required

Option: Reduce Water Levels in Colquitz Creek - NOT RECOMMENDED FOR FURTHER CONSIDERATION

There were three options proposed to reduce flood levels in Colquitz Creek that would help address winter flooding in Durrell Creek. The first two were deleted from further consideration:

- Remove bedrock obstructions in channel bed, as described by KPA Engineering Ltd and PJ Santos, P.Eng. This option is thought to have no effect on reducing maximum water levels at Loenholm Road, or the mouth of Durrell Creek. This option would also have no effect on reducing base flow levels in the agricultural area in Durrell Creek, which are controlled by the culverts at Interurban Road and Hastings Street. Removal would require permission of the Department of Fisheries and Oceans (DFO) and may be opposed. Consequently, this option was eliminated.

- Clear the channel of Colquitz Creek by removing riparian vegetation from the banks, reduce the channel roughness, and lower flood levels by about 0.5 m at Loenholm Road. Maintenance would be required to maintain the benefit. Mechanical clearing would most likely be unacceptable to both DFO and MOELP due to the effect on substrate and bank stability. This option was eliminated.

  Hand clearing in Colquitz Creek near the mouth of Durrell Creek, as part of a stream restoration project, may be acceptable. This would probably only reduce extreme water levels by 10 or 20 cm, at best, and would have no effect on summer base flows.

Option: Store Water in Elk and Beaver Lakes - PROVISIONAL

Beaver and Elk Lakes have a storage licence for 2,800 acre-feet. At present, they are operated to store water in the spring, re-installing flash boards in January, for summer base flow release. It would be difficult to increase storage by raising water levels -- infrastructure around the lake would be flooded and the dam and cut-off berm only has a small freeboard.

However, the licensed storage on Beaver and Elk Lakes is substantial. It may be possible to reduce water levels along Colquitz Creek, and at the mouth of Durrell Creek, by either altering the operation of the existing dam, or by developing bottom storage, by lowering the existing outlet. A detailed hydrologic study would be required to evaluate the potential reduction in water levels and the potential benefits to the floodplain of the Colquitz River and Durrell Creek, and the effects of this option on lakeshore habitat and lakefront properties would need to be evaluated. This option would require further investigation to determine feasibility and benefits.

Option: Diversion of Durrell Creek tributaries out of the watershed - NOT RECOMMENDED FOR FURTHER CONSIDERATION

There were two options proposed for diversion of tributaries, both of which include Porter (Francis King) Creek. This option is based on the suspicion that historical diversion of this creek into the Durrell system has caused some of the flooding.

- Divert Francis King Creek to Portage Inlet. Diversion of this tributary would reduce extreme water levels by a few centimetres and reduce average winter water levels by about 6 to 8 cm. It would also reduce base flow elevations in summer by 1 cm on Hastings and Courtland flats and reduce winter base flow elevations by about 4 cm. Summer peak water levels would be reduced by a few centimetres and the duration of flooding would be marginally reduced.

This project would have to take place on private land, requiring an easement and a water licence, to be held by Saanich or a local dyking district, and a detailed environmental assessment of Durrell Creek and the receiving stream. Interbasin diversions are considered risky by agencies (DFO, MELP) and landowners on the receiving stream would likely be opposed. As a result of the limited benefits to water levels and the potential strong opposition, it is recommended that this option be eliminated from further consideration.

- Divert Francis King Creek and the northern tributary to Durrell Creek to Portage Inlet. Eliminate for the reasons above.

Option: Retention or detention storage in Durrell Watershed – One large structure – NOT RECOMMENDED FOR FURTHER CONSIDERATION

There were two options proposed for detention (stormwater) storage. The best site for a single facility would be on the flats, downstream of the junction of Francis King Creek and the north tributary, with Durrell Creek. The large facility should be eliminating, while the small facilities on the Durrell tributaries can be retained for further consideration.

- Construction of a large facility on the valley bottom would flood private, agricultural land, requiring purchase or expropriation. This project would also require a water licence and a long, expensive berm or dam. Assuming that 3 m of storage can be developed, about 5 ha would be required to reduce the winter peak flow by half; however, a much smaller pond could treat summer storms. The storage facility would only have a minor effect (less than 10 cm) on extreme water levels and it would not significantly reduce winter or summer base flow elevations. However, the facility could eliminate summer flooding of agricultural fields, in combination with a flap gate on the culvert beneath Interurban Road, and provide irrigation water (if required).

This option was eliminated because of potential conflict with agricultural development, and high cost of construction.

Option: Develop retention storage ponds in tributaries of Durrell Creek – RECOMMENDED FOR FURTHER CONSIDERATION

At least three tributaries contribute flow to Durrell Creek – Porter Creek, an unnamed tributary to the north, and Arnason Creek. It may be possible to develop retention storage along these creeks to help manage floodwaters on the valley bottom. Individual facilities would be small and we anticipate that it would be difficult to find suitable sites to develop adequate storage at a reasonable cost. Construction of a small facility on the valley bottom would flood private land and may require purchase or expropriation.

The storage facilities would provide only a small contribution to reducing extreme flood levels as they would usually fill before the peak of the flood. They would also not contribute to reduced summer base flow elevations in summer as these are primarily controlled by culvert elevations. However, the reservoirs could be operated to reduce maximum discharges during summer storms and the duration of flooding of agricultural land. Modelling of the effect of reservoir storage on the duration of flooding is beyond the scope of the work that is currently planned. Note that if the reservoirs are operated to help manage summer flooding, they would be drawn down to minimum levels so that they would not also provide storage for irrigation water.

Summer flooding can be controlled for much less cost by pumping, as described below.

Option: Convert Interurban Road to a Dyke - RECOMMENDED FOR FURTHER CONSIDERATION

As part of this option, Interurban Road would function as a dyke, with a flapgate on the structure at Interurban Road to prevent backflow from the Colquitz River, and a pump station to pass drainage from Durrell Creek to the other side of Interurban Road.

There are four options that could be undertaken as part of this project that vary in cost and complexity. These have been assessed at the conceptual level only and would require technical feasibility analysis to confirm details and costs. They are described in order from the least to most costly:

- Place a flap gate on the existing Interurban Road culvert and purchase a pump. Operate the pump to draw down water levels in early April and help maintain water levels during the summer. This option would lengthen the agricultural season, provide a minor improvement in freeboard during the summer, and reduce the height and duration of summer flooding. It would not reduce winter base flow levels, the duration of winter flooding or extreme water levels.

- Lower the existing Interurban Road culvert by 0.8 m, to about the same elevation as the invert of the culvert at Wilkinson Road. Place a flap gate on the downstream end of the culvert. Purchase a pump and construct a pump house that would draw water levels to the base level in early April (about 8.9 m) and maintain them at that elevation until the end of September. The bed of Durrell Creek would be lowered, as required, and the culvert at Hastings Creek, and the ditch on Hastings Flat would also be lowered, with the culvert replaced. This project would lengthen the agricultural season and provide a freeboard of about 0.8 m on Courtland Flats and about 1.2 m on Hastings Flat. Summer flooding of the fields would be eliminated. The project would not improve winter drainage or lower extreme water levels, though the lower culvert may improve winter drainage and reduce the duration of flooding.

- As above, except replace the Interurban culvert with a larger capacity flood box (size to determined later). The project would meet the summer agricultural criteria described above, plus reduce winter water levels and the duration of winter flooding. The larger flood box may also reduce annual costs of pumping; however, it may also affect seasonal waterfowl habitat on the Durrell Creek flats. The larger capacity flood box may reduce the annual contribution for pump operation.

- As above, except size the pump to meet winter drainage criteria for agricultural lands, providing sufficient capacity to return to base flow elevations within the appropriate length of time. This project would provide an opportunity for perennial crops but would alter seasonal waterfowl habitat on Courtland and Hastings flats.

Issue: Is it worthwhile to improve or replace local drainage structures?

Option: Channel Maintenance of Durrell Creek - RECOMMENDED FOR FURTHER CONSIDERATION

Durrell Creek flows on a low gradient, however, its capacity is further reduced by growth of aquatic vegetation, variations in the cross sectional area along the channel, and deposition of silt and organic material on the bed of the stream. One option would be clear the channel every year with a backhoe. An alternative might be to clear and improve the channel section, then plant riparian species that can survive winter flooding that will shade the channel and reduce growth of aquatic plants. Co-operation from the Wilkinson Road Jail would be required.

Channel maintenance is expected to have no effect on extreme water levels, to slightly reduce flood levels during summer storms, and to reduce the duration of flooding, and the time to drain agricultural lands following summer storms. It is recommended that maintenance of Durrell Creek occur as part of all the options described above. Annual costs can be estimated from previous channel clearing programs by Saanich.

Option: Replace Interurban Road culvert - RECOMMENDED FOR FURTHER CONSIDERATION

In this option, the existing culvert beneath Interurban Road would be lowered by 0.8 m to about the elevation of the invert of the culvert beneath Wilkinson Road. As part of this project, bed elevations upstream of Interurban Road would also be lowered, and the channel from Interurban Road to Wilkinson Road improved. Reducing the elevation of the culvert invert lowers summer base flows by about 0.5 m, providing a freeboard of 0.8 m, on Courtland flats. After lowering the culvert, the 10-year, two-day summer storm does not raise water elevations to the typical or average field elevation. Flooding would be confined to elevations below 9.5 m, in low-lying areas along Durrell Creek itself.

The lowering of the Interurban culvert would not reduce the summer base flow elevation on Hastings flat. This would require replacing or lowering the culvert beneath Hastings Street and deepening the ditch on Hastings flat. The lowered culvert would not reduce extreme water levels in Durrell Creek. However, it may improve winter drainage, reducing average winter water levels and the duration of flooding, and providing lower water levels in the spring. The degree of improvement will be examined in the linked hydrologic and hydraulic model. Maintenance of Durrell Creek upstream and downstream of Interurban Road would also be required to maintain drainage.

Option: Replace Culverts at Hastings Street and Granville Avenue- ONLY ONE RECOMMENDED FOR FURTHER CONSIDERATION

Due to the elevation of the fields and the culvert inverts, it would be worthwhile to lower the Hastings Street culvert. On the other hand, the Granville Avenue culvert is too high to make any difference to backwater flooding. Although the elevation of the lands west of Granville protect them for flooding caused by backwater from downstream, inundation occurs frequently. Flooding at this location is more likely a function of conveyance capacity and condition of this culvert, and Saanich has plans to replace it.

Issue: How can we improve stormwater detention and treatment?

Potential Options	Committee Recommendations
Develop retention storage ponds in tributaries of Durrell Creek	Recommended for further consideration in the context of stormwater treatment, fish habitat, waterfowl management, recreation, and aesthetic objectives.

Based on techniques recommended in the King County "Surface Water Design Manual," a water quality pond would require a dead storage volume of about 13,000m^3 per km^2 of watershed area to be treated, which is about the watershed area of the largest tributaries to

Durrell Creek. The King County technique was developed for a wetter climate than occurs in Saanich and likely over-estimates pond sizes for Durrell Creek, where rainfall intensities are less.

Assuming that the dead storage in the pond averages about 1.5m deep, the pond would require a surface area of 8,500m^2 or say about 100m long x 85m wide. Much smaller ponds would be appropriate for the smaller tributaries. The ponds would be quite large and they would all be on private land near the mouths of the creek requiring purchase, negotiation, or expropriation of the property.

Issue: Are there viable non-structural options for water management?

Option: Master Drainage Plans/Best Management Practices - RECOMMENDED FOR FURTHER CONSIDERATION

Committee members suggested non-structural alternatives for water management such as Master Drainage Plans and adopting Best Management Practices (BMPs) for development. Neither of these approaches would resolve existing flooding problems on Courtland and Hastings flats, though they may help prevent future deterioration.

Issue: Raise elevation of Courtland- Hastings flats

Option: Use fill to raise elevation of Courtland-Hastings flats - NOT RECOMMENDED FOR FURTHER CONSIDERATION

This option was suggested by Committee members and would involve stripping and stockpiling topsoil, adding fill to raise the elevation of the fields, and replacing the topsoil on top. Raising of the fields above the elevation of flooding may resolve problems in this watershed, however, this option does not comply with the Fill Prohibition Bylaw. In addition, since Courtland-Hastings flats are within the Agriculture Land Reserve, a permit may be required under the Soil Conservation Act and/or the Agriculture Land Commission Act. It is a policy of the Commission not to allow widespread filling to create a uniform elevation above the floodplain but rather allows perimeter flood control measures such as dyking and/or ditching.

4.3.2 Agriculture

Issue: How can we minimize the risk of crop loss on Courtland-Hastings flats?

Potential Options	Committee Recommendations
Provide ARDSA drainage and flood control to winter standards	Recommended for further consideration.
Provide ARDSA drainage and flood control to summer standards	Recommended for further consideration.
Construct stormwater detention facilities	Recommended for further consideration in the context of stormwater treatment, fish habitat, waterfowl management, recreation and aesthetic objectives
Channel Maintenance of Durrell Creek/ maintain and enlarge local drainage ditches	Recommended for further consideration
Prevent unauthorized fill placement	General recommendation of IWMP - further detailed study not required
Provide information on landowner drainage responsibilities	General recommendation of IWMP - further detailed study not required
Support implementation of Draft Agricultural Ditch Maintenance Guidelines	Not recommended for further consideration
On-farm drainage improvements	Recommended for further consideration

Option: Provide ARDSA drainage and flood control to winter standards - RECOMMENDED FOR FURTHER CONSIDERATION

Obtaining ARDSA drainage and flood control to winter standards in the Durrell Creek Watershed would allow perennial cropping of Courtland-Hastings flats. The economic and environmental costs involved in obtaining these standards can be reviewed, to determine if they are justified by the benefits to agriculture production. The seasonally flooded fields are classified as an Environmentally Sensitive Area by Environment Canada's Sensitive Ecosystems Inventory, and draining of the fields in winter to ARDSA standards would alter wildlife habitat. This option is not desired by the majority of residents of the watershed.

Option: Provide ARDSA drainage and flood control to growing season standards - RECOMMENDED FOR FURTHER CONSIDERATION

Providing ARDSA drainage and flood control to summer standards would increase cropping flexibility, allow production of new crops (such as carrots, onions, corn, and cauliflower), expansion of existing operations, changes to on-farm drainage, and may allow double cropping of much of the flats in one season. ARDSA summer drainage would not affect wildlife use of the fields in the winter months.

Option: Construct stormwater detention facilities - refer to option under water management section

As outlined in the water management section, two options were considered: constructing a single large facility and construction of several small facilities. Construction of a large facility on the valley bottom and was eliminated because of potential conflict with agricultural development (the facility would flood private, agricultural land requiring purchase or expropriation), and high cost for construction. Construction of small facilities on the tributaries of Durrell Creek is recommended for further consideration.

Option: Maintain and enlarge local drainage ditches - refer to option under water management section

As discussed above, channel maintenance is expected to have no effect on extreme water levels, slightly reduce flood levels during summer storms, reduce the duration of flooding, and reduce the time to drain agricultural lands following summer storms.

Option: Prevent unauthorized fill placement - RECOMMENDED FOR FURTHER CONSIDERATION

Placement of fill within the Fill Prohibition Area is regulated by Saanich's Fill Prohibition Bylaw. Modification of boundary of the Fill Prohibition Area is a potential outcome of this study depending on the type and extent of water management practices that are implemented and their effect on floodplain boundaries. If modification of the Fill Prohibition Area is warranted, details will be provided within the land development guidelines section of the IWMP.

Option: Provide information on landowner drainage responsibilities - RECOMMENDED FOR FURTHER CONSIDERATION

As part of the IWMP, information will be provided to landowners on how to maintain local drainage ditches, and other drainage responsibilities.

Option: Support implementation of Draft Agricultural Ditch Maintenance Guidelines - NOT RECOMMENDED FOR FURTHER CONSIDERATION

Currently, BCE, DFO, BCMAF and the BC Agriculture Council are developing ditch maintenance guidelines. A pilot test project was carried out in the Fraser Valley this past summer, however, results on the pilot test are not yet available and agencies are still in the process of reviewing the guidelines. We do not recommend implementation of these guidelines at this point in time for the Durrell Creek Watershed, until the success of the pilot program is known. In addition, the guidelines were developed for conditions in the Fraser Valley, and may require modification to meet conditions observed in the Durrell Creek Watershed.

Option: On-farm drainage improvements - RECOMMENDED FOR FURTHER CONSIDERATION

With implementation of one or more of the above water management options, on-farm drainage improvements such as installation of drainage tiles and pumping in spring/early summer will be considered.

Issue: How can we improve returns from agricultural production?

Potential Options	Committee Recommendations
Provide suitable quantity/quality irrigation water	Not recommended for further consideration
Increase cropping flexibility	Not recommended for further consideration, as this option is an outcome of improved drainage and flood control. Various strategies under this option may be suitable at a municipal or regional scale.
Establish equestrian trail network	Recommended for further consideration

Option: Provide suitable quantity/quality irrigation water - NOT RECOMMENDED FOR FURTHER CONSIDERATION

No concerns have been raised over the quantity or quality of irrigation water in the watershed. Currently, Courtland-Hastings Flats uses municipal water for irrigation.

Option: Increase cropping flexibility – PROVISIONAL

This option is better described as an outcome of improved drainage and flood control. Water management options will provide drainage and flood control to ARDSA summer (or winter) standards, increasing cropping flexibility.

- Attract businesses that use high quality local agricultural products as raw materials – NOT RECOMMENDED FOR FURTHER CONSIDERATION
- Develop local government procurement policies to utilize local produce – NOT RECOMMENDED FOR FURTHER CONSIDERATION
- Support development of co-operative commercial kitchen utilizing local produce – NOT RECOMMENDED FOR FURTHER CONSIDERATION
- Support direct marketing initiatives of the Island Farmers Alliance- NOT RECOMMENDED FOR FURTHER CONSIDERATION
- Promote and advertise local agricultural producers and products- NOT RECOMMENDED FOR FURTHER CONSIDERATION
- Contribute to consumer awareness and education initiatives about local agriculture- NOT RECOMMENDED FOR FURTHER CONSIDERATION
- Facilitate subscription marketing of local produce- NOT RECOMMENDED FOR FURTHER CONSIDERATION
- Provide locations and structures for farmer's markets- NOT RECOMMENDED FOR FURTHER CONSIDERATION
- Encourage agricultural apprenticeship programs- NOT RECOMMENDED FOR FURTHER CONSIDERATION
- Address farm vehicle movement in the City's transportation plan- NOT RECOMMENDED FOR FURTHER CONSIDERATION
- Encourage agri-tourism- NOT RECOMMENDED FOR FURTHER CONSIDERATION

The above options are not recommended for further consideration. One of the goals of the IWMP is to improve returns from agricultural production by improving summer drainage and flood control. These other options may be valid, however they require policy direction on a municipal or regional scale. General recommendations will be made in the IWMP that relate to some of these issues, such as recommending the Municipality develop an Agricultural Plan, similar to the plan being developed for Surrey.

Option: Establish equestrian trail network - RECOMMENDED FOR FURTHER CONSIDERATION

From the landowner survey and information contained on the agricultural practices map, it is clear that equestrian operations are a prevalent agricultural land use in the watershed. Interest has been expressed in establishing a network of equestrian trails to link operations within the watershed. An equestrian trail network would provide additional recreational opportunities, promote agriculture, and may improve this sector of the local economy. The exact location of these trails is unknown, and may include some level of multiple use (alongside pedestrian trails) of the undeveloped ROW's.

Issue: How can we prevent the loss of land base/encroachment on farm land?

Options:

- Encourage more local involvement in Agriculture Land Commission applications - RECOMMENDED FOR FURTHER CONSIDERATION
- Encourage non-farming property owners to make land available for tenant farming- RECOMMENDED FOR FURTHER CONSIDERATION
- Require farm plans for property transfers to non-farmers for unspecified purposes - RECOMMENDED FOR FURTHER CONSIDERATION
- Encourage agriculture in lots adjacent to ALR - RECOMMENDED FOR FURTHER CONSIDERATION
- Develop recreational plan that addresses agricultural landowner's concerns - RECOMMENDED FOR FURTHER CONSIDERATION
- Establish a process to address current and unauthorized use of agricultural land - RECOMMENDED FOR FURTHER CONSIDERATION
- Establish fund to compensate for unauthorized use of agricultural land - RECOMMENDED FOR FURTHER CONSIDERATION
- Increase buffers between residential and farm areas - RECOMMENDED FOR FURTHER CONSIDERATION
- Develop compensation systems for farmland providing wildlife benefits - RECOMMENDED FOR FURTHER CONSIDERATION

At this time, loss of land base/encroachment on farmland is not a serious issue in the Durrell Creek Watershed. Therefore it is not recommended that the Committee undergo a detailed examination of options to address this issue. This issue will be addressed in the IWMP through land development and land use guidelines/restrictions to prevent loss of agricultural land/encroachment of farmland from becoming an issue in the future. General recommendations may also be made in the IWMP on the need for a Municipal Agricultural Plan to promote and facilitate local agriculture.

Issue: How can we promote agricultural practices that are consistent with environmental guidelines?

Potential Options	Committee Recommendations
Promote adoption of best management practices for manure handling and storage	General recommendation of IWMP - further detailed study not required
Promote environmentally sustainable crop protection techniques	General recommendation of IWMP - further detailed study not required
Encourage posting of notices to inform public where and when crop spraying is to occur	General recommendation of IWMP - further detailed study not required
Encourage pesticide-free production practices in ESAs	General recommendation of IWMP - further detailed study not required
Establish management practices for riparian management zones	Option to be considered within ESA management strategy
Encourage adoption of the agricultural code of practice for waste management	General recommendation of IWMP - further detailed study not required
Promote sustainable agriculture practices	General recommendation of IWMP - further detailed study not required

Option: Promote adoption of best management practices for manure handling and storage. - RECOMMENDED FOR FURTHER CONSIDERATION

No concerns have been raised over manure handling and storage practices in the watershed. However, bacterial pollution is a problem in the watershed and the possibility exists that manure may be a potential source. The IWMP will include general guidelines and recommendations for manure handling and storage that are based on existing guidelines and regulations.

Option: Promote environmentally sustainable crop protection techniques - RECOMMENDED FOR FURTHER CONSIDERATION

Option: Encourage posting of notices to inform public where and when crop spraying is to occur - RECOMMENDED FOR FURTHER CONSIDERATION

Option: Encourage pesticide free production practices in environmentally sensitive areas - RECOMMENDED FOR FURTHER CONSIDERATION

These management practices are regulated by provincial legislation and are thus considered to be outside the mandate of the IWMP. In addition, neither members of the Committee nor residents of the community in the landowner survey have raised concerns over crop protection techniques currently employed in the watershed.

Option: Establish management practices for riparian management zones - REFER TO ESA MANAGEMENT STRATEGY IN ENVIRONMENT SECTION

Option: Encourage adoption of the Agricultural Code of Practice for Waste Management - RECOMMENDED FOR FURTHER CONSIDERATION

The Agricultural Code of Practice for Waste Management maximizes the potential for waste to be converted to beneficial uses on the farm. The IWMP will include a general description of the Code of Practice and how it applies to operations within the Durrell Creek Watershed.

Option: Promote sustainable agriculture practices - RECOMMENDED FOR FURTHER CONSIDERATION

This issue was raised in the landowner survey. Guidelines for sustainable agriculture exist and are supported by the majority residents of the Durrell Creek Watershed. The IWMP will include a general description of sustainable agriculture and how it applies to operations within the Durrell Creek Watershed.

Issue: What steps can we recommend to address 'external impacts' on farmland in the study area?

Potential Options	Committee Recommendations
Land Development Guidelines	Recommended for further consideration.

Option: Develop land development guidelines

There are a number of publications that address the interface between urban and agricultural land, and have recommendations on how to resolve conflicts. These will be reviewed and specific advice for the watershed will be given.

4.3.3 Environment

Issue: How can we improve water quality?

Potential Options	Committee Recommendations
Expand water quality testing program	Recommended for further consideration. Additional data available from CRD Health Department
Septic field testing/upgrade program	Recommended for further consideration. Implement program when/where specific problem areas are identified
Livestock management program	Recommended for further consideration. Implement program when/where specific problem areas are identified
Manure management program	Recommended for further consideration. Implement program when/where specific problem areas are identified
Cross-connection upgrade program	Recommended for further consideration. Implement program when/where specific problem areas are identified
Waterfowl management program	Recommended for further consideration for improvement of water quality. Implement program when/where specific problem areas are identified. Option should be explored within the context of agricultural practices.
Expand Sewer Enterprise Boundary	Recommended for further consideration subject to a determination of the extent of the water quality problem.
Expand Urban Containment boundary	Not recommended for further consideration
Construct stormwater detention facilities	Recommended for further consideration in the context of stormwater treatment, fish habitat, waterfowl management, recreation and aesthetic objectives

Option: Expand water quality testing program - RECOMMENDED FOR FURTHER CONSIDERATION

Water quality data from the 1998 study was very limited and did not pinpoint the location or source of the pollution. The study did however, indicate that problems with bacterial pollution exist. Additional water quality testing would help to pinpoint sources and locations of problems and would narrow time and expense associated with cleaning up the problem.

Option: Septic field testing/upgrade program - RECOMMENDED FOR FURTHER CONSIDERATION

Where appropriate. Additional testing is required to pinpoint areas requiring septic field testing. All faulty systems would be required to be upgraded.

Option: Livestock management - RECOMMENDED FOR FURTHER CONSIDERATION

Where appropriate. Additional water quality testing is required to pinpoint problematic farm operations.

Option: Manure management - RECOMMENDED FOR FURTHER CONSIDERATION

Where appropriate. Additional water quality testing is required to pinpoint problematic farm operations.

Option: Cross-connection upgrade program - RECOMMENDED FOR FURTHER CONSIDERATION

Where appropriate. Additional water quality testing is required to pinpoint problematic cross-connections.

Option: Waterfowl management program - NOT RECOMMENDED FOR FURTHER CONSIDERATION

Wildlife have not been identified as the source of the bacterial pollution problem in this watershed, and eradication of wildlife may not result in an improvement to water quality. Therefore, at this point in time, a wildlife management program is not justified. This option is not recommended unless future water quality testing indicates that wildlife is a major source of bacterial pollution.

Option: Expand Sewer Enterprise Boundary - RECOMMENDED (PROVISIONAL)

If septic systems prove to be a widespread source of bacterial pollution, extension of the sewer enterprise boundary is a potential, but costly solution. Additional water quality testing is required to pinpoint problematic septic systems and determine the extent of system failure in the watershed. Expansion of the sewer enterprise boundary is often coupled with expansion of the urban containment boundary, which in this case is not recommended at this time.

Option: Expand Urban Containment Boundary - NOT RECOMMENDED FOR FURTHER CONSIDERATION

Expansion of urban services to the rural areas of the watershed may result in increased property taxes, alter the area's livability for many local residents, and may negatively impact agricultural operations. Such an expansion has not been identified within the Official Community Plan (OCP). Changes to the OCP may set precedents to other areas of rural Saanich and is not recommended. The impact of this expansion on water quality is unknown.

Issue: How can we prevent gradual habitat loss and loss of biodiversity?

Potential Options	Committee Recommendations
Maintain seasonally flooded fields	Recommended for further consideration
Streamside planting/riparian buffer	Recommended for further consideration
ESA management plan	Recommended for further consideration

Two ESA studies are available for the watershed: Environment Canada's Sensitive Ecosystems Inventory and Saanich's ESA study. These maps are similar; however, some discrepancies exist between the two initiatives. Saanich's study will be used for the IWMP.

Option: Maintain seasonally flooded fields - RECOMMENDED FOR FURTHER CONSIDERATION

This option is recommended for a number of reasons: winter flooding will not impact on ability to obtain ARDSA growing season drainage criteria, and waterfowl are considered to be an important quality of the watershed to many residents. Maintaining seasonally flooded fields will preserve valuable habitat and prevent local loss of biodiversity.

Option: Streamside planting/riparian buffer - RECOMMENDED FOR FURTHER CONSIDERATION

This option is recommended to lower summer water temperatures in Durrell Creek to improve fish habitat, provide forage for birds and wildlife, and improve aesthetic values of the watershed. Riparian plantings should be designed in such a way as to not have an effect on agricultural operations and channel maintenance objectives.

Option: ESA management plan - RECOMMENDED FOR FURTHER CONSIDERATION

- Remove invasive plant species
- Revise areas classified as ESA
- Establish Farmland/Wildlife Trust

- Purchase of ESAs by municipality/conservation organization
- Education/Interpretation Program
- Acquisition of land at mouth of Durrell Creek (where empties into Colquitz River)
- Adopt Naturescape Practices
- Special Management Zones
- Education Program
- Verbal agreements
- Written agreements without tax incentives
- Written agreements with tax incentives

  Leases

  Licenses

  Conservation covenants

  Restrictive covenants

  Easements
- Donations or bequests
- Sale to municipality or conservation organization
- Habitat enhancement – Strawberry Knoll Park
- Habitat enhancement – Riparian Areas

Most of these options can be consolidated into a single option – development of an Environmentally Sensitive Areas (ESA) management plan. ESAs are identified in Saanich's Environmentally Significant Areas Atlas, and by Environment Canada's Sensitive Ecosystem Inventory. Due to the regional significance of some of these ESAs, development of an ESA management plan is recommended. This option may include a recommendation to purchase highly sensitive ESAs, habitat enhancement work, land development/land use guidelines, and modifications to the ESAs identified by previous studies.

It is recommended that an ESA Management Strategy include a voluntary private land stewardship program. Stewardship options for private landowners in British Columbia are described in the Ministry of Environment's 1996 Stewardship Series, and DFO's 1999 Habitat Conservation and Stewardship publications. More and more landowners are recognizing the role they can play in protecting and enhancing local wildlife and fish habitat. A wide variety of plants and animals, especially in the Durrell Creek Watershed, rely on habitat on private land. There is growing recognition that the acquisition of parks to preserve these habitats will not solve the problem, even if we had the financial resources to buy them. Landowner participation is an essential part of the work needed to protect sensitive species and ecosystems. A *voluntary* private land stewardship program is recommended for this watershed since many of the ESAs in the watershed are privately owned. Many of the native plant communities have been disturbed by human activity, and ongoing disturbance may eliminate species from the area. Many residents of the watershed have expressed an interest in undergoing some level of stewardship. The watershed could serve as an example for stewardship programs that may be adopted elsewhere in the province.

4.3.4 Recreation

Issue: How can we maximize appropriate opportunities for passive recreation?

Potential Options	Committee Recommendations
Recreational use of undeveloped rights-of-way	Recommended for further consideration
Identify locations for bird watching	Recommended for further consideration
Establish farmland and recreation trust	Recommended for further consideration
Commuter cycling network	Not recommended for further consideration
Interurban bikepath	Not recommended for further consideration as suitable cycling lane is adequate
Convert Courtland-Hastings to parkland	Not recommended for further consideration
Consider purchase/designation of ESAs for parks or nature reserves	Recommended for further consideration
Safe walking routes to school network	Not recommended for further consideration in context of IWMP
Colquitz River Greenbelt (as described in 1972 proposal by Saanich)	Not recommended for further consideration in context of IWMP

Option: Recreational use of undeveloped ROW's - RECOMMENDED FOR FURTHER CONSIDERATION

Option: Erect birdwatching blinds/viewing platforms - RECOMMENDED FOR FURTHER CONSIDERATION

Option: Establish farmland and recreation trust - RECOMMENDED FOR FURTHER CONSIDERATION

A proposal which included rezoning of all undeveloped road allowances into pedestrian trails, construction of ponds at 7 locations along the road allowances, construction of three wildlife viewing platforms at Interurban Road, Holland Avenue and Hastings Flats, and construction of a boardwalk on the Pansy Street right-of-way was reviewed. It is recommended that there be no further consideration of the proposal to construct ponds at 7 locations along the road allowances. In the agriculture and environment sections, maintaining seasonal flooding of Courtland and Hastings Flats is recommended, and providing drainage and flood control to ARDSA standards during the growing season (April to October). This strategy will not affect waterfowl use of the flats in the winter months, making the construction of new ponds for waterfowl unnecessary. However, should the Committee decide to meet ARDSA criteria during winter months, this option should be reconsidered.

Construction of a boardwalk on the Pansy Street ROW is not recommended. However, it was recommended that use of the ROW as a pedestrian/equestrian trail be considered. Wherever possible, recreational activity should be directed to the fringes of agricultural areas to minimize the potential for conflicts.

Consideration should be given to the construction of one or more wildlife viewing platforms at Interurban Road, Holland Avenue and Hastings Flats. The following potential uses of the following undeveloped road allowances should also be discussed further by the Committee:

Potential Uses of Undeveloped ROW's

Right of Way	Potential Uses
Charlton Road	Multiple use trail (pedestrian/equestrian); potential habitat restoration area
Prillamon Avenue	Road development; leave undeveloped; pedestrian trail
Unnamed b/w Courtland and Charlton	Offer for purchase by adjacent landowners, pedestrian trail
Cherry Road	Multiple use trail (pedestrian/equestrian)
Holland b/w Charlton and Cherry	Multiple use trail (pedestrian/equestrian); purchase/ lease by adjacent landowners for agricultural use
Pansy Street	Purchase/lease by adjacent landowners for agricultural use; multiple use trail (pedestrian/equestrian)
Glenside Avenue	Add to Strawberry Knoll Park; pedestrian trail
Herbert Street east of Holland	Add to Strawberry Knoll Park; pedestrian trail
Herbert Street west of Holland	Leave undeveloped
Wallingford Avenue	Multiple use trail (pedestrian/equestrian)

Generally, outdoor recreation pressures are expected to grow in rural areas. Current conflicts may escalate without co-operative strategies and a plan of action for the future. Implementation of a recreational plan should include planning and management strategies that encourage communication between recreation users and farmers, and minimize the potential for conflict. Some of these strategies may include:

- Directing recreation uses to the fringes of agricultural areas
- Distributing information on public access sites and sign privately owned areas, place signs and leaflets with maps throughout agricultural areas that direct recreation users to appropriate areas

- Establishing a code of conduct for recreational users
- Developing transportation and parking plans - i.e. control parking at informal access points through parking regulations, no parking signs, and ticketing/towing power
- Developing a rural watch program to report littering, dumping, vandalism, and trespass
- Implementing "adopt a trail" program to maintain trails, fences, gates, collect litter, etc.
- Encouraging farmers to spray as little as possible during high use recreation times (i.e. weekends)
- Developing leaflets and signs that talk about livestock harassment, littering, importance of controlling dogs, etc. in rural areas.
- Establishing a mechanism to compensate landowners for losses sustained from vandalism on properly posted lands.
- Establishing a Farm-Recreation Trust, a community based group to oversee management and maintenance of recreational areas and to ease implementation of recreational use in the watershed

Option: Commuter cycling network - NOT RECOMMENDED FOR FURTHER CONSIDERATION

This option was rejected due to a lack of interest from local residents.

Option: Interurban bikepath - NOT RECOMMENDED FOR FURTHER CONSIDERATION

This option was rejected because a bikepath already exists along Interurban Road.

Option: Convert Courtland-Hastings Flats to parkland - NOT RECOMMENDED FOR FURTHER CONSIDERATION

This costly option was rejected because Courtland-Hastings Flats is highly productive agricultural land within the Agriculture Land Reserve, and for this reason agricultural use of the Flats should be promoted. Integration of land uses with a minimal impact on agriculture, such as seasonally flooded waterfowl habitat, improving fish habitat by restoring the riparian zone, and recreational use of undeveloped ROW's are recommended over outright conversion to parkland.

Option: Consider purchase/designation of following ESAs for parks or nature reserves - RECOMMENDED FOR FURTHER CONSIDERATION

This option will be further explored in the ESA Management Strategy, discussed in Environment Section. Some of the areas that *may* be recommended for purchase or designation as parks or nature reserves include:

- Gillie Road Lots
- Charlton Road ROW
- Glenside Avenue (add to Strawberry Knoll)
- Herbert Street east of Holland (add to Strawberry Knoll)
- Some of the areas identified in Saanich's Environmentally Sensitive Areas Atlas and the Environment Canada Sensitive Ecosystem Inventory.

Option: Safe walking routes to school network - NOT RECOMMENDED FOR FURTHER CONSIDERATION

This option was removed from further consideration because it is being addressed by staff and parents at Strawberry Vale School.

Option: Greenbelt - NOT RECOMMENDED FOR FURTHER CONSIDERATION

This option involves implementation of a 1972 proposal by Saanich to purchase of land along the Colquitz River for a Greenbelt. This option was rejected because it is beyond the scope of this study and is being addressed by the Colquitz Restoration Committee.

Issue: How can we maintain or improve aesthetic values and liveability in the watershed?

Potential Options	Committee Recommendations
Develop general land use guidelines	Recommended for further consideration
Improve visual quality of watershed soil mixing operations	Not recommended for further consideration in context of IWMP

Option: Land use guidelines - RECOMMENDED FOR FURTHER CONSIDERATION

General land use/land development guidelines will be developed within the IWMP to address the desire to maintain or improve aesthetic values/liveability of the watershed.

Option: Improve visual quality of watershed soil mixing operations - NOT RECOMMENDED FOR FURTHER CONSIDERATION

This option is a result of concerns raised by numerous residents of the community in the landowner survey. Common complaints include: this type of operation should not be permitted in the ALR; suspicion of potential adverse health impacts from the operation on humans, fish and wildlife arising from water pollution; and negative impacts on the aesthetic appeal and liveability of the region resulting from noise and odours. This operation was granted a special-use permit by the Agriculture Land Commission, because it pre-dated the formation of the Agriculture Land Reserve. Concerns over water quality issues should be addressed with additional water quality sampling, and rectified if a problem is identified. Issues over noise pollution should be addressed by Saanich's Noise Bylaws, and concerns over air pollution should be addressed by the MOELP.

4.3.5 Land Development

Issue: What recommendations can we make about the use of undeveloped road rights-of-way to help achieve the goals of the IWMP?

Potential Options	Committee Recommendations
Road development	Not recommended for further consideration
Allow purchase by adjacent landowners	Recommended for further consideration
Convert to agricultural use	Recommended for further consideration
Recreational use - pedestrian trails	Recommended for further consideration
Recreational use - equestrian trails	Recommended for further consideration
Habitat restoration areas	Recommended for further consideration
Leave undeveloped	Not recommended for further consideration

Option: Road development - NOT RECOMMENDED FOR FURTHER CONSIDERATION

Many of undeveloped ROW's are seasonally flooded, prohibiting their use during the rainy season. Road development may require the addition of fill, which is prohibited within the Fill Prohibition Area. In addition, many of residents in the watershed do not favour road development. Refer to the table in the Recreation section.

Option: Allow purchase by adjacent landowners - RECOMMENDED FOR FURTHER CONSIDERATION

Some residents have expressed interest in purchasing undeveloped ROW's adjacent to their property. Private ownership of the ROW's may increase agricultural production in the watershed and should be considered where appropriate. Refer to the table in the Recreation section.

Option: Recreational use/pedestrian trails - RECOMMENDED FOR FURTHER CONSIDERATION

This option is discussed in greater detail under Recommended Recreation Options. Refer to the table in the Recreation section.

Option: Recreational use/equestrian trails - RECOMMENDED FOR FURTHER CONSIDERATION

This option is discussed in greater detail under Recommended Recreation Options. Refer to the table in the Recreation section.

Option: Habitat restoration areas - RECOMMENDED FOR FURTHER CONSIDERATION

Loss of biodiversity and habitat are important issues to the residents of this watershed. The undeveloped ROW's provide an opportunity to recreate some of the lost habitat. Very little of the watershed is publicly owned, which limits the opportunities available to restore lost habitat. This option should be considered alongside recreational use. Refer to table in the Recreation section.

Option: Leave undeveloped - NOT RECOMMENDED FOR FURTHER CONSIDERATION

This is generally not considered to be a valid option. The municipality and some members of the community consider these ROW's to be an under-utilized resource, and considerable interest has been expressed from the community to make use of these ROW's in some form or another. Refer to the table in the Recreation section above.

Issue: What should we encourage for the long term uses of the Gillie Road Lots?

Potential Options	Committee Recommendations
Allow residential development on each lot	Not recommended for further consideration
Allow residential development with restrictions	Recommended for further consideration
Municipal purchase	Recommended for further consideration
Land swap	Recommended for further consideration
Convert to agricultural use	Recommended for further consideration
Maintain current land use	Not recommended for further consideration

Option: Allow residential development on each lot - NOT RECOMMENDED FOR FURTHER CONSIDERATION

Much of this area is seasonally flooded and within the Fill Prohibition Boundary. High water tables would prohibit installation of septic fields, and not enough land is available for septic systems with the current density of lots. Development of these lots would require extension of the Sewer Enterprise Boundary, and/or a reduction in the number of lots, and prevention of seasonal flooding (an option not desired by many residents of the watershed).

Option: Allow some residential development - RECOMMENDED FOR FURTHER CONSIDERATION

Additional residential development could occur on some of the Gillie Road land, but it would require changes from the present day conditions. Residential development would require resolution of drainage problems, modification of the fill prohibition boundary, and resolution of septic system requirements. Land development guidelines may include consolidation of lots to a reduced number of housing parcels, expansion of sewer enterprise boundary, and provision of a buffer to adjacent agricultural land.

Option: Municipal purchase - RECOMMENDED FOR FURTHER CONSIDERATION

The municipality may consider purchasing these lots and consolidating the land into a single parcel. The land could be leased for agricultural use, converted to parkland, or restored to a natural area.

Option: Land swap - RECOMMENDED FOR FURTHER CONSIDERATION

This is an alternative to municipal purchase that does not require raising of funds.

Option: Convert to agricultural use - RECOMMENDED FOR FURTHER CONSIDERATION

The Gillie Road lots are zoned Rural Residential, which allows agricultural use and single family housing. Lot sizes are much smaller than zoning allows, resulting in a legal non-conforming land use. In the past, the lots have been farmed but are currently idle. Consolidation of the lots into a single parcel and sale to a private landowner for agricultural use would comply with existing zoning.

Option: No change - NOT RECOMMENDED FOR FURTHER CONSIDERATION

This is not considered a valid option for these parcels, due to the extended period of time that use of this land has not been resolved. A solution should be sought that benefits the lot owners, municipality, local residents, regulatory and environmental conditions.

Issue: What guidelines are required for land use and development to maintain or improve the environment?

Potential Options	Committee Recommendations
ESA management strategy	Recommended for further consideration
Stormwater management strategy	Recommended for further consideration
Riparian management strategy	Recommended for further consideration
Land use buffer adjacent to agricultural areas	Recommended for further consideration
Passive recreation management strategy	Recommended for further consideration
Land development guidelines	Recommended for further consideration
Promote sustainable agriculture practices	General recommendation of IWMP - further detailed study not required

Option: Land Development/Land Use Guidelines - RECOMMENDED FOR FURTHER CONSIDERATION

The purpose of land development and land use guidelines is to protect values -- such as fish and wildlife habitat, aesthetics, water quality - from potential damaging effects of land development and land use activities. Guidelines may include strategies for:

- ESA management
- Stormwater management
- Riparian management
- Land use adjacent to agricultural areas

- Passive recreation management
- Livestock/manure management

As much as possible, these will draw on existing documents, with an explanation of applicability to the Durrell Creek Watershed.

Issue: What long-term infrastructure development should be considered to meet the needs of integrated watershed management?

Potential Options	Committee Recommendations
Expand Urban Containment Boundary	Not recommended for further consideration
Expand Sewer Enterprise Boundary	Recommended for further consideration subject to a determination of the extent of the water quality problem
Expand municipal water supply	Recommended for further consideration in the context of expanding municipal water supply for agricultural purposes

Option: Expand urban containment boundary - NOT RECOMMENDED FOR FURTHER CONSIDERATION

Refer to comments in Environment section.

Option: Expand sewer enterprise boundary - RECOMMENDED FOR FURTHER CONSIDERATION

Refer to comments in Environment section.

Option: Expand municipal water supply - NOT RECOMMENDED FOR FURTHER CONSIDERATION

Expansion of municipal water supply has not been identified as an important issue to rural residents of the watershed. Therefore we do not recommend pursuing this option further.

Option: Expand Urban Containment Boundary - NOT RECOMMENDED FOR FURTHER CONSIDERATION

Expansion of urban services to the rural areas of the watershed may result in increased property taxes, alter the area's liveability for many local residents, and may negatively impact on agricultural operations. Such an expansion has not been identified within the Official

Community Plan (OCP). Changes to the OCP may set precedents to other areas of rural Saanich and is not recommended. The impact of this expansion on water quality is unknown.

4.4 Refined Issues List

After several Committee meetings, the following list of issues (and associated viable options) were referred back to the consulting team to proceed to the next step of developing the integrated scenarios:

1. How can we reduce the risk of flooding of agricultural land and valley flat of Durrell Creek?
2. Is it worthwhile to improve or replace local drainage structures?
3. How can we minimize the risk of crop loss on Courtland-Hastings flats?
4. How can we promote agricultural practices that are consistent with environmental guidelines?
5. What steps can we recommend to address external impacts on farmland in the study area?
6. How can we improve water quality?
7. How can we prevent habitat loss and loss of biodiversity?
8. How can we maximize appropriate opportunities for passive recreation?
9. What recommendations can we make about the use of undeveloped road rights-of-way to help achieve the goals of the IWMP?
10. What should we encourage for the long term uses of the Gillie Road lots?
11. What guidelines are required for land use and development to maintain or improve the environment?

The issues listed below were eliminated from further consideration, either by reduced concern on the part of the Committee or lack of viable options to resolve the issue:

1. Are there viable non-structural options for water management?
2. How can we improve stormwater detention and treatment?
3. How can we improve returns from agricultural production?
4. How can we maintain or improve aesthetic values and liveability in the watershed?
5. What long term infrastructure development should be considered to meet the needs of integrated watershed management?

Chapter 5 – Integrated Watershed Management Scenarios

A variety of approaches to structuring recommendations for water management plans are available, depending on their focus, and there is no standard approach. Two of the main driving issues for a watershed management plan for Durrell Creek are the flooding of the Durrell Creek Valley and drainage of agricultural lands adjacent to the creek. Addressing these two issues is central to the development of the plan. Other issues, such as environment, land use, and recreation are then considered within the framework of a range of flooding, drainage and agricultural alternatives. These alternatives were combined into scenarios, with compatible options for environment, land use and recreation incorporated within them.

Four scenarios were developed and their proposed measures, potential benefits, and potential impacts are described in this chapter. No judgement is passed as to which scenario is best. That recommendation, and its justification, is the subject of Chapter 6.

5.1 Scenario Development Process

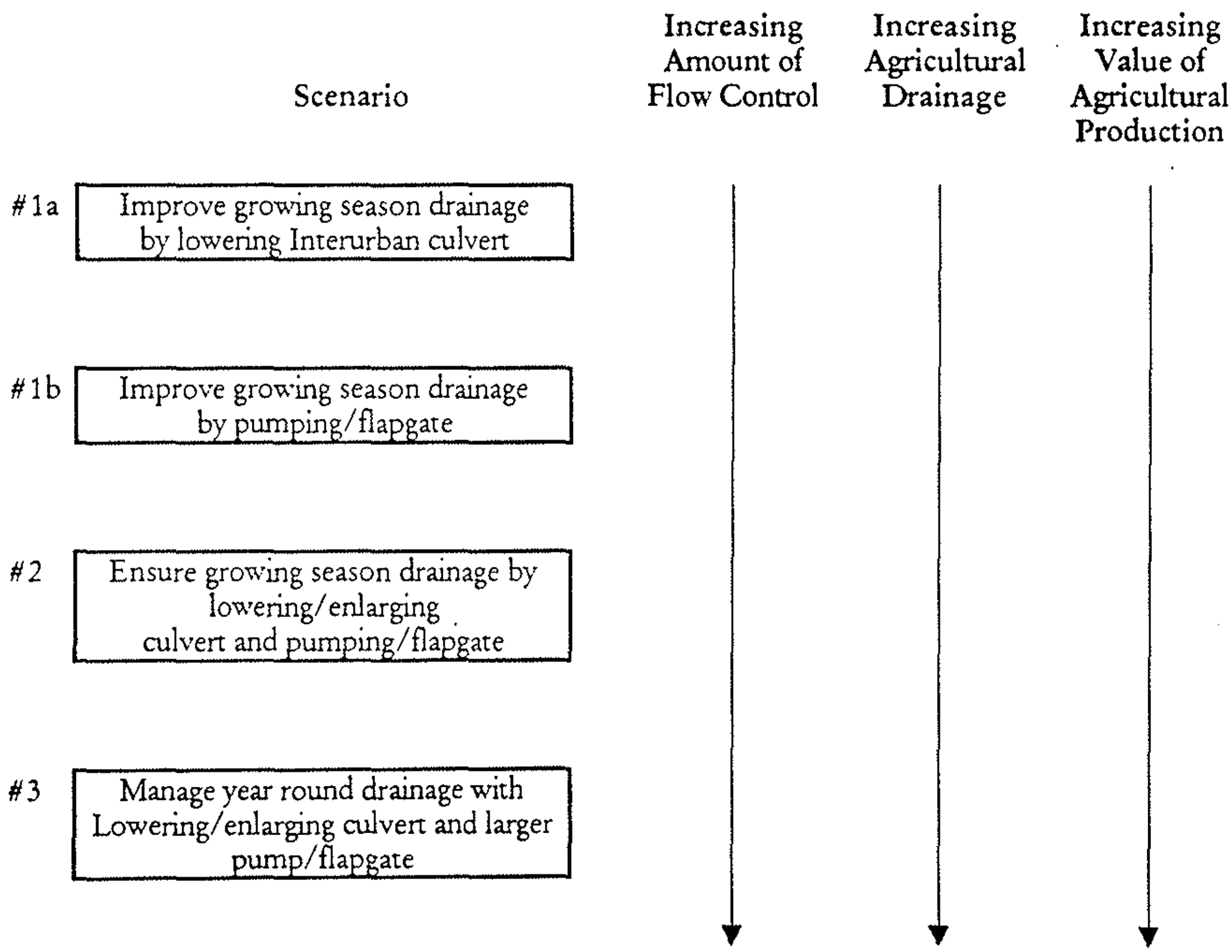
Four scenarios were developed to improve management of the Durrell Creek watershed. After some discussion, the Committee concluded that the existing situation was not a scenario worthy of further consideration. The four scenarios differ in the extent to which they manage water levels and control flooding upstream of Interurban Road during the growing (summer – eight months of April to November) and dormant (winter) seasons and how they address other issues in the watershed (Figure 5.1). They all require some treatment of the culvert at Interurban Road (Figure 5.2).

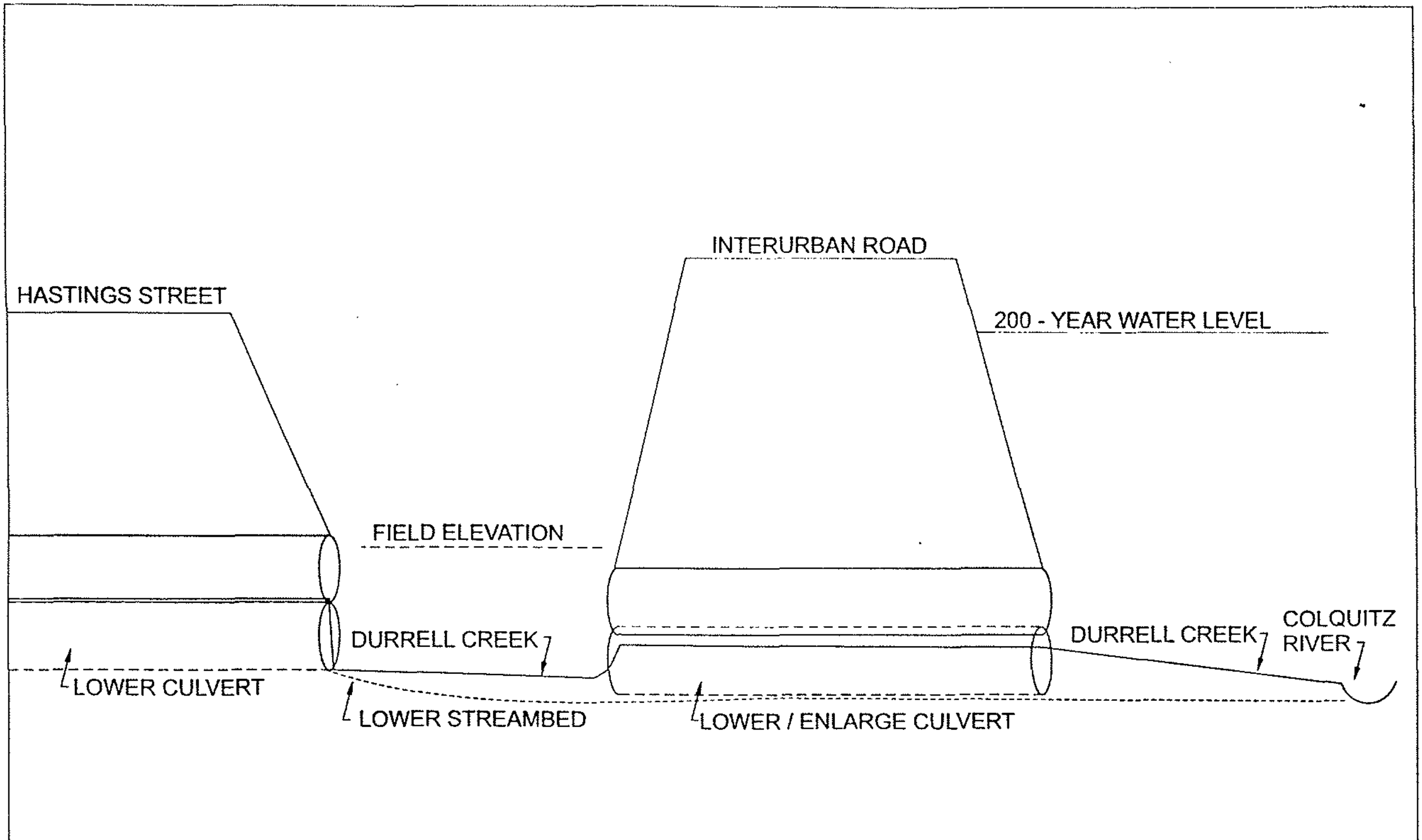
5.1.1 Drainage/Agricultural Basis of the Scenarios

The portions of Durrell Creek valley that are flooded are primarily used for agricultural production and lie mostly within the Agricultural Land Reserve (ALR). Consequently, the watershed management scenarios address the effect of flooding on potential agricultural production. The effect of the scenarios on agricultural production were evaluated based on how they met the drainage criteria of the Agricultural and Rural Development Subsidiary Agreement (ARDSA).

The ARDSA criteria are intended to benefit agriculture by creating good drainage. This allows for earlier seeding, later harvest, less damage to soil structure, reduces soil erosion, and provides an opportunity to grow cover, or green manure/ cover crops over the winter. The recommendations concentrate on providing adequate freeboard (the elevation difference between the lowest field level and the water surface at base flow in Durrell Creek) to allow for land drainage and operation of on-farm drain systems, and on limiting the duration of flooding. The duration of flooding is thought to be more important than the severity -- crops will survive deep flooding but only for short periods.

Figure 5.1 Watershed Management Scenarios





Schematic Of Drainage Improvements At Interurban Road

Figure 5.2

File.: Durrell `Creek Integrated Watershed Management Plan
Date: March 2000
Client: The Corporation of the District of Saanich

Pottinger Gaherty
Environmental Consultants Ltd.

D PROJECTS\1336-01.01\1336010\DRAIN.CDR

ARDSA recommends maintaining freeboard at about 1.2 m, although a freeboard of as little as 0.9 m below the lowest point in fields may be acceptable for adequate field drainage. They also recommend limiting the duration of flooding, for a moderately severe storm, to 2 days during the growing season and 5 days during the dormant season.

At present, neither the freeboard nor the duration of flooding criteria are met for the agricultural fields on the Courtland and Hastings flats. All of the scenarios developed for Durrell Creek aim to provide improved freeboard, particularly during the growing season. As indicated in the table below, two scenarios do not meet the duration of flooding criteria (Scenarios #1a and #1b). One scenario meets just the growing season duration of flooding criteria (Scenario #2) and one meets both the growing and dormant season duration of flooding criteria (Scenario #3).

Summary of Scenario Attributes

Scenario	Meets ARDSA freeboard Requirements?		Meets ARDSA Flood Duration Requirements?	
	Summer	Winter	Summer	Winter
1A	no	no	no	no
1B	no	no	no	no
2	yes	no	yes	no
3	yes	yes	yes	yes

The following sections briefly describe measures for drainage improvements for each of the four scenarios. These measures are only concepts at this stage. A detailed technical feasibility analysis would be required to size the pumps, culverts, or other drainage structures required for the scenarios and establish firm costs. Further hydrologic and hydraulic modelling of the Colquitz River would be required to quantify the extent that downstream water levels are altered by any of the four scenarios. For Scenario #3, a geotechnical investigation of the Interurban Road fill would be recommended.

Three scenario worksheets were developed for the Committee's consideration, to summarize the options that were recommended in Chapter 4 for further consideration. The worksheets provide a summary of the proposed measures and the effects of each scenario (see the following three tables). These were reviewed and discussed by the Steering Committee over several meetings, to expand and refine the details of the proposed scenarios. The integration between competing and often conflicting demands was achieved through discussion at the

Watershed Management Scenarios - Pros and Cons of the Scenarios

Scenario #1a - Improvement of Growing Season Water Levels by Lowering Interurban Culvert	Scenario #1b - Improvement of Growing Season Water Levels by Flapgate/Small Pump on Existing Culvert	Scenario #2 - Management of growing season water levels and improved winter drainage	Scenario #3 - Management of water levels throughout the year
Water Management Lower Interurban culvert by 0.8m to 8.8m invert level, set culvert flat, add flapgate	Add flapgate and small pumping station to existing Interurban culvert	Lower and replace Interurban culvert with larger capacity floodbox, add flapgate and weir, add pump (500-1000 l/s)	Lower and replace Interurban culvert with larger capacity floodbox, add flapgate, add pump (1000-2000 l/s)
Not economic to install on farm drainage Extreme (winter) water levels unchanged Eliminate overbank flooding in summer Reduce summer flooding by approx. 30% Summer soil drainage freeboard 0.9m Water levels in the Colquitz not affected	Not economic to install on farm drainage Extreme (winter) water levels unchanged Eliminate overbank flooding in summer Summer flooding not affected Summer soil drainage freeboard 0.9m Water levels in the Colquitz not affected	Improve local and on farm drainage structures. Extreme (winter) water levels unchanged Eliminate overbank flooding in summer Summer flooding almost eliminated Summer soil drainage freeboard 0.9m Winter flows to the Colquitz not affected	Water levels can be controlled year round Lower stream water levels from Apr-Oct winter water levels depend on pump operation Summer flooding almost eliminated Year round soil drainage freeboard 1.2m Increased winter flows to Colquitz by 15cm
Agriculture Reliable growing season estimated 4.5 mo. Doesn't meet ARDSA summer Decreases risk of crop loss Small increase in return Soil erosion / lost productivity Winter cover cropping not possible	same as Scenario #1a	Growing season up to 8 months Will meet ARDSA summer criteria Decrease risk of crop loss Higher crop yield Use of winter cover crops possible	Year round or double cropping possible Meet ARDSA summer/winter criteria Minimize risk of crop loss, higher yield Long term soil sustainability enhanced Use of winter cover crops possible
Environment Summer flooding and any associated habitat would be reduced	same as scenario #1a	same as Scenario #1a	same as Scenario #1a
Winter use of seasonally flooded field not affected	Pumping would not affect fish habitat	same as Scenario #1a	some winter use of seasonally flooded fields may be affected
Improved protection of ESA's			winter water levels on seasonally flooded field depends on pumping
Channel maintenance combined with riparian enhancement Decreased soil loss and sedimentation Improved water quality			winter use of fields by waterfowl will be affected if fields drained
Recreation Improved trail network, better connections Improved bird watching stations and parking Improved education about agriculture and environment Some trail use would be seasonal due to flooding	same as scenario #1a	same as scenario #1a	same as scenario #1a Bird watching opportunities will be altered in winter Some mitigation of impacts to waterfowl if cover crops used
Land Use Flooding of Gillie Road lots not changed	same as scenario #1a	same as scenario #1a	Flooding of Gillie Road lots reduced but not

Watershed Management Scenarios (Worksheet 2) As Revised by Committee Jan 27, 2000	Scenario #1a Improvement of Growing Season Water Levels by Lowering Interurban Culvert	Scenario #1b Improvement of Growing Season Water Levels by Flapgate/ Pumping with Existing Culvert	Scenario #2 Management of Growing Season Water Levels and Improved Drainage in Winter	Scenario #3 Management of Water Levels Throughout the Year
ater Management				
1 Manage water levels in Colquitz watershed to minimize downstream effects	GR	GR	GR	GR
2a Install flapgate & pump at Interurban Road to improve growing season water levels	I	R	I	I
2b Install flapgate & pump at Interurban Road to meet growing season ARDSA criteria	I	I	R	R
2c Convert Interurban Road to a dyke / install flapgate & pump to meet winter ARDSA criteria	I	I	I	C
3 Channel maintenance of Durrell Creek	R	R	R	R
4 Replace/Lower Interurban Road culvert	R	I	R	R
5 Replace culverts at Hastings Street	R	R	R	R
Agriculture				
6 Provide ARDSA drainage and flood control to winter standards	I	I	I	C
7 Provide ARDSA drainage and flood control to growing season standards	I	I	R	R
8 On-farm drainage improvements	R	R	R	R
9 Land development guidelines to prevent encroachment on agricultural land	R	R	R	R
Environment				
10 Continue periodic water quality testing, cross-connection upgrades where necessary	GR	GR	GR	GR
11 Continue septic field testing/upgrade where necessary	GR	GR	GR	GR
12 Encourage observance of agricultural codes of practice for livestock/manure management	GR	GR	GR	GR
13 Consider waterfowl (Canada goose) management program to improve water quality	GR	GR	GR	GR
14 Maintain seasonally flooded fields	R	R	R	I
15 Encourage landowners to undertake private land stewardship in riparian zones	GR	GR	GR	GR
16 Undertake stewardship of ESA's	C	C	C	C
Recreation/Aesthetics				
17 Recreational use of undeveloped ROW's -summer	C	C	C	C
18 Recreational use of undeveloped ROW's - winter	I	I	I	C
19 Identify opportunities for bird watching	R	R	R	R
20 Consider purchase/designation of ESA's for parks or nature reserves	C	C	C	C
Land Development				
21 Allow purchase of ROW's by adjacent landowners	C	C	C	C
22 Consider residential development above floodplain with restrictions on some Gillie Road lots	I	I	I	C?
23 Consider public purchase/land swap of Gillie Road lots for parkland	C	C	C	C
24 Encourage agricultural use of Gillie Road lots	C	C	C	C

R = Required/Recommended as part of that scenario
I = Incompatible with that scenario
C = Compatible with that scenario
GR = General Recommendation

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WATERSHED MANAGEMENT SCENARIOS - Effects of Scenarios

Effects	Scenario #1a Improvement of Growing Season Water Levels by Lowering Interurban Culvert	Scenario #1b Improvement of Growing Season Water Levels by Flapgate/Small Pump on Existing Culvert	Scenario #2 Management of Growing Season Water Levels and Improved Drainage in Winter	Scenario #3 Management of water levels throughout the year
Water	Extreme water levels same as current levels Lower water levels in Durrell Creek in summer Reduce summer flooding Faster drainage in winter/spring Water levels in the Colquitz not affected	Extreme water levels same as current levels Lower water levels in Durrell Creek in summer Reduce summer flooding Faster drainage in winter/spring Water levels in the Colquitz not affected	Extreme water levels same as current levels Lower water levels in Durrell Creek in summer Reduce growing season flooding to meet ARDSA Faster drainage in winter/spring winter flows to the Colquitz would not be affected	Water levels can be varied over winter Lower water levels in Durrell Creek from April to October Reduce growing season flooding to meet ARDSA Winter water levels depend on how pumping station is operated flows to the Colquitz could be increased by 15 cm in extreme events
Agriculture	Growing season estimated 4.5 mo Scenario may not meet ARDSA summer standards Decreases risk of crop loss, slight improvement in agriculture On-farm drainage required Potential agricultural use of Gillie Road lots is slightly improved Achieve summer freeboard of 0.8m	Growing season estimated at 4.5 mo Scenario may not meet ARDSA growing season standards Decreases risk of crop loss, slight improvement in agriculture On-farm drainage required Potential agricultural use of Gillie Road lots is slightly improved Achieve summer freeboard of 0.8 m	Growing season up to 8mo., allowing double cropping Scenario will meet ARDSA growing season water levels Decrease risk of crop loss, higher crop yield, greater crop flexibility On-farm drainage required Potential agricultural use of Gillie Road lots is slightly improved Achieve summer freeboard of 0.8 m	Year round or double cropping possible Scenario will maintain ARDSA growing season water levels Scenario minimizes risk of crop loss, higher crop yield, greater cropping flexibility On-farm drainage required Potential agricultural use of Gillie Road lots is possible Achieve freeboard of 1.2m year round
Environment	Summer flooding (and any associated habitat) will be reduced Slightly lower water levels in seasonally flooded fields in winter Winter use of seasonally flooded fields not affected Channel maintenance to follow guidelines to ensure protection of fish habitat	Summer flooding (and any associated habitat) will be reduced Slightly lower water levels in seasonally flooded fields in winter ESA management plan recommended Winter use of seasonally flooded fields not affected Channel maintenance to follow guidelines to ensure protection of fish habitat	Durrell Creek will dry out in summer, particularly just upstream of Interurban Slightly lower water levels in seasonally flooded fields in winter ESA management plan recommended Winter use of seasonally flooded fields may be affected Channel maintenance to follow guidelines to ensure protection of fish habitat	Durrell Creek will dry out in summer, particularly just upstream of Interurban Water levels on seasonally flooded fields depends on pumping station operation Winter use of seasonally flooded fields by wildlife will be affected if fields drained ESA management/compensation plan recommended Channel maintenance to follow guidelines to ensure protection of fish habitat
Recreation	May slightly alter birdwatching opportunities - slight alteration to habitat Summer recreational use of rights-of-way possible	May slightly alter birdwatching opportunities - slight alteration to habitat Summer recreational use of rights-of-way possible	May slightly alter birdwatching - slight alteration to habitat, species mix Summer recreational use of rights-of-way possible	Birdwatching opportunities will be altered in winter Summer recreational use of rights-of-way possible Winter recreational use of right-of-way possible
Land Development	Residential use of Gillie Road lots/ROWs is not attractive	Residential use of Gillie Road lots/ROWs is not attractive	Residential use of Gillie Road lots/ROWs is not attractive	Low winter water levels may permit residential development of Gillie Rd lots

Committee and Subcommittee level. The practical solutions outlined below are compromises reached through a consensus-seeking exercise of community interests, rather than solutions favoured by only one interest. These tables summarize the basics of the scenarios, with the details outlined in the sections below.

5.1.2 Characteristics of Current Agricultural Land Use

Current Agricultural Use

At present, the farmers are unable to get onto the land until May in most cases. This results in late seeding and by necessity, the choice of short season variety of crops. The fall season poses similar problems, in that harvesting may be compromised by wet conditions. The expected net return from current agricultural operations is about 30% of gross return, or approximately $2,000 per acre. This calculates to a current benefit stream on the 37.5 acres of $75,000 annually.

The table below summarizes the current agricultural practices and the net revenues associated with them. Note that the probability of not getting adequate drainage affects the probability of attaining target net revenues and a certain proportion of realized net revenue outcomes will be below target. We emphasize that the probabilities used are confirmed by scientific evidence for Durrell Creek but are considered to be realistic for the watershed, given the hydrological information generated and the results of responses to improved drainage in other farming areas.

Net revenues of the current (status quo) situation have been subtracted from net revenues estimates generated in the scenarios under review to estimate incremental net benefits under each scenario.

It is critical to note that expected net revenues are expected to decrease as the effects of soil degradation are felt. In other words, agricultural activity is not sustainable at current levels without alleviation of seasonal inundation of the soils. To assist in the comparison of the scenarios with the existing situation, we have assumed that soil degradation from flooding will cause a reduction in net agricultural returns of 1% per year into the future.

Soil maintenance and improvement in the Durrell Creek lowlands is hampered by the inability of farmers to grow cover crops. A cover crop is grown to protect and improve the soil, between periods of cash crop production. A green manure crop, which has a similar effect, is one grown to provide organic matter when incorporated into the soil. Cover/green manure cropping is advocated by agricultural and environmental specialists because the benefits are numerous:

- Improves soils structure and drainage
- Protects soil from the effects of heavy rainfall
- Minimizes soil erosion and loss
- Captured soil nutrients and reduced nutrient loss
- Builds up soil organic matter
- Provides feed and habitat for wintering waterfowl
- Benefits water quality by preventing nutrient, soil and chemical loss into watercourses

Finally, the problems associated with farming on poorly drained soils are well recorded. The use of farm machinery on saturated soils damages soil structure and field access is reduced or eliminated during periods of the year. Improved drainage also contributes to improved soil biology and reduction in the incidence of certain plant diseases. Most recently, as food safety concerns have emerged, the benefits of avoiding exposure to contaminated soil and agricultural water risks have become apparent.

Agricultural Use under the Scenarios

The effects of improved drainage may result in extended growing season (particularly in the spring and fall shoulder seasons), selection of late season varieties, double cropping, and perennial cropping. Each of the various scenarios permits different cropping options, but does not guarantee conditions under which they may carried out.

For example, a scenario may theoretically make possible double cropping 30% of the time. The farmer, however, may choose to produce a single crop because of a risk preference level which requires that the potential for crop loss due to flooding be eliminated. For this reason, it is difficult to predict cropping pattern under less than perfect drainage conditions. In two of the scenarios, separate examples of cropping options, and their revenue characteristics, have been prepared to account for the possibility that farmers might prefer a greater chance of lower revenues rather than a lower chance of higher revenues.

The cropping options that have been used to evaluate the effects of the scenarios on agricultural returns are labelled Options A, B and C. As shown below, the more intensive drainage scenarios make possible more intensive agricultural cropping. Essentially, Options range from less intensive to more intensive agriculture from A to C, and net revenues increase correspondingly. If a scenario permits Option B cropping, it will also allow Option A cropping but not Option C cropping. A scenario permitting Option C cropping will allow all other Options to occur.

Cropping Option	Description	Types of Crops Drainage Allows	Expected Annual Net Income Per Acre
Cropping Option A	Short season	Current cropping pattern	$2,000
Cropping Option B	Double cropping, Late season cropping	Short season Late season	$3,124
Cropping Option C	Perennial crops	Short season Late season Perennial	$4,250

The table below indicates current agricultural practices and the net revenues associated with them. Note that the risk of flooding affects the probability of attaining target net yields. The table provides the framework to discuss expected net returns for the scenarios.

Current Annual Agricultural Expected Net Returns Per Acre under the Status Quo.

Cropping Pattern	Probability of Adequate Drainage	Net Revenue Target	Realized Net Revenues	Annual Expected Net Revenue (1)
Cropping Option A	80%	$2,000	$2,000	$1,600
	20%	$2,000	$1,000	$200
Annual Expected Revenue (Example 1)				$1,800
Cropping Option B	20%	$4,500	$4,500	$900
	60%	$4,500	$2,000	$1,200
	20%	$4,500	$1,000	$200
Annual Expected Revenue (Example 2)				$2,300
Average Net Revenue Expectation from Cropping				$2,000

Notes: (1) Expected Net Revenue = Target * Probability

5.2 Watershed Management Scenario #1a – Improvement of Growing Season Water Levels – Lower Interurban Culvert

For each scenario, the proposed measures are outlined under the subheadings of drainage improvements, agricultural development, environmental management, recreation plan, and land use changes. For each category the effects, both positive and negative, of each measure are described. Some proposed measures are general in nature and common to all scenarios. If there is no change between scenarios in either the proposed measure or effects of that measure then its description is not repeated.

5.2.1 Drainage Improvements

COLQUITZ WATER MANAGEMENT: Water management on the Colquitz River system, including such options as storing additional water in its headwater lakes (Elk and Beaver), should be investigated by the Municipality. The Capital Regional District and District of Saanich holds a water licence on Beaver and Elk Lakes for 2 800 acre-feet of storage. The purpose of this water licence is to improve land use surrounding the lakes, release fish conservation flows and provide flow control on the Colquitz. At present, the dam at the outlet is operated so that water is stored in the spring, by installing flashboards on the dam in January. This stored water is slowly released over the summer to maintain low flows in Colquitz River for fish conservation. It would be difficult to increase storage by raising the existing maximum water level, as waterfront properties and infrastructure such as trails around the lake would be flooded. The existing dam and cut-off berm has only a small freeboard and would have to be modified to allow greater storage. The concept of negative storage, that is lowering the lake outlet and storing water below the existing minimum lake level, could be considered.

Preliminary analyses by Water Management Branch, MOELP indicates that reducing the discharge at the lake outlet will not significantly reduce the discharge in the Colquitz River downstream or lower flood elevations. Further hydrologic and environmental studies would be required to determine the benefits and effects of additional storage in lowering water levels along the Colquitz River and in Durrell Creek.

LOWER INTERURBAN CULVERT: Scenario #1a is one of two options under Scenario #1 that lowers growing season base flow elevations and reduces the duration of flooding of fields during growing season storms. Scenario #1a just meets the ARDSA growing season minimum criteria for freeboard through part of the summer. However, it may not provide adequate freeboard in April, May and early June. It also reduces the duration of summer flooding to about 2 days on fields before water levels return to base flow.

Under Scenario #1a, the existing culvert at Interurban Road would be lowered by 0.8 m, so that its invert is at an elevation of 8.8 m. It is recommended that the culvert be set on a flat gradient. Headwalls would be required at the culvert entrance and exit to retain the road fill, or the culvert would need to be extended at each end. A flap gate would be added to the downstream end of the culvert to eliminate backflooding from Colquitz River. The flap gate would only prevent fish passage when it was closed, which would occur when water levels are rising rapidly on the Colquitz River and flooding lower Durrell Creek.

As an alternative, the existing culvert could be replaced with one of a larger diameter, which would provide some additional benefit by further reducing the duration of summer flooding on Courtland and Hastings flats. Further hydraulic studies would be required to evaluate the best size, consistent with the cost of the structure and installation. If there are no plans for future pumping, the existing culvert could be replaced with a bottomless multi-plate arch. This would allow a natural streambed substrate to be recreated, potentially resulting in a net gain in fish habitat.

LOWER HASTINGS STREET CULVERT: The invert of the culvert on a tributary of Durrell Creek beneath Hastings Street would be lowered by about 0.6m to an elevation of 9.0m to provide adequate growing season freeboard on Hastings Flats and to take advantage of the drainage improvements resulting from lowering the culvert at Interurban Road. It would be advantageous, but more expensive, to replace the culvert with a larger one.

REPLACE GRANVILLE AVENUE CULVERT: While the elevation of the Granville Avenue culvert is high enough to prevent backwater flooding from downstream, it does appear to have inadequate conveyance and local flooding results. Saanich has included replacement of this culvert in its capital works program. It should be installed to provide suitable freeboard for drainage of upstream fields and sized to pass a moderate flood.

DURRELL CREEK ADJUSTMENTS: When the Interurban and Hastings Street culverts are lowered the streambed of Durrell Creek will require lowering to ensure adequate freeboard and to maintain water in the channel. We would propose to lower the bed of Durrell Creek from Interurban Road to Hastings Street, providing a smooth gradient from 8.3m at Interurban to 8.7m at Hastings Street. The channel bed would be lowered on average about 50 cm. It would also be necessary to lower Durrell Creek downstream of Interurban Road by about 0.3 m to ensure that the benefits of the culvert lowering on reducing the duration of floods are achieved.

As part of this work, silt that had deposited in the stream, and aquatic weeds, would be removed from Durrell Creek. The streambed would be over-excavated along part of the course to provide occasional deep pools. The banks of Durrell Creek would be graded to a 2H:1V or a suitable stable angle that prevents erosion and re-sedimentation, and the channel widened or filled, if required, to provide a consistent cross sectional area. The excavated material should be placed as a low, flat continuous levee or berm, setback from the channel, and planted with suitable riparian species. Machine excavation would be required for the initial channel regrading.

Community groups may wish to participate in planting of riparian species along Durrell Creek. As some maintenance may be required along Durrell Creek, the riparian planting can either be of hardy species that can tolerate disturbance, or the plantings can be alternated from bank to bank to provide access.

Durrell Creek, upstream of Interurban Road, flows through a municipal road right-of-way. This parcel of land is in the order of 20m wide and 500m long. If desired, the right-of-way provides sufficient width to meander the channel or construct deep pools along its course, and re-establish riparian vegetation. This possibility will be discussed further in the Environmental Measures Section, as it has potential environmental benefits.

It is hoped that further channel maintenance and clearing of aquatic vegetation from the wetted perimeter of Durrell Creek would be minimized by the lowered culvert and planting of riparian vegetation to provide shade and reduce erosion. If required, local maintenance would be discussed with appropriate government agencies and a plan developed to minimize potential environmental impact. Where practical, the maintenance work would be completed with hand labour.

Both the initial channel re-construction, and any required channel maintenance work, would be conducted under a Water Act, Section 9 approval from the Ministry of Environment, Lands and Parks. Application for an approval is normally submitted by May 1, allowing a 45-day review period prior to the instream works window. Provincial standards for ditch and channel maintenance are forthcoming from an interagency committee (which includes DFO representatives) in the near future, and the above-proposed works could be reviewed against those standards prior to implementation.

Maintenance of all drainage structures in the watershed must be part of an ongoing program. The actual elements of the plan will vary depending on the scenario (ie – some will include maintenance of a pump), but the elements of a systematic maintenance program include:

- An inventory of all drainage structures and ditches
- Develop a status and performance rating system for each section
- Note potential problem areas and priorize for repairs/maintenance works
- Develop annual inspection of priority areas. Look for sediment build-up, excessive vegetation, debris build-up, capacity of ditch
- Schedule and timing of routine maintenance (ie – mowing)

- Documentation and notification to agencies with an interest (ie - DFO, MOELP, Ministry of Agriculture)

Effects of Scenario #1a on Drainage

A detailed hydrologic and environmental study of the Colquitz system would be required to evaluate the potential benefits of reduced downstream flooding versus the costs of increased storage. MOELP Water Management Branch is of the opinion that such a study is not worthwhile, as the environmental impacts would be significant and no real benefits would be gained.

Lowering the culvert at Interurban Road would reduce the percentage of time that water levels in Durrell Creek are at, or above, the minimum field elevation on Courtland flat from about 40% of the time to about 10%. A similar effect would occur at Hastings Flats, if the culvert under Hastings Road were lowered. Lowering the Interurban culvert alone would not reduce flooding at Hastings Flats. Water levels would overtop the stream banks during 10-year, 2-day summer storm but would return to base flow levels over about 2 days, meeting ARDSA criteria. Lowering the Interurban culvert would just achieve the minimum freeboard of 0.9 m during minimum flows. Freeboard may not be adequate early in the growing season, during April, May and early June.

Extreme (winter) water levels would not be reduced at all, remaining at 12.1 m. However, the fields will drain to a lower elevation, and more frequently lowering average winter water levels. Still, the water levels in Colquitz River would still control the elevation of winter water levels on Courtland and Hastings Flats.

This scenario is not expected to increase extreme flows or water levels in Colquitz River downstream of Durrell Creek. As described in Appendix C, lowering the culvert is expected to cause a small or minor increase in peak flows, amounting to about 3% of the 200 year discharge from Durrell Creek.

5.2.2 Agricultural Improvements

Proposed Measures

LAND USE GUIDELINES TO PROTECT AGRICULTURE: Land development guidelines to minimize impacts of other land use on agriculture are recommended. Their goal is to enhance the compatibility between agriculture and surrounding land uses, to help achieve the goals of the IWMP. There are numerous issues that arise at the interface between agriculture and other land uses, as indicated in the table below.

ISSUES THAT ARISE AT THE INTERFACE BETWEEN AGRICULTURE AND OTHER LAND USES	
FARMER'S PERSPECTIVE	NON-FARMER'S PERSPECTIVE
Compensation for damage (indemnification)	protection of fish habitat
Complaints about farm practice	protection of wildlife habitat
Liability for damage	doors
Trespass	chemical spray
Theft	dust
Harassment of animals	emissions from farm traffic
Vandalism	light (i.e. – greenhouses)
Crop and irrigation spray limits	lack of animal containment
Water recharge and pollution	irrigation overspray
Flooding and stormwater runoff	extended hours of operation
Shading of crops	pollution of groundwater
Loud noises	debris on roads
Spread of noxious weeds and pests	visual impact
Restrictions on ditch maintenance	intensive farming operations
Safety related to farm equipment on roads	

Of this list, the key issues for farmers in the Durrell watershed include: indemnification for agricultural losses, possible pollution and sediment load effects on water quality, alterations to the quantity and timing of flow, buffering at the boundaries between development and agriculture, trespass and vandalism, size of subdivisions, use and location of buildings, community lack of understanding of farmer's needs and processes, lack of understanding by "hobby farmers" of legislation, and impacts on the environment.

To overcome these potential conflicts, it is recommended that the following options be considered:

- The Saanich General Plan (OCP) and zoning bylaws be amended to provide for a Development Permit Area (DPA) for the protection of farming in the Durrell Creek watershed. The DPA should be made applicable to the entire study area. The items to be dealt with in the OCP include building location, buffering, subdivision and drainage.
- When local area plans are prepared, it is suggested that they focus on drainage issues to ensure that farmland is not affected by changes in quantity or quality of stormwater.
- The Approving Officer be encouraged to ensure agricultural areas are protected when approving subdivisions.
- Encourage communication between the agricultural and non-agricultural components of the community: through the bylaw amendment process, public notices, articles, etc, mail-

out related to good farm and farm neighbour practices, article on the Saanich website, disclosure of agricultural presence during real estate transactions, and to set up an agricultural advisory committee.

AGRICULTURAL CODES OF PRACTICE. Agriculture operations are subject to the Code of Agricultural Practice for Waste Management in BC, part of the regulations under the Waste Management Act. The code describes generally accepted farming practices for using, storing and managing agricultural wastes, and was drafted by a multi-agency committee including municipal representatives. If a farm operation is in compliance with the code, then they are exempt from obtaining a waste discharge permit. Environmental guidelines have been produced for each of the livestock industries (horses, beef, dairy) and well as other agricultural sectors (field vegetables, greenhouse growers, mushroom producers, nursery and turf producers, tree fruit and grape producers) which support and provide implementation details to ensure compliance with the code. The guidelines are in the process of being updated, and they will be including a section on farm planning. In addition, there are environmental guidelines in the Farm Practices Protection Act, and its reference guide, Strengthening Farming in BC (1996).

These reference documents provide a good source of guidelines for agricultural practices, and their acceptance and implementation would be beneficial to the Durrell Creek watershed. Many of the operations in the watershed are already knowledgeable of and in compliance with the Code. A program to educate the remainder of the agricultural community in the watershed of the code is recommended. In particular, hobby farmers and other users of rural residential land are a sector that would benefit from an education program. Various mechanisms to reach this audience can be considered including direct mail outs, open houses or site visits.

RIPARIAN GUIDELINES. Riparian guidelines are currently being investigated by a multi-agency committee, the Partnership Committee on Agriculture and the Environment (which includes DFO representatives). Numerous topics are being reviewed, including ditch maintenance and stormwater runoff. Agricultural ditch maintenance policy guidelines for BC have been drafted and are currently under review. A draft process called a riparian self-audit has been designed, which guides a farmer through a process of assessing the condition of riparian areas on their property. It would then review the farm operation/practices and determine if there are any improvements that can be made. This may take the form of a type of risk assessment, which would determine linkages between farm operations, materials and the environment. This entire process is being described as a complete farm plan or farm environmental management planning, and it is being recommended for both existing and new operations.

Effects of Scenario #1a on Agriculture

With the proposed drainage improvements outlined above, the following changes for local agriculture would be anticipated:

- Reduced risk of summer crop damage due to inadequate drainage
- Lower shoulder season water levels
- Marginally reduced risk of flooding in the shoulder seasons, leading to longer growing season from 20% (current) to about 30% of the time
- Insignificant effect on winter water levels or drainage
- Marginally greater flexibility in cropping choices
- Marginal changes in cropping
- Increased yields, due to extended cropping in years when weather permits
- Expected annual net revenue increase of $275 per acre
- Soil capability degradation over time due to flooding effect

5.2.3 Environmental Management

Proposed Measures

WATER QUALITY TESTING. Water quality testing is recommended on an as-required basis. The purpose would be to determine if there are any point sources of pollution. The primary concern is sewage from leaking septic systems, so the septic field testing and upgrade program under the Regional District program is the best vehicle. If any cross-connections are identified, the Municipality would be notified for scheduling of an upgrade.

TERRESTRIAL ESAs - PRIVATE LAND. Environmentally sensitive areas (ESA) in the Durrell Creek watershed have been identified as part of municipal and regional studies (Saanich, 1998 and Canadian Wildlife Service, 1999), and a map of the ESAs in the watershed is included in Appendix D. Many of the terrestrial ESAs and rare plant occurrences are located on private property. An education program directed specifically at landowners with an ESA on their property is recommended. The goal would be to encourage maintenance of existing ESAs in their current state as a minimum. An information package with a map, a field visit to point out the species of concern and their significance, and some specific recommendations for management of the ESA can all be provided to encourage private stewardship. With some technical direction (i.e.- municipal environmental staff), such a project could be quite cost effectively delivered by summer students or local high school or college students. There might be a local stewardship group that would be interested in participating in such a program. . To provide more long-term protection to the ESAs, Saanich could hire an Environmental Steward to reach stewardship agreements with landowners of ESAs.

RIPARIAN ESAs - PRIVATE LAND. Riparian ESAs were identified as part of the Saanich study but not the SEI study at a regional scale. The width of identified riparian ESAs is variable, depending on the presence of riparian vegetation. An educational program similar to the one outlined above for terrestrial ESAs should be implemented. The riparian ESAs are separated for different treatment, due to the complicating objectives of maintaining agricultural production and improving channel conveyance. In general, the species found in riparian ESAs are not rare or unusual; their value lies in their location along a watercourse. On those reaches of Durrell Creek where channel maintenance is recommended, stream restoration and riparian enhancement can also be considered. The objective of improved flow conveyance which would remove silt and aquatic vegetation from the channel has the potential added benefit of faster velocities, less suspended sediment and improved water quality. If some overhanging riparian vegetation is planted, more shading and lower water temperatures would also be possible. Riparian planting can be designed to avoid conflict with the channel maintenance program, by planting on one side of the channel only or alternating sides. The goal would be to plant a narrow strip of vegetation to provide some shade, but not affect the agricultural value of the adjacent fields. This should be done in compliance with the landowners, and follow the progress made by the Partnership Committee on Agriculture and the Environment. These improved channel conditions would have the benefit of delivering better water quality to salmonid habitat downstream in the Colquitz system.

If instream enhancements of fish habitat are necessary or desired as compensation for the channel clearing activities, they could be located on the lower reach of Durrell Creek just above the Colquitz confluence or on the mainstem Colquitz. The reach of Durrell Creek between Interurban and Wilkinson Roads crosses the Wilkinson Road jail (Ministry of Attorney General, Corrections Branch) property. Several riparian enhancement projects have been conducted on these stream reaches, including initiatives by CHAPS with BC Hydro and Saanich. Jail officials are amenable to stream improvements, provided that clear sightlines are maintained. Low stature riparian species can fulfil many functions of fish habitat, while meetings the jail's criterion.

STEWARDSHIP ON MUNICIPAL LAND: The municipality should practice stewardship by enhancing habitat and protecting ESAs on public lands. This would include ESAs, parks, rights-of-way and other lots owned by the municipality. This kind of leadership would be important in the effort to get private landowners to steward ESAs on their land. The municipality is also encouraged to promote preservation of ESAs by passing an ESA bylaw and including ESAs on "Permit Plan". Saanich should also consider purchasing ESAs, based on a municipal-wide canvassing of the most deserving ESAs. This larger context review of ESA purchase should be based on habitat value and risk, and set priorities on a regional scale. Any purchase of ESAs would have to have a right-of-way, as municipal property cannot be landlocked. Once purchased, the municipality would be obliged to manage the ESA for danger trees, vandalism and garbage.

Another option for riparian enhancement would be on the reach of Durrell Creek immediately upstream of Interurban Road. As the stream flows along a municipal right of way for approximately 500m, this reach could be enhanced as part of the channel restoration/maintenance proposed under drainage improvements. The opportunity would exist to design a reconstructed channel that is more stable, provides meanders and pools, some form of biofiltration and sediment settling. If a stable channel is successfully established, then less maintenance would be required. The full width of the right of way (approx. 20m) could be planted with riparian species, providing a significant improvement to the fish and wildlife habitat of the Courtland Flats. Willow thickets currently in the vicinity would provide a good indication of suitable species, and the songbird habitat present would be enhanced.

GENERAL ENVIRONMENTAL STEWARDSHIP: Based on the results of the landowner survey (Chapter 3), there is considerable interest in environmental stewardship among the local residents who responded. This sentiment should be encouraged and specific programs developed to take advantage of volunteer support. This would be a good opportunity to educate and raise the awareness of local residents to the special environmental features of the watershed. All Saanich residents should be made aware of existing municipal bylaws that protect natural features (Watercourse, Fill Prohibition, Zoning and Tree bylaws). Brochures could be added to tax notices or other municipal mail-outs to reach a wider audience.

Effects of Scenario #1a on Environment

The overall environmental effects of the measures proposed in this scenario include:

- Potential impacts during construction of culverts, to be mitigated by environmental monitoring
- Disturbance of stream bed during initial channel clearing
- Periodic disturbance during ongoing channel maintenance
- Less open water waterfowl habitat, some displacement of birds
- Increased riparian vegetation
- Decreased soil loss and sedimentation to the stream
- Decreased agricultural runoff (manure, herbicides, pesticides) through implementation of agricultural codes of practice and riparian guidelines on farmland.
- Improved water quality through periodic water quality testing

- Protection and maintenance of ESAs through private and public stewardship
- Improved riparian habitat on Durrell above and below Interurban
- Improve rights of way for wildlife habitat

The possible flood control measures on headwater lakes in the Colquitz system have several potentially significant environmental impacts. They would include flooding of shoreline properties, inundation/dewatering of nearshore habitat, and downstream flow changes on riverine habitat. A detailed environmental assessment of the proposed measure would be required, to be considered in conjunction with the water licence application.

The agencies with a mandate for fish habitat protection (DFO and MOELP) have indicated that physical fish habitat upstream of Interurban Road is not significant, and the inventory data (Chapter 3) indicates that no salmonids have been observed in the upper Durrell system. DFO typically looks for net gain or at least no net loss of fish habitat when reviewing any proposed stream works. The goal that the agencies have for the upper Durrell system is to improve water quality contributions to salmonid habitat in the lower Durrell and Colquitz systems. Those water quality criteria would include decreased suspended sediment, decreased water temperature in summer, and decreased levels of pesticides, herbicides, and fecal coliforms.

Most of the apparent effects of Scenario #1a on wildlife apply to birds, primarily waterfowl. Summer waterfowl habitat, that created by the flooding of Hastings and Courtland flats, will be reduced in relation to the flooding reduction due to the lowered culvert.

Several other wildlife elements might also be altered by the proposed Scenario. The proposed increase in riparian vegetation will likely be a benefit to a variety of wildlife, particularly songbirds and possibly raptors. Recreation proposals directed at nature viewing may not directly benefit wildlife, but it will aid in wildlife appreciation.

5.2.4 Recreation Plan

Proposed Measures

RECREATIONAL OPPORTUNITIES: To help achieve the goals of the IWMP and the interests of the community, parkland and road rights-of-way should be used in a way that:

- facilitates opportunities for local recreation
- helps to connect the neighbourhood and enhances the urban/rural lifestyle

- supports opportunities for residents and schools to observe and learn about farming and food production
- minimizes encroachment on wildlife and wildlife habitat
- facilitates wildlife viewing opportunities
- respects private property and the privacy of property owners
- minimizes inconvenience of farmers
- ensures cost-effective development and maintenance of trails
- facilitates ditch and culvert maintenance
- maintains public safety standards

A number of options were explored:

- Shift, transfer or switch ROW from one location to another
- Construct new trails or boardwalks along unused, unopened ROW
- Construct new trails/walkways through new subdivisions
- Widen existing ROW to allow new areas to be created
- Widen existing roadway for better use
- Use existing roadway edges for walking, parking and riding
- Improve park and ROW for bird viewing and/or habitat enhancement
- Purchase/ exchange land for recreation and /or habitat purposes
- Improve educational and interpretive signs, brochures and other material

The recommendations are:

- That the recreational opportunities outlined in Figure 5.3 be considered by Saanich.
- That the existing ROW be retained in their present locations and not sold or moved unless for habitat purposes. Some ROW are not to be used for trails due to flooding, agriculture and/or wildlife concerns. Some fencing along the edges may need to be relocated to ensure security for adjacent private property. The concerns of adjacent landowners should be solicited and incorporated prior to implementation of the plan.
- That because some trail routes will require time to resolve land acquisition, that these routes should be identified in any future updates of local area plans.
- That any proposed regrading of Durrell Creek include consideration of enhancing habitat by using riparian modification techniques, particularly the Charleton ROW across Courtland Flats.

The Corporation of
the District of Saanich
Durrell Creek
Integrated Watershed
Management Plan

0 250 500

Recreation Opportunities

Base Map

- Approximate Watershed Boundary
- Drainage
- Wetland
- Treed Wetland
- Seasonally Flooded Land
- Lake
- Road 2 Lane
- Loose Road
- Trail

TN
UTM N
mN

Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 1980 FOR CENTRE OF MAP
Annual change decreasing 4.1'

Recreation

- CRD Park
- Saanich Park
- Bird Viewing Area
- Proposed Access Parking
- Habitat Restoration Area
- Bicycle Route
- Existing Trails
- Proposed Trails on Roads
- Proposed Trails
- Proposed East/West Connector

MAP REFERENCES

Source Material provided by the Durrell Creek Steering Committee Recreation Sub-Group

Figure 5.3

Pottinger Gaherty Environmental Consultants Ltd.
a member of the Pottinger Gaherty Group

- That designs for recreational trails and bird viewing stations consider:
- The privacy of adjacent residences
- Barriers to limit unauthorized access to privately owned open spaces and farmland
- Keeping areas open for access needs of farming vehicles and equipment
- Signs for informing the public about using and parking in areas adjacent to farming operations
- Planting of trees and native vegetation for screening and visual amenity
- Use of a rural/agricultural theme
- That local trail connections are key features of the rural community and they need to be extended to link with other trails and parks beyond the study area
- That trail improvements be included in the Saanich Parks Capital program, with a phased trail construction plan to follow.
- That neighbourhood trails connect with the proposed "east-west corridor trail", which lies north of the watershed.
- That an educational component be developed by Saanich to inform residents about:
  - The history of the area and the people
  - The importance of agriculture and how food is produced
  - The value of bird, fish and natural vegetation habitats
  - The existence of a neighbourhood trails plan
- That lands with a high potential for both environmental and recreational value be considered for acquisition. Further discussion is needed to determine if there is some merit in changing the land use in the Gillie Road area for environmental and or recreational purposes.

Effects of Scenario #1a on Recreation

Implementation of the recreational opportunities outlined above would significantly improve passive recreation in the watershed. In particular, the individual measures and existing features take on a much higher value because of their connection to each other.

Some of the rights of way will still be flooded during winter, so trail use in some areas will be seasonal. Drainage improvements proposed under this scenario will have almost no effect on the trails. There may be some change to the birdwatching activities due to change in species mix from habitat alterations.

5.2.5 Land Use Changes

Proposed Measures

LAND USE PLAN: Several of the measures proposed above (Land Use Guidelines for Agriculture, Recreational Opportunities) recommend changes to the Saanich OCP and local area plans. The major change would be designating the entire watershed as a Development Permit Area (DPA) which would allow more detailed analysis of any applications for development in the study area. The OCP for Rural Saanich has not been updated for many years and the next review is scheduled for 2000/2001. Major changes to land use are not expected.

Effects of Scenario on Land Use

Under this scenario, the potential for flooding of the Gillie Road lots is not substantially changed from the present condition. Much of the area is seasonally flooded and within the Fill Prohibition Boundary. High water tables would prohibit installation of septic fields. The lots are currently zoned rural residential, which allows agricultural use. The smaller lot sizes are less than the current zoning would permit. Undertaking a replotting scheme to reconfigure lot sizes, a land swap for other municipal land and provision for a buffer between adjacent agricultural land and residential lots are possible solutions.

5.2.6 Financial Implications/Overall Value

The capital costs of the proposed drainage improvements under Scenario #1a would be $80 000 if the same culvert is reused. If a new open arch culvert is used, the cost would be in the order of $150 000. The excavation of Interurban Road is the major item included in this cost estimate.

Therefore, in Scenarios #1a or 1b, we expect some marginal improvement in net revenues but really since the cropping patterns will not change we are talking about changes in the probabilities of experiencing adequate drainage in any given year. Nevertheless, the framework can be used to analyze the net return effect of changing the probabilities of successful cropping patterns.

In the table below, the probabilities of optimal net return outcomes are indicated to increase under scenarios 1A and 1B. Option A cropping would experience a greater expectation of attaining target yields. In addition, farmers may attempt Scenario 2 cropping when it appears that weather is cooperating (e.g. 30% of the time). The effect is to raise the expected net return up to $2,275 per acre. The net benefit is the $2,275 minus the status quo, i.e., $2,000

= $275 per acre. The total net annual agricultural benefit is calculated at $275 x 37.5 acres = $10,312.

However, there are other non-monetary costs to scenarios #1a and #1b. These include:

- Absence of cover cropping benefit
- Degeneration of organic soil
- Soil erosion
- Reduced agricultural viability over time
- Limited cropping flexibility

The indication is that winter inundation of agricultural soils will result in a longer term loss of productivity and eventual conversion of the lands into marginal, low intensity agricultural uses. The expected increases in yields and/or net revenues are not sufficient to lead to on-farm drainage improvements.

Annual Expected Agricultural Net Returns Per Acre under Scenarios 1A and 1B.

Cropping Pattern	Probability of Adequate Drainage	Net Revenue Target	Realized Net Income	Annual Expected Net Revenue (1)
Cropping Option A	90%	$2,000	$2,000	$1,800
	10%	$2,000	$1,000	$100
Annual Expected Revenue (Example 1)				$1,900
Cropping Option B	30%	$4,500	$4,500	$1,350
	60%	$4,500	$2,000	$1,200
	10%	$4,500	$1,000	$100
Annual Expected Revenue (Example 2)				$2,650
Average Net Revenue Expectation from Cropping				**$2,275**

Notes: (1) Expected Net Revenue = Target * Probability

5.3 Watershed Management Scenario #1b – Improvement of Growing Season Water Levels – Install Flapgate and Small Pump on Existing Interurban Culvert

This option of Scenario #1 provides an alternative approach that reduces growing season base flow elevations, extends the growing season, and limits the duration of flooding of agricultural fields during the growing season. This option of Scenario #1 closely resembles the present situation, in that a temporary water licence was obtained in 1999, by R. Galey, to pump water from Courtland Flats at Interurban Road. This application was reviewed and approved by all three levels of government, taking environmental and downstream concerns into consideration.

5.3.1 Drainage Improvements

Proposed Measures

COLQUITZ WATER MANAGEMENT: Water management study on the Colquitz system – see Section 5.2.1

FLAPGATE AND PUMP AT INTERURBAN: There is a second option to achieve lower growing season base flow elevations and reduce the duration of flooding of fields during growing season storms. Under this scenario, a flapgate would be added to the existing Interurban Road culvert to prevent backflooding from Colquitz Creek. A small pump house would be built on the upstream side of Interurban Road near Durrell Creek, and a right of way or easement would be arranged if the site is on private land. A small electric or gas-powered pump would be installed. Electrical service would be required, if an electric powered pump were purchased. A passage through Interurban Road would be installed to discharge pumped water to the downstream side of the culvert. Operation and maintenance of the pump and pump house would have to be conducted on an annual basis.

The farmer who leases the Courtland and Hastings flats (R. Galey) presently uses this approach to manage growing season water levels and storm runoff, as a private initiative. Operating the pump each year would require a water license, under Section 9 of the Water Act, from the Ministry of Environment, Lands and Parks. An application is now submitted each year, however, with a permanent facility, a permanent license could be obtained and held by the District of Saanich. Typically, the pump would be operated starting in late March or early April to draw down water levels in Durrell Creek to provide adequate freeboard for drainage of the fields. The pump would be operated as required over the summer and early fall. The pump would not have adequate capacity to prevent flooding by summer rainstorms. During operation of the pump in late March or early April the flapgate would close, blocking upstream or downstream fish migration. As water levels drop in the Colquitz River, the flap gate would open, allowing migration. Access may also be blocked again during the fall, if water is pumped to maintain freeboard.

It is thought, that with appropriate design of the instream works and environmental construction monitoring, these works do not need to have a significant impact on instream or downstream water quality and habitat.

LOWER HASTINGS CULVERT: Lower Hastings Street culvert – see Section 5.2.1

CHANNEL CLEARING: Excavation/clearing/maintenance of Durrell Creek channel bed – see Section 5.2.1

Effects of Scenario #1b on Drainage

Under Scenario #1b, pumping would just about meet minimum freeboard under base flow. The pumping would draw down water levels earlier in the growing season and maintain them later in the fall, but it would not affect the duration of flooding during the growing season that results from intense summer rainstorms. Water may remain on the fields for more than two days and up to about 4 days as occurs under existing conditions.

Extreme (winter) water levels would not be reduced at all, remaining at 12.1 m. Average winter water levels would remain the same as they are now. The water levels in Colquitz River would still control the elevation of winter water levels on Courtland and Hastings Flat. Hand clearing of vegetation along Colquitz Creek may reduce extreme water levels by 10 to 20 cm.

This scenario is not expected to increase extreme flows or water levels in Colquitz River downstream of Durrell Creek. As conditions will remain the same as they are now during winter.

5.3.2 Agricultural Development

Proposed Measures

LAND USE GUIDELINES TO PROTECT AGRICULTURE: Guidelines to minimize the impacts of other land uses on agriculture are recommended – see Section 5.2.2.

AGRICULTURAL CODES OF PRACTICE: Agriculture operations are subject to the Code of Agricultural Practice for Waste Management in BC – see Section 5.2.2.

RIPARIAN GUIDELINES: Guidelines for riparian areas on agricultural land are recommended – see Section 5.2.2.

Effects of Scenario #1b on Agriculture

With the proposed drainage improvements outlined above, the following positive benefits to local agriculture would be realized: longer growing season, lower summer water levels in Durrell Creek, reduce summer flooding, faster drainage in winter, and better growing conditions. This would result in greater flexibility in cropping choices and higher yields per acre. This scenario would decrease the risk of crop loss, but would not entirely meet ARDSA growing season standards.

5.3.3 Environmental Management

Proposed Measures

WATER QUALITY TESTING: The ongoing program by the municipality/regional district to continue water quality testing and upgrades as required should be continued – see Section 5.2.3.

TERRESTRIAL ESAs – PRIVATE LAND: A program to inform private landowners about stewardship of ESAs on their property should be implemented – see Section 5.2.3.

RIPARIAN ESAs – PRIVATE LAND: Stewardship of riparian ESAs on private land is encouraged, to be developed in combination with other objectives of maintaining agricultural production and improving channel conveyance. See Section 5.2.3.

STEWARDSHIP ON MUNICIPAL LAND: The municipality should practice stewardship by enhancing habitat and protecting ESAs on public lands – see Section 5.2.3.

GENERAL ENVIRONMENTAL STEWARDSHIP: A general education program on environmental stewardship and municipal initiatives should be developed – see Section 5.2.3.

Effects of Scenario #1b on Environment

In 1999, DFO reviewed the water application for pumping made by R. Galey and found that there were no negative impacts on fish habitat. That application was very similar to the drainage measures proposed above, hence the environmental effects are not expected to be significant.

For all other aspects of this scenario, the effects on the environment are as described under Scenario #1a.

5.3.4 Recreation Plan

Proposed Measures

RECREATIONAL OPPORTUNITIES: It is recommended that the recreational opportunities outlined in Section 5.2.4 and on Figure 5.2 be explored by the municipality.

Effects of Scenario #1b on Recreation

Lowering the growing season base flow elevations using a flap gate and small pump would also not have significant effects on the trails or recreation activities. The same comment pertaining to channel clearing in the Durrell Creek would apply to all scenarios.

5.3.5 Land Use Changes

Proposed Measures

See Section 5.2.5.

Effects of Scenario on Land Use

See section 5.2.5.

5.3.6 Financial Implications/Overall Value

The capital costs of the proposed drainage improvements under Scenario #1b would be $80,000. There would also be an annual commitment for pump operation and maintenance.

The costs and benefits to agriculture of Scenario #1b would be identical to those presented for Scenario #1a in Section 5.2.6.

5.4 Watershed Management Scenario #2 – Management of Growing Season Water Levels and Improved Drainage in Winter – Lower Interurban Culvert, Add Flapgate and Small Pumping Station

Scenario #2 provides increased water management on Durrell Creek during the growing (summer) season yet maintains the seasonally flooded agricultural fields during the dormant (winter) season. The growing season would be extended to about 7 months, allowing one good crop and establishment of a cover crop or, theoretically, double-cropping. Freeboard over base flow water elevations, during the growing season, would meet minimum ARDSA criteria.

5.4.1 Drainage Improvements

<u>Proposed Measures</u>

COLQUITZ WATER MANAGEMENT: Water management study on the Colquitz system - see Section 5.2.1

LOWER/ENLARGE INTERURBAN CULVERT, ADD FLAPGATE, WEIR OR STOPLOGS AND SMALL PUMP: Scenario #2 would replace the existing Interurban Road culvert with a larger culvert or concrete flood box, though it could operate with the existing culvert at a lower elevation. Further hydraulic analysis would be required to provide the best culvert size for field drainage, consistent with cost. The new culvert/floodbox would have an invert elevation of 8.8m, which would be about 0.8m below the existing culvert. A flapgate would be added to the downstream end of the culvert, and the culvert would be set at a flat gradient. Headwalls would be required at the culvert entrance and exit to retain the Interurban road fill. A weir or stoplogs would be fitted to the culvert in order to retain water during the dormant season.

A pump large enough to meet the growing season ARDSA criteria, which is estimated to require a maximum capacity of between 500 and 1000 litres per second, would be installed. The pump would have a screened wet well, to prevent entrainment of fish. Prior to pump operation, a reconnaissance to determine if fish are present immediately upstream of Interurban Road should be conducted. If juvenile fish are present, a salvage would be undertaken and the fish transported to lower Durrell Creek or the Colquitz River. A secure pump house and wet well would be constructed on the upstream side of Interurban Road, and a right of way arranged if necessary. A passage through Interurban Road would be installed to discharge pumped water to the downstream side of the culvert. Operation and maintenance would be conducted annually, and the operating procedures, including adjustment of pumping rates to meet agricultural and environmental criteria, should be reviewed periodically. The operating protocol would be established to achieve the agricultural drainage, while minimizing the other effects. Targets can be quantified, based on the water levels to be achieved by given dates.

Typically, the stoplogs would be removed starting in late March or early April to draw down water levels in Durrell Creek to provide adequate freeboard for drainage of the fields. The pump would also be operated as required over the summer and fall. During operation of the pump in late March or early April the flapgate would close, blocking upstream or downstream fish migration. As water levels drop in the Colquitz River, the flap gate would open, allowing migration, although it would close again during summer rainstorms. Access may also be blocked again during the fall, if the pump is operated to maintain freeboard. The flap gate would remain open over the winter, and the stoplogs would be reinstalled. The Durrell system would continue to provide floodwater storage for the Colquitz.

Typically, this type of installation and its operation would require a water licence held by the District of Saanich, and a Section 9 Approval for construction within the instream construction window, from MOELP. A water licence application would take many of the issues raised by this study into consideration, and apply conditions to the licence as necessary to address the concerns. Note that a temporary water approval (Water Act, Section 9) for this type of pumping operation has been issued in the past to R. Galey, following a review of potential instream and downstream effects. An Application for a Section 9 Approval is normally submitted by May 1, allowing a 45-day review period prior to the instream works window. Approvals for a water licence would take considerably more time than a Section 9. With appropriate design of the instream works and environmental construction monitoring, these works do not need to have a significant impact on instream or downstream water quality and habitat.

LOWER HASTINGS CULVERT: Lower Hastings Street culvert – see Section 5.2.1

CHANNEL CLEARING: Excavation/clearing/maintenance of Durrell Creek channel bed – see Section 5.2.1

ON-FARM DRAINAGE IMPROVEMENTS: On-farm drainage improvements such as the installation of drainage tiles, pumping or deepening of ditches are required to take maximum advantage of the other proposed drainage improvement measures under Scenario 2. Experience in the Lower Mainland indicates that over 95% of the land in ARDSA areas becomes tile drained as farmers realize the increased yield potential associated with better regional and on-farm drainage. The local drainage level is determined by the base flow elevation in Durrell Creek. These on-farm improvements would be the responsibility of the individual farmer.

Effects of Scenario #2 on Drainage

The new floodbox and pump would just meet ARDSA minimum freeboard requirements for base flow. The pump would have a greater capacity than is required to meet the ARDSA growing season duration of flooding criteria. This would allow water levels on Courtland and Hastings Flats to be drawn down rapidly to base flow elevation in early April and maintained near that elevation until late September or October. The period of lowered water levels would depend on the crops planted, weather, and other factors. The frequency of pump operation and the costs for operation would also depend on summer weather. The expectation is that April and October would be the main months that pumping would be required.

Extreme (winter) water levels would not be reduced at all, remaining at 12.1 m. The water levels in Colquitz River would still provide the main control of the elevation of winter water levels on Courtland and Hastings flats. This scenario is not expected to increase extreme flows in the Colquitz River downstream of Durrell Creek. As described in Appendix C, lowering the culvert causes a small increase of peak flows from Durrell Creek amounting to about 3% of the 200 year discharge.

5.4.2 Agricultural Development

Proposed Measures

LAND USE GUIDELINES TO PROTECT AGRICULTURE: Guidelines to minimize the impacts of other land uses on agriculture are recommended – see Section 5.2.2.

AGRICULTURAL CODES OF PRACTICE: Agriculture operations are subject to the Code of Agricultural Practice for Waste Management in BC – see Section 5.2.2.

RIPARIAN GUIDELINES: Guidelines for riparian areas on agricultural land are recommended – see Section 5.2.2.

Effects of Scenario #2 on Agriculture

With the proposed drainage improvements outlined above, the following changes for local agriculture would be anticipated:

- Reduced risk of summer crop damage due to inadequate drainage
- Lower shoulder season water levels

- Reduced risk of flooding in the shoulder seasons, leading to longer growing season from 20% (current) to about 50% of the time
- No effect on winter water levels and drainage
- Greater flexibility in cropping choices
- Increased double cropping and extended season cropping
- Increased range of rotational options to control disease and respond to market opportunities
- Cover cropping on higher elevation fields
- Increased yields, due to extended cropping in years when weather permits
- Expected annual net revenue increase of $1124 per acre
- Soil capability degradation over time due to flooding effect
- Reduced damage to soil from the use of farm machinery on saturated soils in some years

5.4.3 Environmental Management

Proposed Measures

WATER QUALITY TESTING: The ongoing program by the municipality/regional district to continue water quality testing and upgrades as required should be continued - see Section 5.2.3.

TERRESTRIAL ESAs - PRIVATE LAND: A program to inform private landowners about stewardship of ESAs on their property should be implemented - see Section 5.2.3.

RIPARIAN ESAs - PRIVATE LAND: Stewardship of riparian ESAs on private land is encouraged, to be developed in combination with other objectives of maintaining agricultural production and improving channel conveyance. See Section 5.2.3.

STEWARDSHIP ON MUNICIPAL LAND: The municipality should practice stewardship by enhancing habitat and protecting ESAs on public lands - see Section 5.2.3.

GENERAL ENVIRONMENTAL STEWARDSHIP: A general education program on environmental stewardship and municipal initiatives should be developed - see Section 5.2.3.

Effects of Scenario #2 on Environment

The likely effects of Scenario #2 on wildlife are a small increment beyond those impacts discussed for Scenario #1. Under Scenario #2, pumping capability would be used to limit or prevent flooding which might affect the cultivation of crops. That is, any time after mid-March pumping or drainage through the lowered culvert would eliminate the flooding of fields, to permit seeding. Wintering ducks continue to use flooded field habitat until mid-March, but start to disperse soon thereafter. For this reason, drainage of fields at the end of March may not represent a major impact to wintering ducks on the flats.

5.4.4 Recreation Plan

Proposed Measures

RECREATIONAL OPPORTUNITIES: It is recommended that the recreational opportunities outlined in Section 5.2.4 and on Figure 5.2 be explored by the municipality.

Effects of Scenario on Recreation

Changing the Interurban culvert and adding a new pump would result in lowering the water levels. The draining of fields to a lower elevation earlier in the year would not have an effect on the proposed trails. Lowering the average winter water levels may have a positive effect on some bird populations but no significant long-term detrimental effects are anticipated.

5.4.5 Land Use Changes

Proposed Measures

LAND USE PLAN: Changes to the land use plan for the Durrell watershed should be made at the next OCP – see Section 5.2.5.

Effects of Scenario #2 on Land Use

While there would be reduced flooding of the Gillie Road lots under Scenario #2, many of the issues outlined under Scenario #1 would still apply. See Section 5.2.5.

5.4.6 Financial Implications/Overall Value

The capital costs of the drainage improvements under Scenario #2 would be $220,000, with and annual allowance for operation and maintenance.

Scenario 2 would presumably provide improvements in shoulder season flooding and would increase the probability of drainage that would facilitate scenario 2 cropping patterns. The table below suggests that the probability of Scenario 2 cropping Option B target yields would increase as a result of the drainage improvements. Note that on-farm drainage improvements could be made, depending on the effectiveness of the flood control.

The effect is to raise the expected net return up to $3,124 per acre. The net benefit is the $3,124 minus the status quo, i.e., $2,000 = $1,124 per acre. The total net annual agricultural benefit is calculated at $1,124 x 37.5 acres = $42,150.

Again, however, there are other costs in Scenario 2 that have been alluded to by the agricultural review. These include:

- Absence of cover cropping benefit
- Degeneration of organic soil
- Soil erosion
- Reduced agricultural viability over time

The indication is that winter inundation of agricultural soils will result in a long term loss of productivity and eventual conversion of the lands into marginal, low intensity agricultural uses.

Annual Expected Agricultural Net Returns Per Acre under Scenario 2.

Cropping Pattern	Probability of Adequate Drainage	Net Revenue Target	Realized Net Revenue	Annual Expected Net Revenue (1)
Cropping Option B	50%	$4,500	$4,500	$2,250
	40%	$2,000	$2,000	$800
	10%	$1,000	$1,000	$100
Minus annualized on-farm drainage improvements (2)				-$26
Annual Expected Revenue				**$3,124**

Notes: 1) Expected Net Revenue = Target * Probability
2) Drainage costs based on 40 ft spacings, 30 year life ($52) on 50% of agricultural acres.

5.5 Water Management Scenario #3 – Management of Water Levels Throughout the Year – Replace Interurban Culvert with Floodbox, Add Larger Pumping Station

Scenario #3 provides the potential to meet growing (summer) and dormant (winter) season ARDSA criteria for drainage. Winter, or perennial crops, would be technically feasible, as would single cropping with a cover or green manure crop. Scenario #3 differs from Scenario #2 primarily in the size of the installed pump and the annual operation costs; all other measures are similar.

5.5.1 Drainage Improvements

Proposed Measures

COLQUITZ WATER MANAGEMENT: Water management study on the Colquitz system – see Section 5.2.1

LOWER/ENLARGE INTERURBAN CULVERT, ADD FLAPGATE AND LARGE PUMP: Scenario #3 would replace the Interurban Road culvert with a larger culvert or concrete floodbox of about the same size as that proposed for Scenario #2. Further hydraulic analysis would be required to provide the best culvert size for field drainage, consistent with cost. The new floodbox would have an invert elevation of 8.8m, which is a lowering of 0.8m. A flapgate would be added to the downstream end of the floodbox, and it should be set flat. Headwalls would be required at the floodbox entrance and exit to retain the road fill. A pump large enough to meet the winter ARDSA criteria, which would require a maximum capacity of between 1,000 and 2,000 litres per second, would be installed.

Electrical service would be provided to the pump house, and the pump would be activated automatically if water levels rise above some pre-set minimum value. A secure pumphouse and wet well should be constructed on the upstream side of Interurban Road, and a right of way arranged if necessary. A passage through Interurban Road would be installed to discharge pumped water to the downstream side of the culvert. Operation and maintenance would be conducted annually, and the operating procedures, including adjustment of pumping rates to meet agricultural and environmental criteria, should be reviewed periodically.

For perennial crops, or green manure crops, the pump would be operated all year round, maintaining freeboard and reducing the duration of flooding to meet ARDSA dormant season criteria. One possibility is to allow the lowest part of the field, near the creek, to remain flooded to provide wildfowl habitat, while maintaining a cover crop at higher elevation. The range in elevations on Hastings and Courtland Flats is only about 30 cm so it would require very fine control of pump operation to achieve this end. Alternatively, water levels may be allowed to fluctuate over the winter, allowing storage to reduce downstream water levels or to provide waterfowl habitat.

Maximum water levels would be less than occur now. However, the pump would not be large enough to control extreme floods, or pump failure may occur, and fill prohibition still would be required. Floodproofing of any structures on the Courtland and Hastings flats would also be required.

Pump operation may result in blocking of upstream or downstream migration of fish during a large part of the year. The use of intake screening to prevent mortalities due to entrainment or use of a fish-friendly pump may be required to permit fish movement between upper Durrell Creek and the Colquitz River.

Typically, this type of installation would require a water license held by the District of Saanich, and a Water Act, Section 9 Approval for construction within the instream construction window, from the MOELP. An Application for a Section 9 Approval is normally submitted by May 1, allowing a 45-day review period prior to the instream works window. Approval of a water licence would take considerably longer than a Section 9. With appropriate design of the instream works and environmental construction monitoring, these works do not need to have a significant impact on instream or downstream water quality and habitat.

LOWER HASTINGS CULVERT: Lower Hastings Street culvert – see Section 5.2.1

CHANNEL CLEARING: Excavation/clearing/maintenance of Durrell Creek channel bed – see Section 5.2.1

ON-FARM DRAINAGE IMPROVEMENTS: On-farm drainage improvements – see Section 5.2.1

Effects of Scenario #3 on Drainage

The basic premise of Scenario #3 is to provide a pump and floodbox sufficient to meet growing (summer) season and dormant (winter) season ARDSA criteria. However, water levels could be varied over the winter, as deemed most suitable for waterfowl habitat, maintaining them below some maximum elevation deemed for fill prohibition in Durrell Creek watershed. Maximum water levels would depend on the size of pump installed to meet winter ARDSA criteria. The pump would be inadequate to handle the predicted 200-year flood discharge and ponding would be expected on fields. Further analysis would be required, but maximum water levels may be about 10.5 to 11 m.

Summer impacts and conflicts would be similar to those described for Scenario #2. Winter conflicts would depend on how the pumping station is operated and what water level regime is maintained in Durrell Creek. However, it would make most sense to operate it to allow multiple cropping or perennial cropping (i.e.: ARDSA winter criteria). Under these circumstances, winter water levels would remain low, altering some of the waterfowl habitat and recreational opportunities associated with birdwatching.

Scenario #3 would eliminate some of the storage available for Colquitz and Durrell Creek floodwaters. The estimated maximum storage volume during a large flood on Courtland and Hastings Flats is about 300 dam^3 (250 acre-feet), compared to a daily maximum flood flow on the Colquitz at Violet Avenue of about three or four times that, or 1,400 dam^3. Note that not all the storage would be available during the peak flow, it will be partly or completely filled prior to the peak. Further, the discharge from Durrell Creek to Colquitz Creek would be regulated to some maximum by the pump capacity, which may be about 1 to 2 m^3/s. It is expected that this would be less than the maximum contribution from Durrell Creek during a big flood, as occurs under the existing circumstances (see Appendix C).

The actual effect on downstream water levels in Colquitz River from Scenario #3 cannot be accurately predicted, and it may result in a slight increase or slight decrease. The worst case would be to assume that the combination of the pump operation and loss of storage increases flows in the Colquitz River by about 2 m^3/s, which we believe is very conservative, which would increase water levels during an extreme flood would be about 15 cm. This analysis is based on the rating curve at the Colquitz at Violet Avenue gauging station. Further hydrologic analysis would be required to predict the actual change in water levels along the Colquitz River.

5.5.3 Agricultural Development

Proposed Measures

LAND USE GUIDELINES TO PROTECT AGRICULTURE: Guidelines to minimize the impacts of other land uses on agriculture are recommended - see Section 5.2.2.

AGRICULTURAL CODES OF PRACTICE: Agriculture operations are subject to the Code of Agricultural Practice for Waste Management in BC - see Section 5.2.2.

RIPARIAN GUIDELINES: Guidelines for riparian areas on agricultural land are recommended – see Section 5.2.2.

Effects of Scenario #3 on Agriculture

With the proposed drainage improvements outlined above, the following changes for local agriculture would be anticipated:

- Reduced risk of summer crop damage due to inadequate drainage
- Significantly reduced shoulder season water levels
- Reduced risk of flooding in the shoulder seasons, leading to longer growing season from 20% (current) to about 80% of the time
- Significant effect on winter water levels and drainage, assuming system operation to agricultural standards
- Significantly greater flexibility in cropping choices
- Increased double cropping, extended season cropping and perennial crops
- Greatest range of rotational options to control disease and respond to market opportunities
- Cover cropping in the entire agricultural area to control soil erosion in the winter and provide organic matter to the soil when incorporated
- Increased yields, due to extended cropping, except in major storm event years
- Expected annual net revenue increase of $2250 per acre
- Soil capability enhancement over time due to drainage effect
- Soil damage reduced because farm operations do not have to be undertaken under saturated conditions
- Improved soil structure and health due to drainage effect

On-farm drainage improvements would be essential to achieve the full benefit of the scenario #3. These improvements are likely to be the responsibility of the individual farm owners or operators.

5.5.4 Environmental Management

Proposed Measures

WATER QUALITY TESTING: The ongoing program by the municipality/regional district to continue water quality testing and upgrades as required should be continued - see Section 5.2.3.

TERRESTRIAL ESAs - PRIVATE LAND: A program to inform private landowners about stewardship of ESAs on their property should be implemented - see Section 5.2.3.

RIPARIAN ESAs - PRIVATE LAND: Stewardship of riparian ESAs on private land is encouraged, to be developed in combination with other objectives of maintaining agricultural production and improving channel conveyance. See Section 5.2.3.

STEWARDSHIP ON MUNICIPAL LAND: The municipality should practice stewardship by enhancing habitat and protecting ESAs on public lands - see Section 5.2.3.

GENERAL ENVIRONMENTAL STEWARDSHIP: A general education program on environmental stewardship and municipal initiatives should be developed - see Section 5.2.3.

Effects of Scenario #3 on Environment

Scenario #3 would control water levels year round on Courtland-Hastings flats. The flats would typically be flooded only an estimated 5 days in winter, which would permanently reduce the winter habitat suitability for most ducks. The seasonally flooded fields on Courtland-Hastings Flats are classified as an ESA by the Canada Wildlife Service study. These birds would likely be displaced to other habitats, which are considered adequate regionally. There would not be actual mortalities due to the field drainage, and nesting season, which starts in April, would not be disrupted. The use of cover/green manure cropping may partially mitigate for that loss of habitat, by provision of alternative habitat.

Positive effects of Scenario #3 on the environment include increases in the populations of other birds, such as raptors and Canada geese.

5.5.5 Recreation Plan

Proposed Measures

RECREATIONAL OPPORTUNITIES: It is recommended that the recreational opportunities outlined in Section 5.2.4 and Figure 5.3 be explored by the municipality. With greater winter drainage, there may be opportunities that are only possible under Scenario 3#.

Effects of Scenario #3 on Recreation

This scenario may significantly change the use of the area for some times of the year. The seasonally lower water elevations may result in more spontaneous exploration along public rights-of-way next to agricultural operations. Wildlife and existing habitat would be negatively affected and the rights-of-way would need to be managed differently. For example, greater security along boundaries may be needed, possibly in the form of more fencing. This would have a negative effect on the visual appeal of the area. Alternatively the ROW may need to be closed. Neither of these possibilities have much value for the community.

This scenario may reduce birdwatching opportunities by reducing waterfowl habitat or altering the mix of species.

5.5.6 Land Use

Proposed Measures

LAND USE PLAN: Changes to the land use plan for the Durrell watershed could be considered at the next OCP – see Section 5.2.5.

Effects of Scenario on Land Use

There is the potential to reduce flooding of the Courtland – Hastings flats for agricultural purposes. There is still a small risk of flooding and about half of the Gillie Road lots still lie below the 1:200 year flood line. Due to the constraints outlined in Section 5.2.5, these lots are not suitable for residential development.

5.5.7 Financial Implications/Overall Value

Scenario 3 is the most expensive of the three options. The capital costs of the drainage improvements at Interurban Road are in the order of $300,000, with an additional allowance for annual operations and maintenance costs. The improvement of drainage to achieve winter ARDSA criteria allows marginally greater returns from agricultural production, as well as other less quantifiable benefits. They would include the benefits to soil quality and wildlife habitat of providing winter cover/green manure crops, increased diversity of annual and perennial cropping, and increased food safety. Costs of implementation of the recreation or environmental measures have not been estimated.

Under Scenario 3, double cropping is possible, as well as the potential for late season varieties and perennial cropping. While the target net returns do not increase dramatically, note that the probability of receiving adequate drainage to attain those benefits does. On-farm drainage improvements would almost certainly be made to optimize drainage under most weather conditions.

The revenue effect is to raise the expected net return up to $4,250 per acre. The net benefit is the $4,250 minus the status quo, i.e., $2,000 = $2,250 per acre. The total net annual agricultural benefit is calculated at $2,250 x 37.5 acres = $84,375. In current dollars, it would take 4 years to pay off the capital costs of the project with agricultural net benefits under scenario 3.

In contrast to scenarios, 1A, 1B and 2, there are other benefits to scenario 3. These include:

- Cover cropping benefit
- Available of feed for wildfowl
- Effective management of organic soil
- Control of soil erosion
- Increase cropping flexibility
- More efficient field operations and soil management
- Increased agricultural viability

Annual Expected Agricultural Net Returns Per Acre under Scenario 3.

Cropping Pattern	Probability of Adequate Drainage	Net Revenue Target	Realized Net Revenue	Annual Expected Net Revenue (1)
Cropping Option B	90%	$4,500	$4,500	$4,050
	10%	$4,500	$2,500	$250
Minus annualized on-farm drainage improvements (2)				-$52
Annual Expected Revenue (Example 1)				**$4,248**
Cropping Option C	80%	$4,800	$4,800	$3,840
	20%	$4,800	$2,400	$480
Minus annualized on-farm drainage improvements (2)				-$52
Annual Expected Revenue (Example 2)				**$4,268**
Average Net Revenue Expectation from Cropping				$4,250

Notes: 1) Expected Net Revenue = Target * Probability
2) Drainage costs based on 40 ft spacings, 30 year life on 100% of agricultural acres.

5.6 Financial Comparison of Water Management Scenarios

The estimated economic characteristics of the scenarios are presented in the table below. It is important to note that the benefits are agricultural benefits, and that no effort has been made to quantify environmental and recreational benefits.

Column A presents our best estimate of the capital costs of each scenario. No provision has been made for possible capital improvements within the assumed 30 year life of the structures. Column B presents the operating and maintenance costs associated with each scenario.

Column C represents the per acre net revenue stream estimated for each scenario. It is apparent that the net agricultural revenues increase as the level of drainage and flood control increases. Column D presents the soil degradation cost due to flooding and associated disbenefits as a percent of the net revenue stream in column C. That is, in the status quo situation, the modelled effect of soil degradation is a $20 decrease in net revenue in year 2001. In the thirtieth year at 1% loss per year, annual net revenue per acre would have declined to $1,465 in current dollars (calculation not shown).

Column E indicates the Present Value (PV) of the operations and maintenance costs (capital costs excluded) of the various scenarios. For simplicity, the annual O&M costs is assumed to stay constant over the life of the structures. A discount rate of 8% has been used. A higher rate (e.g. 10%) would discount future costs more rapidly and the PV would be lower than indicated, while a lower rate (e.g. 6%) would result in the reverse effect. The PV of scenario 3 is 6 times higher than scenarios 1a and 1b and two fold of scenario 2.

Column F shows the aggregate net agricultural benefit for the various scenarios and the status quo. It should be noted that the "do nothing" option still results in a stream of agricultural benefits, since agriculture will continue regardless of the drainage solutions chosen. Implicit in the estimate, however, is that the net revenue stream declines over time because of the soil degradation effect. PV has been calculated using an 8% discount rate. The PV of agricultural benefits increases as more effective drainage improvements are considered. Scenario 3, with ARDSA drainage criteria, would increase the PV of net agricultural benefits by almost 1.5 times over the status quo.

Column G indicates changes in the 30 year agricultural benefit streams between the scenarios. For example, aggregate net value in the status quo is negative because of the assumption that soil degradation will result in reduce annual benefits over time. Scenarios1a and 1b result in similar increases in net benefit compared to the status quo because we concluded that the two scenarios would have identical cropping response. The value for Scenario 1a in Column G is derived by subtracting the PV of Net Revenues of Scenario 1a from the PV of the status quo in Column F and then subtracting the PV of the incremental agricultural net benefit for the status quo in Column G. The interpretation of this value is that the net revenue increase from scenario 1a offsets the soil degradation costs of the status quo and produces an agricultural benefit of some $31,000. Overall, the largest increase in agricultural net benefits is registered, as expected, by scenario 3.

Column H presents the aggregated costs and benefits associated with the various scenarios. Because the status quo is affected only by soil degradation, the value of project net benefit is identical to the PV of Incremental Agricultural Net Benefit in Column G. For the other scenarios, the value in column H is the sum of PV of agricultural net revenues (Column F), the PV of O&M costs, the PV of capital costs and the PV of soil degradation costs. The analysis suggests that the costs exceed benefits (PVs) for scenarios 1a and 1b while benefits exceed costs by almost $50,000 for scenario 2. Scenario 3 is the preferred option according to net benefit criteria used in this analysis. This table indicates that the $300,000 capital cost and annual $30,000 O&M cost of scenario 3 would lead to overall net benefits in the $400,000 range.

Project Costs and Agricultural Benefits associated with Durrell Creek Watershed Management Scenarios

Scenario	A Drainage Capital Cost Year 2000 (1,9)	B Annual Operating & Maintenance Costs	C Yearly Net Agricultural Revenues/Ac	D Soil Degradation Cost (2)	E Over 30 yrs Present Value (PV) O&M (3,4,5)	F Over 30 yrs Present Value Agricultural Net Benefit (3,4)	G Over 30 yrs Present Value Agricultural Net Benefit (3,4)	H Over 30 yrs Project Net Benefit (5)
Status Quo	$0	$0	$2,000	1% per year	$0	$784,123	-$76,534	-76,534 (6)
Scenario 1A	150,000	5,000	2,275	1% per year	57,377	891,939	31,283	-99,560 (7)
Scenario 1B	80,000	5,000	2,275	1% per year	57,377	891,939	31,283	-29,560 (7)
Scenario 2	220,000	15,000	3,124	1% per year	172,131	1,224,799	364,143	48,546 (8)
Scenario 3	300,000	30,000	4,250	Nil	344,263	1,828,895	968,239	400,510 (8)

Notes:

(1) It is assumed that capital improvements would not be required over the life of the project or their present value would be negligible
(2) It is assumed that winter inundation will reduce net income stream by 1% per year
(3) A discount rate of 8% is used to convert current dollars expended in the future into year 2000
(4) PV of per acre net returns multiplied by 37.5 acres
(5) PV of the project net benefit = PV of incremental agricultural benefit minus PV of capital and O&M costs
(6) Negative value indicates the PV of the estimated loss due to soil degradation
(7) Negative value indicates the PV of the project costs exceeds the PV of incremental agricultural benefit
(8) Positive value indicates the PV of incremental agricultural benefit exceeds the PV of project costs
(9) Includes cost associated with engineering works only, not costs associated with environmental enhancements

Chapter 6 – Committee Draft Recommendations

Based on the four scenarios laid out in Chapter 5, the Steering Committee then met to consider and recommend a preferred scenario. The criteria to assess and select a scenario, the pros and cons of each scenario, the justification for the one recommended by the Committee, and other general recommendations are all presented in this chapter.

6.1 Criteria for Scenario Selection

The Committee brainstormed potential criteria to assist in informing the committee's judgement on scenario selection. That discussion resulted in the following 'measuring sticks' of success — with the overarching question being "which scenario contributes most to realizing an appropriate balance of social, economic and environmental values in the study area?

The selected scenario needs to:

- maximize environmental benefits
- support farming operations in the area
- comply with public policy (law, legislation and regulations)
- propose an acceptable outcome (recognizing council's obligation to get the best solution for all and the lowest possible cost)
- maximize potential benefits to private property owners (contribute to a reconciliation of private rights with public responsibilities)
- enhance community livability (education values, social interaction (bearing in mind some might prefer privacy to interaction, aesthetics)
- 'do no harm' downstream
- maximize value for the money (the 'affordability' test)
- integrate public feedback (survey, open house)

6.2 Comparison of Scenarios

Based on the criteria outlined in the previous section, the four scenarios were compared and discussed at several Committee meetings. The Committee members represented their opinions on the scenarios based on a simple 3 part scale: positive, neutral or negative. They arrived at the judgements outlined below subjectively, often based on their comfort levels at either extreme. For example, Scenario 1a was considered of no increased benefit to agriculture, whereas Scenario 3 was considered negative for both fish and wildlife. Not surprisingly, Scenario 2 represented an appropriate balance that all members felt that they could support.

SELECTION CRITERIA	Scenario 1A	Scenario 1B	Scenario 2	Scenario 3
Agriculture	negative	negative	soil: negative drnge: positive	soil: positive drnge: positive
Environment – waterfowl	neutral	neutral	neutral	negative
Recreation	neutral	neutral	neutral	positive
Fish	neutral	neutral	neutral	negative
Flooding – upstream of Interurban	negative	negative	neutral	positive
Flooding – downstream of Interurban	neutral	neutral	neutral	negative
Private Property Effects	U/S: negative D/S: neutral	U/S: negative D/S: neutral	U/S: neutral D/S: neutral	U/S: positive D/S: negative
Affordability	less expensive	less expensive	best value	most expensive
Integrates public feedback				
Community Livability				

6.3 The Recommended Scenario

The advantages and disadvantages of each of the scenarios outlined above were carefully considered by the Steering Committee. A full day Committee meeting was held to discuss the selection, and Scenario #2 was selected.

In reviewing the goals of the Integrated Watershed Management Plan (Chapter 1.4), Scenario #2 was felt to best achieve those objectives. Finding a solution that resolved the drainage issues, ensured viable agricultural production, protected environmentally significant areas and improved local recreation was the challenge. Most of the desired outcomes of the IWMP have been addressed with Scenario #2, and the guiding principles as well as the regulatory framework were respected. By comparison to the other scenarios, Scenario #2 did the best job of balancing improvements against cost of implementation. It also had the advantage of not impacting one interest in the course of trying to improve or resolve another. The end result is that it represents the best balance between potentially competing interests.

The key elements of the preferred scenario are as summarized below. More detail on the proposed measures is given in Chapter 5, in the sections as indicated below in the brackets.

Water Management

- Replace the existing Interurban culvert with a larger culvert or floodbox, and lower it by 0.8m to an invert elevation of 8.8m. Add a flapgate to the downstream end of the culvert to prevent backwater flooding from downstream, and provisions for stoplogs or a weir. A 500 - 800 litres per second (l/s) pump and pump house would be installed, as well as a passage to discharge pumped water to the downstream side. The pump intake would be screened to prevent fish entrainment. The pump would be operated in spring and fall to improve drainage of the agricultural land in the shoulder seasons (Section 5.4.1)
- Lower Hastings Street culvert by 0.6m to 9.0m, to improve drainage of the fields of Hastings flats (Section 5.2.1)
- Replace Granville Avenue culvert (Section 5.2.1)
- Adjust Durrell Creek channel from Interurban to Hastings, grading from 8.3m to 8.7m. This work would lower and rebuild the stream channel, thereby improving agricultural drainage of Courtland flats and minimizing the loss of soil from the surrounding fields. 500 m of this channel immediately upstream of Interurban Road would be restored and enhanced, with channel stabilization, habitat complexing and riparian revegetation (Section 5.2.1)
- A drainage management/operating procedures program should also be developed (Section 5.2.1)

Agriculture

- Land development guidelines to minimize impacts of other land use on agriculture should be included in the next OCP or Local Area Plan. The following options should be considered: use of development permit areas to protect farming, minimize effect of stormwater on farmland, inform the subdivision approving officer regarding protection of farmland, encourage communication between the agricultural and residential components of the community (Section 5.2.2).
- A program to educate watershed residents on the codes of agricultural practice should be developed (Section 5.2.2)

- Stewardship guidelines for riparian/farm environmental planning being developed by federal and provincial agencies should be made available to the local farming community when finalized (Section 5.2.2)

Environment

- The municipality and regional district should continue water quality and septic field testing/cross connection upgrade where necessary (Section 5.2.3)
- A program to inform landowners about the ESAs (both terrestrial and riparian) on their property and to encourage private land stewardship should be implemented (Section 5.2.3)
- It is recommended that the municipality negotiate with the Province to revegetate and enhance the reach of Durrell Creek behind the Wilkinson Road jail (Section 5.2.3)
- The municipality should look for opportunities to practice environmental stewardship on ESAs on municipal land (Section 5.2.3).
- The municipality should encourage general environmental stewardship and identify desirable practices (section 5.2.3)

Recreation

- Implement recreational opportunities plan outlined in Section 5.2.4 and as indicated on Figure 5.3, including construction of trials on undeveloped rights of way, bird viewing stations, retaining the existing ROW and developing an educational component.

Land Development

- Amend the Saanich OCP and Local Area Plan to reflect the recommendations above (Section 5.2.5)

6.4 General Recommendations

Some of the measures outlined in Chapter 5 were more general recommendations that applied to a larger area, up to and including the entire municipality. These are summarized below, to reinforce the Committee's advice to Saanich.

Water Management

- Recommend a water management study on the Colquitz system

Agriculture

- Recommend land development guidelines to minimize impacts of other land use on agriculture
- Encourage observance of codes of agricultural practice
- Recommend stewardship guidelines for riparian/farm environmental planning

Environment

- Encourage landowners to undertake private land stewardship for terrestrial ESAs
- Encourage revegetation of riparian ESAs on private land
- Encourage municipality to undertake stewardship on municipal ESAs
- Encourage general environmental stewardship and identify desirable practices

Chapter 7 – Plan Implementation/Monitoring

The IWMP outlined in Chapter 5, Scenario #2, is recommended to Saanich Council for their consideration. Clearly, there are a number of ways that the proposed IWMP could be implemented, depending primarily on schedule and budget considerations. The Committee discussed the matter at length, before making the following recommendations on phasing and implementation. Brief comments on possible avenues for funding and a monitoring program are also offered.

The following general principles were developed to assist with implementation:

- inasmuch as the goal of this process was an integrated plan, any phasing and implementation should recognize the diverse interests involved in the process and, as far as possible, attempt to achieve some of the recommended actions from each of the interest areas at each phase.
- the work of each phase should be complementary, that is to say that if there are aspects or components of the work which, when combined yield a benefit greater than the sum of the individual parts, these components should be provided simultaneously
- the phasing should recognize and allow for anticipated difficulties in implementation. For example, the environmental enhancements planned for the portion of Durrell between Interurban and Wilkinson have been identified in Phase II, because of the time it would likely take to reach agreement with the property owner (Ministry of Attorney General) on this work.
- The phasing of the work should be structured in a fashion which does not render subsequent phases more difficult or costly. Ideally each phase will complement and encourage future phases.

7.1 Implementation

To achieve the principles outlined above, a phased approach is recommended. Based on the normal cycle of municipal approvals and budget forecasts, it was felt to be reasonable to assume that Phase I could be conducted in fiscal year 2001, with Phases II and III to follow. This allows sufficient time for debate at the Council level, and time for staff to develop detailed cost estimates and confirm feasibility of the individual measures and environmental approvals from DFO and MOELP to be obtained. There has been some discussion of interim measures, but only some of the agricultural drainage measures have a time-sensitive dimension. Discussions with the lessee who farms most of the flats would quickly resolve whether the conditions experienced to date in year 2000 warrant the implementation of interim measures.

Phase I

- Remove existing culvert at Interurban Road. Replace with new culvert/flood box, including flap gate, and stoplogs/weir at lower elevation. Ensure design is compatible with pump installation under proposed phase II works.
- Replace Granville Avenue culvert. Ensure the culvert design is sized appropriately to drain uplands area during peak rainfall events.
- Carry out environmental enhancement works, including channel regrading and enhancement and planting/development of riparian vegetation along Durrell Creek in the Charleton right-of-way west of Interurban Road
- Construct parking and wildlife viewing area near Interurban at Charleton
- commence environmental stewardship program as staff and funding permits
- continue water quality testing program as conditions dictate
- commence negotiations with Correctional Institute for access to land and approval of planned recreational and environmental enhancements under phase II.

Phase II

- Construct wet well and pump on upstream side of new Interurban culvert. Ensure that pump size and operating protocol are sufficient to meet summer ARDSA requirements.
- Carry out environmental enhancements in area between Interurban Road and Wilkinson road (subject to land owner approval).
- Construct Roy Road parking and trail access
- Construct trail along Durrell Creek between Wilkinson and Interurban (subject to land owner approval)

Phase III

- All remaining aspects of the plan would be incorporated into the official planning documents of the municipality (Saanich General Plan and/or the appropriate Local Area Plan) and work will proceed as funding and staffing permit.

7.2 Funding

With respect to funding issues, the Committee concluded that it was premature to go to possible partners at this time. However, it is anticipated that funding could be found for several elements of this IWMP. Private sources of funding for environmental stewardship as well as federal and provincial agency initiatives for both environmental protection and the encouragement of sustainable agriculture should all be available. The following general principles apply to the search for funding:

- That Saanich endeavour to involve as many funding partners as possible in the work (i.e., Ducks Unlimited, Natures Trust, Habitat Conservation Trust Fund, Ministry of Agriculture, Ministry of Environment, Department of Fisheries and Oceans, Environment Canada, PCC, etc).
- That as much as possible those parties or agencies who would benefit directly from the work should be involved in funding the work.
- That Saanich should continue work with the members of the Committee to identify and explore funding opportunities
- That the community will want to participate in the implementation phases, and that volunteer labor (particularly for stream restoration/enhancement) is a valuable resource.
- That cost sharing through Specified Area levies be supported where improvements are for the benefit of a particular community or group. It was felt that all of Phase I should be funded by the municipality and/or other agencies without funding assistance from the area residents. Other components of the work such as the pump installation under Phase II, should be funded with the assistance of the benefiting parties.

7.3 Monitoring

The high level of interest and commitment by the community to participate in this study is a resource which Saanich should continue to cultivate. The Committee may be willing to stay involved in the project, albeit at a reduced level of effort, to see the proposed works through the implementation phase.

Using the database established as part of this study, there are a number of parameters that could be monitored over time, as measures of success of the IWMP. These do not necessarily involve the actual collection of data, but rather a compilation of data from existing sources, for example:

- Water quality data
- Christmas and Spring bird counts
- Fish presence information from DFO, Streamkeeper groups
- Climate data from Atmospheric Environment Service
- Discharge data from Water Survey of Canada
- Records of dates of field drainage
- Changes in patterns of land use and agricultural practices

Some other monitoring tools that do involve some data collection that could be considered include:

- Recreational use of study area, via a survey
- Casual wildlife observations
- Plotting of flood contours for specific flood events
- Records of flood duration
- The hydrologic model is a working tool that can be updated or used to test other scenarios or measures

Saanich is likely breaking new ground in the development and implementation of an Integrated Watershed Management Plan. Too often, these documents are planning tools that don't get implemented. Use of a watershed based approach to management at the local level is long overdue in BC. If adopted and implemented, the combination of environmental and agricultural stewardship recommended by the Committee will be a model for cooperative community-based planning.

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Zoning Maps, March 15, 1999 zoning 16, 17, 23, 24, 25, 30, 31, 32

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1:2,500 Cadastral Base for Durrell Creek

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-All water quality raw data from Jan 1998-Apr 1999
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-Water quality testing raw data for Jail Creek Restoration Project Aug 15, 1999 (before machine work) and August 19, 1999 (after machine work)

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Munro Farm 1933 - Raspberries, Loganberries
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March 14, 1997	BCB 97005: 15-22; 121-128; 154-160

Air Photos	BC:245:76
	BC 1670:43
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	BC 7692 # 168
	15 BC 80005 # 65
	30 BC 84027 # 151
	15 BCB 97005 # 18
	15 BCB 90144 # 34
	15 BCB 92141 # 297

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APPENDIX A

TERMS OF REFERENCE

0330-00.01

REQUEST FOR PROPOSAL NO. 2/99

TITLE: DURRELL CREEK WATERSHED MANAGEMENT PLAN

DATE: MONDAY, FEBRUARY 1, 1999

TIME: 3:00 p.m.

RESPONSE TO BE SUBMITTED TO:
Wendy May
The Corporation of the District of Saanich
770 Vernon Avenue
Victoria, B. C., V8X 2W7

The Municipality of Saanich invites qualified consultants to submit a Proposal to undertake the development of an Integrated Watershed Management Plan of the Durrell Creek Watershed. The Proposal must outline the firm's capabilities and professional qualifications related to such a study along with a list of recently completed related projects c/w respective references. **Each response must demonstrate a clear understanding of the "Scope of Work". The upset amount available for consultant fees is $150,000.00. The work necessary to address the questions contained in this document must be included in the overall cost. The Consultant should clearly itemize separately the value of work. Refer to Section 10 - General Instructions 10.1.6.**

For reference, the following documents are attached:

- Terms of Reference
- Appendix A, Work Flow Chart
- Appendix B, Stormwater Management Fact Sheet. B.C. Ministry of Agriculture, Fisheries & Food
- Appendix C, District of Saanich Map showing approximate study area
- Appendix D, Water Quality Testing, description of work
- Overall map of Saanich showing Colquitz River catchment area (Durrell is tributary to the Colquitz)
- Detailed drawings of Durrell Creek (also called Jail Creek) between Interurban Road and Wilkinson Road. (Jail Creek, Creek Profile, Wilkinson to Interurban sheets 1 and 2)
- Colquitz Creek Flood Plain mapping by KPA Engineering. (Proposed Fill Prohibition Map, Colquitz River, drawings 3051-1 thru 3051-6 inclusive)
- Topographic contour maps covering the catchment area for Durrell Creek (contour maps 7, 8, 12 and 13)
- Fill Prohibition/Deposit of Fill Bylaw (1993) Mapping for Durrell Catchment area. (Bylaw 7058, maps 16, 17, 24, 25, 30, 31 and 32)
- Map of Durrell Creek Watershed

The base plans and Watershed information prepared in stage one will be used as the basis for much of the subsequent work.

TERMS OF REFERENCE

1.0 BACKGROUND

The study area is located within the political boundaries of the Municipality of Saanich, British Columbia. The Colquitz Creek drains approximately **SIXTY PERCENT** (60%) of the municipality's 150 square kilometres. Durrell Creek is a tributary of the Colquitz and drains an area of approximately 454 hectares. The typical land use is agricultural though some land has developed as urban residential and a small portion is commercial/industrial and institutional. Approximately **TWENTY-FIVE PERCENT** (25%) of the area remains forested with mature Douglas Fir and associated species of trees and shrubs. There are areas of ecological significance (Garry oaks, rare flowers).

In the lower reach of the Durrell Watershed, there is a lowland; parts of which have historically flooded and in the last century have been farmed. Landowners have complained that their land has been flooded beyond the normal winter conditions and periodically they have been unable to produce or harvest crops.

In relation to water flows in Durrell Creek, there has been a claim that natural flows from an adjacent catchment area may have been diverted to this creek. The potential of any diversions and their impact should be determined. The impact of upstream urbanization should also form part of the study.

There was a bridge at Interurban Road/Charlton Road that was removed and replaced with a concrete culvert. There are claims that the installation of this culvert and the surrounding road base resulted in restrictions and limitations to the natural drainage capabilities and detention of water on the valley floor. In 1985, the culvert under Wilkinson Road was replaced. Subsequent to the flood of 1990, the ditch section from Wilkinson Road to the Jail property was cleaned and lowered. During extreme flood conditions, Colquitz Creek creates back water effects on the Durrell Creek flood plain.

In the early 1900's, some of the lands in the watershed were subdivided, creating small, single family lots. However, many of these lots are subject to flooding and under current conditions unable to be used for single family use. Long term use of these parcels is a concern.

In the last few years, there has been renewed interest in both the environment and recreation within the Watershed. There are concerns of maintaining and improving the environment from a fisheries and wildlife habitat perspective. Simultaneously, the need to provide opportunities for passive recreation has been raised in the community.

As a result, the Municipality has invited a broad spectrum of stakeholders (Durrell Creek Watershed Management Committee, **the Committee**) to participate in preparation of a Watershed Management Plan which will assist the continuance of agriculture in the Watershed and which will provide ecologically sensitive guidelines for land uses within the entire watershed.

1.0 BACKGROUND (cont'd.)

The Committee consists of representatives from Saanich staff, residents, farmers, Ministry of Agriculture and Food, Ministry of Environment Land and Parks, Department of Fisheries and Oceans, Agricultural Land Commission, the Vancouver Island Regional Correction Centre and private land owners. The committee is tasked by Saanich Council with the generation of a Watershed Management Plan which encompasses a wide variety of interests within the Durrell Creek catchment lands including agriculture, fisheries, ecology, recreation and existing land uses. The Committee is supported by a facilitator whose primary role is to assist the parties in reaching consensus of the IWMP. The facilitator acts as a process manager with responsibility for:

- convening and facilitating meetings
- brokering ideas, and
- mediating disputes

The facilitator does not make decisions, pass judgements or impose solutions on the Committee.

Saanich has appointed a Saanich staff member as Project Manager who will be responsible for overseeing the Consultant's work and ensuring communication is maintained between the Consultant and the Committee. The Committee will report to the Saanich Council at the end of each stage and the Consultant will assist with presentations as noted in the Work Program.

Saanich's Project Manager will co-ordinate an initial meeting between the Consultant and the Committee to review the work program.

In this document, current and historical conditions are referred to in terms such as "creek", "Durrell Creek", "flood plain", "watercourse", "ditch", etc. The Consultant should not presume accuracy or reliability of all apsects of this information or the use of these terms. Instead, the Consultant should be satisfied as to the actual and historical conditions that are important to any conclusion or recommendation.

2.0 WORK PROGRAM

The attached work program flow chart is intended to provide guidelines to the Consultant toward achievement of the Committee's goal. The Consultant must undertake sufficient work to provide the final document which will be the long term Watershed Management Plan.

2.0 WORK PROGRAM (cont'd.)

When providing interim and the final reports, the Consultant shall provide originals suitable for black and white copying on 8 ½ x 11 for text and 11 x 17 for maps. If, at any time throughout the project the Steering Committee wishes to modify the Terms of Reference or focus of the Consultant, this may not proceed without written authorization of the Client.

3.0 HYDROLOGY/HYDRAULICS

The Consultant is to prepare a hydrological and hydraulic assessment of Durrell Creek and document all findings. A hydrological and hydraulic computer model(s) of the entire Durrell catchment must be prepared and field checked. The model must account for current and future land use and varying runoff conditions throughout the study area including rural, urban and institutional areas. It should also identify the impact of Durrell Creek on Colquitz Creek and vice versa. The model should account for backwater flooding conditions determined by the KPA model prepared for the Colquitz Creek flood conditions. These are to be used as downstream boundary conditions.
The objectives of the model are to determine flood flows and flood levels for base flow conditions to establish field drainage elevations and for the 10,25 and 200 year flood events (the last one to meet MELP criteria for defining a flood plain). Duration of flooding is also to be identified since this factor determines the viability of land for agricultural use. Duration of flooding is not necessarily related to single storm events. There is evidence that the cumulative effect of many small storm events over a short period of time have a significant impact on flood levels. The model will evaluate existing channels and culverts delineated on the plan, the feasibility and physical (channels and culverts) requirements to meet scenarios involving target water levels and timing constraints.

The issue of possibly redirected flows from adjacent catchment lands must be addressed. The impact of reversing this diversion should be reviewed, paying attention to the downstream culverts at the Victoria Regional Hospital, Vancouver Island Highway and Burnside Road. The impact of flows from this sub-catchment area on the Durrell Creek system must be identified.

A major objective of this study is maintenance of the agricultural area shown on the Watershed Plan (within the lower flat lands of the valley). Late spring and early fall flooding have occasionally resulted in loss of crops. The study must identify the causes for the flooding so that options for remedial works can be prepared. An analysis of the agricultural area in the lower valley must be undertaken to determine means of providing sufficient drainage to maintain agricultural viability of these lowlands during the normal growing season

3.0 HYDROLOGY/HYDRAULICS (cont'd.)

The Ministry of Agriculture and Food has established goals for regional drainage for agricultural areas within the province. These are appended to this document. The study should assess the practicality of achieving these goals and list any conditions which need to be modified to meet the Ministry's goals. This will include water table elevations with respect to drainage capabilities of the low lands of the valley and an assessment of lands which cannot benefit from possible remedial works.

Sufficient field survey must be completed to establish profile and cross-sectional data on the major creeks feeding the valley. Water detention areas must be documented for inclusion in the model and for future management evaluation. Critical culverts and their state of repair should be identified and survey data of channel inverts in and adjacent to the culverts provided. Channel invert/cross sectional surveys at 50m spacing should be confirmed in all reaches which have minimal gradients and where sedimentation may cause flow restriction (the channel between Interurban Road and Wilkinson Road has been surveyed). Causes of sedimentation should be identified. In steeper gradient sections, the Consultant must ensure sufficient sections are taken to reflect the modelled stream channels .

The model(s) shall be provided to the municipality in digital form for future use as required. A hard copy of the model output shall be appended to the study document.(The municipality may, at a later date, elect to purchase a copy of the software)

The deliverables are:

- hydrological and hydraulic model (s) of the valley (include extent of impervious cover; present and future)
- a map showing limits of the Watershed, creek alignments and any other information gathered
- flood profiles for base flow, 10, 25 and 200 year conditions with and without diversion of the upland catchment.
- a map showing the flood plains listed above both with and without any significant diversions.
- a brief overview of original wetlands, flood plain and re-direction of flows into the Watershed
- verify the extent of the Wilkinson Road and Interurban Road culvert changes and their impacts.

4.0 BIOLOGICAL MAPPING OVERVIEW

Several areas within the watershed are reported to be natural habitat or have ecological significance. These must be identified for evaluation of preservation or protection possibilities. Some water quality data will have been gathered in a separate study, however, the Consultant must evaluate the streams and determine if there are any point or non-point sources of pollution. These are to be identified where possible and reported for correction. (Where practical, these will be corrected immediately).

4.0 BIOLOGICAL MAPPING OVERVIEW (cont'd.)

This component of the project is intended to provide a wide spectrum of information gathering, and assessment, on the following:

4.1 Using 1:2500 scale mapping provided by Saanich

4.1.1 streams and riparian zones (Saanich 1997 Inventory Map may be sufficient)

4.1.2 quality of surface water (review of existing data)

4.1.3 wetlands, including classification of wetland type

4.1.4 vegetation and biodiversity, including:

4.1.4.1 Plants,
4.1.4.2 Shrubs,
4.1.4.3 Trees,
4.1.4.4 Rare and endangered species (provincial, regional red and blue listed)

4.1.5 wildlife communities, including habitat, biodiversity, species and populations (Observed or presumed to occur because of the evidence of or presence of suitable habitat)

4.1.5.1 birds including raptors, songbirds, waterfowl and migratory birds (bird counts done by Victoria Natural History),
4.1.5.2 rare and endangered species (provincial, regional red and blue listed)
4.1.5.3 mammals, reptiles, amphibians

4.1.6 aesthetic values

4.2 Fish habitat, addressing fish use, habitat areas and quality, overwintering areas and timing, barriers to fish movement, potential for habitat improvements and "Net Gain" areas.

4.3 Impact of human activity in recent history on animal and plant habitat, through review of air photos and discussion with community members.

4.0 BIOLOGICAL MAPPING OVERVIEW (cont'd.)

4.3 (cont'd.)

Deliverables are:

4.3.1 a set of maps showing streams, critical flow restrictions and problematic maintenance areas, ecologically sensitive areas, habitat restoration areas, areas requiring pollution correction.

4.3.2 analysis of water quality sampling data (quality data and accompanying report will be available from a separate study, refer to Water quality Testing Attachment)

5.0 LAND USE MAPPING

An assessment of the farming practices within the watershed should be made including mapping of soil types, identification of areas of significant farming capability, farming methods employed and best crop potentials for various farm locations (i.e. lands within the A.L.R. and/or assessed as farmland for tax purposes)

A portion of the Watershed is within the Urban Containment Boundary of Saanich and is therefore subject to residential development. A present and long term land use assessment is required. In addition, Camosun College occupies land at the north east extremity of the study area. Only a portion of the college lands are within the Watershed but there are development plans for a part of this property and a water quality and quantity impact evaluation should be made. There are also several industrial operations active in the Watershed. Their impact should be addressed.

The Consultant shall incorporate all the previous information with the desires of the community to provide opportunities for diverse non-intrusive and low impact recreation within the area. In conjunction with all concerned, a document is to be generated which will highlight recreational opportunities in keeping with policies of Saanich's Parks, Healthy Saanich and mindful of wildlife needs, environmentally sensitive areas and the area's increasing population and recreational needs. Special attention must be paid to: farmers' concerns related to vandalism and safety, and their impacts on agriculture; wildlife needs and environmentally sensitive areas.

5.0 LAND USE MAPPING (cont'd.)

The Deliverables are:

5.1 a set of maps showing existing land uses, location of farming opportunities, development areas and recreational opportunities.

5.2 maps showing future land uses and impact zones related to those uses.

5.3 any additional information the Consultant feels is necessary to complete a thorough evaluation of the options available to the Committee,

5.4 a detailed map of soil classification for 'A' zoned land in the Watershed and a general map of the soils outside 'A' zoned lands.

5.5 a map showing ideal water levels in agricultural areas during dormant and growing seasons and water levels for irrigation requirements.

6.0 SPECIFIC INFORMATION REQUIRED BY THE MUNICIPALITY

It may be already covered above, but for clarity, in addition to the foregoing, the Consultant shall research and report on the following specific questions:

6.1 Whether flooding has increased in Durrell Creek Valley flood plain area over the last 50 years in terms of height of flood waters and duration of water on the land. If it has, what are the reasons?

6.2 Describe the boundaries and elevations of the original natural flood plain in the Durrell Creek Valley.

6.3 Describe current and historical length of growing season in Durrell Creek Valley. Related to this, research extent of pumping and ditching measures used by the previous landowners and farmers to extend the growing season and whether such measures are currently used.

6.4 Whether there has been a diversion of water into Durrell Creek Valley in or about the BC Hydro property, near Strawberry Vale School or along Hector Road, west of Interurban Road.

6.5 Review history of Interurban Road culvert and whether culvert elevation was increased, decreased or in the same place as original natural drainage channel.

6.6 Research history of existence of the current creek location crossing the Durrell Creek Valley. When was it constructed, how did it differ from the original creek and where was the original creek?

6.0 SPECIFIC INFORMATION REQUIRED BY THE MUNICIPALITY (cont'd.)

6.7 Address quality of water entering Durrell Creek Valley from drainage sources including presence of contaminants from BC Hydro property and other sources.

6.8 Address whether MacNutt property is flooded from diversion of water from the Hydro substation and whether such flooding is affecting viability of this land for crops.

6.9 Address drainage from Mount View property over MacNutt property.

All of the work necessary to address the questions contained in this section must be included in the overall fee indicated as the cost for the Integrated Watershed Management Study. However, the Consultant should clearly identify, separately the value of work contained in this section to allow its removal from the overall contract. The work included in Section 6 may be removed at the discretion of the Municipality, provided the Municipality notifies the Consultant prior to the commencement of work on this item.

7.0 DEVELOPMENT, ASSESSMENT AND REFINEMENT OF OPTIONS AND RECOMMENDATIONS

This component of the project will address the identification of options, their assessment and refining. Drainage options must be sustainable and respect the use of private property, and should reflect the need to reduce maintenance in the creek channel thereby reducing impacts on aquatic habitat. Special attention should be paid to maintenance and possible regeneration of fish habitat (rearing, overwintering).

It will be critical that the Consultant interviews affected land owners and farmers to obtain input on the various options. Once a number of schemes are prepared, their implementation costs and impacts shall be listed. Both negative and positive influences should be presented and a rating system devised to assist the Committee in its evaluation of the report. A 'net gain policy' should be adopted for fish habitat, in keeping with D.F.O. policy and legislation.

The Consultant will present Options and Recommendations to the Committee at a workshop to ensure that all facets of the proposed Options and Recommendations are properly integrated, compatible and sustainable. Changes will be made if required. The Committee will identify preferred Options and Recommendations. If there is conflict then this has to be resolved in accordance with the T.O.R. of the Committee.

The Deliverables are options and recommendations related to acceptable management plans of the environment, land use, agriculture, recreation areas, fish habitat, wildlife habitat and storm water complete with impacts and costs of implementation, specifically:

7.0 DEVELOPMENT, ASSESSMENT AND REFINEMENT OF OPTIONS AND RECOMMENDATIONS (cont'd.)

7.1 Options for stormwater management facilities which provide drainage systems which meet the needs of agriculture and the natural environment.

7.2 Options for drainage maintenance programs which will be compatible with MAF, MOELP and DFO requirements.

7.3 Recommendations for farming practices near the stream in the lower valley specific to this study, in accordance with existing guidelines.

7.4 Recommendations on the need for a possible riparian zone adjacent to the stream in accordance with existing guidelines.

7.5 Recommendations to enhance and protect environmentally sensitive areas, fish and wildlife habitat.

7.6 Options for passive recreational opportunities.

7.7 Any other concepts which the Consultant raises.

7.8 A map showing how the various options affect water levels on agricultural land **and a cost/benefit analysis of the various options on agriculture in the valley.**

7.9 Recommendations for land use options.

8.0 THE WATERSHED MANAGEMENT PLAN

Having the refined Options and Recommendations, the Consultant will prepare an implementation program which is realistic and practical while taking into account the need for a speedy resolution of drainage issues for agriculture. Each activity on that list will have been assigned to a responsible agency (private or public) Once this program is established, each step will be assessed for related costs.

Subsequently, the Consultant will develop a proposed implementation schedule, budget, and monitoring program. The Plan will include a component detailing the means of ensuring sustainability of its recommendations.

This information will be reviewed and finalized by the Committee then will be incorporated in the final document entitled "the Durrell Creek Watershed Management Plan".

The document will be presented to Council along with a recommendation for establishing a funding, action and monitoring plan to be adopted by the municipality. The deliverables are:

8.0 THE WATERSHED MANAGEMENT PLAN (cont'd.)

8.1 Provisional Watershed Management Plan

8.2 A priorized list of actions for the Watershed Management including methods of implementation and means of ensuring sustainability of the plans

8.3 A list of responsible agencies for each activity

8.4 Budget requirements associated with implementation of the activities

8.5 priorized activity implementation plans

8.6 Finalized "Durrell Creek Watershed Management Plan"

9.0 INTERACTION WITH COUNCIL AND PUBLIC

Interaction with Council and the Public will occur at two milestones, namely when the Steering Committee has reviewed the initial Options and Recommendations and when the Draft Watershed Management Plan is prepared. The Consultant will assist the Committee when:

9.1 Initial Options and Recommendations

9.1.1 The Committee provides Council with information on the limits of the watershed, the flood plain mapping and Initial Options and Recommendations.

9.1.2 The Committee hosts a public Open House where all the current information, including watershed limits, flood plain location and Options and Recommendations, will be presented. Public input will be received and the Consultant will prepare a post meeting report.

9.1.3 The Committee reviews the Consultant's report and reaches agreement on the Options and Recommendations in accordance with its Terms of Reference

9.2 Provisional Watershed Plan

9.2.1 The Committee presents the draft Watershed Management Plan to Council, for information purposes, including:

9.0 INTERACTION WITH COUNCIL AND PUBLIC (cont'd.)

9.2.1.1 The Refined Options and Recommendations including specific recommendations on:

9.2.1.1.1 Environment Management Plan for Watershed

9.2.1.1.2 Drainage Capital Works and Maintenance Programs to resolve the drainage issues related to agriculture in the lower valley, including a budget and recommended schedule of the work. Council will be asked to approve the funding and implementation of these works as soon as possible.

9.2.1.1.3 Farming opportunities and practices

9.2.1.1.4 Passive recreational opportunities and their costs

9.2.1.2 The Committee has an Open House to present the final findings to the public.

9.2.1.3 The Committee, after review of public input at Open House, presents the Final Watershed Management Plan, including implementation program to Council for approval.

10.0 GENERAL INSTRUCTIONS

10.1 The Proposal

The Consultant's Proposal shall be presented in the following format for each stage of the project:

10.1.1 project understanding and methodology

10.1.2 assigned staff, experience and area of expertise

10.1.3 sub consultants including experience

10.1.4 work program - this should include a list of tasks, assigned staff, task deliverables, time assigned to each staff member and schedule.

10.0 GENERAL INSTRUCTIONS (cont'd.)

10.1 The Proposal (cont'd.)

10.1.5 schedule bar chart showing critical dates and meetings: include committee review times and final report presentation

10.1.6 fee estimates based upon the work program, broken down by stage and deliverable - include individual charge out rates and anticipated expenses

10.1.7 resumes of all assigned personnel

10.1.8 a list of recently completed projects of a similar nature c/w client references

10.1.9 if copies of drawings listed are required, contact the Purchasing Department.

10.2 Submission

10.2.1 All Proposals must be enclosed in a sealed envelope or appropriate packaging addressed to The Corporation of the District of Saanich, 770 Vernon Avenue, Victoria, B. C., V8X 2W7. The name and address of the participant must appear on the outside envelope. The envelope must display the Request for Proposal title, due date and time.

DUE DATE: Monday, February 1, 1999 TIME: 3:00 p.m.

THREE (3) copies of the Proposal are to be submitted as well as an original copy suitable for black and white reproduction. Paper size is to be 8 ½" x 11".

10.3 The Corporation of the District of Saanich expressly reserves the following rights:

10.3.1 the Municipality reserves the right to reduce the Scope of Work to facilitate the budget, if required. The upset fee is $150,000.00

10.3.2 to reject any and/or all irregularities in the Proposals submitted.

10.3.3 to reject any and/or all Proposals or portions thereof

10.3.4 to make decisions with due regard to quality of service, experience, compliance with requirements and any other such factors as may be necessary in the circumstances.

10.3.5 to work with any participant whose Proposal, in the opinion of management, is in the best interest of the Municipality.

10.0 GENERAL INSTRUCTIONS (cont'd.)

10.4 A Proposal will not be considered if it is deemed to be incomplete in any fashion or unsigned by the appropriate authority.

10.5 Any Proposal received after the hour and date specified will not be considered and will be returned unopened.

10.6 Phone Proposals are not acceptable.

10.7 Modification of a Proposal after submission will cause the return of the Proposal to the participant.

10.8 Any contract that may be entered into as a result of this Proposal will be subject to the laws of the Province of British Columbia.

10.9 All documents, reports, Proposal submittals, working papers or other materials submitted to The Corporation of the District of Saanich shall become the sole and exclusive property of The Corporation of the District of Saanich, in the public domain, and not the property of the participant.

10.10 Participants are requested to list references for similar projects completed.

10.11 Participants are requested to identify a delivery time.

10.12 All technical enquiries should be directed to The Project Manager, Mr. Colin Doyle, P. Eng., at 475-1775, Extension 3454. All enquiries regarding the Proposal submissions should be directed to Wendy May, Buyer, Telephone 475-1775, Extension 3487.

Any verbal representations, promises, statement or advice made by any employee of the District of Saanich, other than those made through the Office of the Director of Purchasing Services should not be relied upon.

11.0 AWARD

THREE (3) prime consultants have been short listed from an earlier response to a call for Expressions of Interest. Each prime consultant will provide **THREE** (3) copies of their Proposal plus originals suitable for black and white copying (maximum page size to be 8 ½ x 11) to:

Director of Purchasing Services
The Corporation of the District of Saanich
770 Vernon Avenue
Victoria, B. C., V8X 2W7

The Steering Committee is concerned not only about the qualifications and experience of the prime consultant, but also those of the sub-consultants, especially, but not limited to the areas of environmental, public involvement and drainage expertise and will be interested in processes which directly involves them in the selection of such.

The sub committee of the Committee will review the Proposals received and will evaluate them on the following basis:

11.1 Quality and general expertise of project leader

11.2 Quality and general expertise of individual sub-consultants and methodology whereby committee can be involved in the choice of sub-consultants

11.3 Direct experience of consultant and sub-consultants with similar projects

11.4 Quality of Proposal content

11.4.1 Overall Schedule of Activities

11.4.2 Allocation of Resources

11.4.3 Fees and Disbursements

12.0 Upon reviewing the Proposals, the sub-committee may ask to meet with Consultants to get a better appreciation of their Proposals and to answer specific questions related to the Proposal, the choise of sub-consultants, etc.

13.0 REJECTION

The Municipality reserves the right to reject any and all Proposals.

The following information is available from various sources regarding **the Durrell Creek Watershed:**

Sub-committee Issue Reports on Water Management, Ecology, Agriculture and Recreation.
*Contour maps from 1956
Detailed aerial photos from March 1997 in 1/2500 scale
Aerial photos for 1946/58/72/74/80/90/92
*Map showing watershed boundary as of 1997
Victoria weather office monthly and annual precipitation from 1941 to present
Monthly and annual mean discharges of water at the Hyacinth/Colquitz station 1978 to 1996
Listing including size and description, of the 33 culverts in the watershed area
Many photographs of the lowlands during the earlier part of the century and statements from "old timers" as to conditions of the land during this period.
First Trestle Valley Preliminary Drainage Study by Hoel Engineering, March 1996
**Colquitz River Proposed Fill Prohibition Boundary* report by KPA Engineering Ltd., March 1993
Riparian Inventory report, by Saanich, September 1996
Christmas Bird Count and Spring Bird Count report by Victoria Natural History Society, 1987-96
SWANS Proposal
Stefan Svec Survey of January 1995
Design Criteria for the Farm Drainage Outlet Assistance in the Lower Fraser Valley, K. Wilson, Ministry of the Environment, 1980
Stewardship Guidelines, Governments of Canada and British Columbia
*BC Agricultural Drainage Manual(1997), Ministry of Agriculture and Food
Historical information from Mrs. Gillie, Vancouver Island Regional Correction Centre and from the executive of the First Trestle Valley Association.
Information on Eagles in the Watershed from Mrs Gustafsen
Soil Survey of S.E. Vancouver Island and Gulf Islands, British Columbia. Report No 6 of the BC Soil Survey, Day and Laird, 1959
Environmental Guidelines for Various Industries, available from BCMAF
Sonja Nienaber - Soil testing results, water quality and fish/fry trapping results
*Saanich is currently having 1m contour interval mapping prepared. It is expected that this air photo mapping will be completed in time for Stage 1 work.
*Water quality test results and report for Durrell Creek when available

It will be the responsibility of the Consultant to obtain and pay for any charges related to obtaining the information listed. While the Municipality believes this list to be accurate, it has been compiled from a variety of sources and the Consultant should confirm the availability of the information if he/she intends to rely on such information in carrying out the Request for Proposal. Items marked with an asterisk (*) will be provided by the Municipality at no charge to the Consultant.

14.0 INFORMATION SOURCES

The following agencies should be contacted to determine any engineering, environmental or other information applicable to the project.

12.1 The Corporation of the District of Saanich
12.1 First Trestle Valley Ratepayers Associations
12.3 Provincial Agricultural Land Commission
12.4 Ministry of Agriculture and Food (MAF)
12.5 Ministry of the Environment, Lands and Parks (MELP)
12.6 Department of Fisheries and Oceans (DFO)
12.7 S.W.A.N.S.
12.8 V.I.R.R.C.
12.9 Peninsula Agricultural Commission
12.10 Strawberryvale Ratepayers Association
12.11 Courtland Hastings Agricultural Preservation Society

APPENDIX B

PROCESS AGREEMENT

Durrell Creek IWMP Steering Committee

Process Agreement

Definitions

Consultant:	means the person or company contracted by the District of Saanich to undertake the development of an integrated watershed management plan for the Durrell Creek Watershed.
Integrated Watershed Management Plan (IWMP):	means the integrated watershed management plan for the Durrell Creek drainage basin
Shared decision-making:	means that on a certain set of issues, for a defined period of time, those with authority to make a decision and those who will be affected by that decision will jointly seek an outcome that accommodates the interests of all concerned.
Steering Committee:	means the Steering Committee for the Durrell Creek Integrated Watershed Management Plan created by the District of Saanich.

Purpose

1. The Steering Committee will participate in the development of the IWMP. The IWMP will support agriculture and provide ecologically sensitive guidelines for land use in the Durrell Creek drainage basin. The IWMP will include recommendations to address storm water management, flooding, water storage, water quality, drainage, sustainable farming, alternative land uses, wildlife, fisheries and other ecological issues.

Process

1. The Consultant will gather information, conduct research and prepare the IWMP pursuant to the Terms of Reference developed by the Steering Committee. The Consultant's work program will include:

- regularly interacting with the Steering Committee, reporting on progress and assisting in the preparation and delivery of timely reports from the Steering Committee to the Saanich Municipal Council
- presenting options and recommendations for the consideration of the Steering Committee
- submitting a provisional IWMP to the Steering Committee for review and finalization.

2. The Steering Committee will work together in a shared decision-making process to reach consensus on the IWMP. The consensus recommendations of the Steering Committee will be submitted without amendment to the Saanich Municipal Council and, if required, other approving authorities for consideration.
3. To help inform the development of its recommendations to Saanich Municipal Council and, if required, other approving authorities, the Steering Committee (assisted by the Consultant) will host a public Open House when it has reviewed the Initial Options and Recommendations and when the Draft Watershed Management Plan is prepared.
4. The Steering Committee will report its recommendations to Saanich Municipal Council on completion of the Committee's Initial Options and Recommendations, on completion of the draft IWMP and, on completion of the final IWMP, including the implementation program.

Structure

Representation

1. The Steering Committee will consist of representatives from:

Agency / Organization / Interest Group	Number
Department of Fisheries and Oceans	1
Ministry of Agriculture	2
Agricultural Land Commission	1
Ministry of Environment, Lands and Parks	1
District of Saanich (Project Manager/Engineering, Planning, Environmental Management Departments)	3
Camosun College	1
Wilkinson Road Jail ("watching brief")	1
Local Community Associations (Strawberry Vale Ratepayers' Association, First Trestle Residents' Association)	2
Local Environmental Groups (SWANS, Victoria Natural History Association)	2

Community Members	8
Saanich Peninsula Agricultural Strategy Committee	1
Total Representatives:	**23**

2. The representatives' responsibilities are defined in the Appendix A.
3. Representatives participating as spokespersons for government agencies, interest groups, institutions or other individuals will:
   - accept the responsibility to be accountable to their constituents by keeping them informed of the progress of the planning process and to seek advice and direction as required.
   - advise the Steering Committee about whom they represent, how they communicate with their constituency, what authority they have to make decisions on behalf of constituents, and how they will ratify agreements with constituents.

Attendance

1. The Steering Committee will make every effort to schedule meetings so that all representatives can attend and representatives will make every effort to attend scheduled meetings.
2. In the event of an unavoidable absence of a community member from a Steering Committee meeting, the Steering Committee may defer important decisions or seek to ensure that the interests of the absent community member are represented in any decision to the best of their ability.
3. In the event of an unavoidable absence of a government, community group, or environmental organization representative, that representative may designate an alternate to serve in their place. In the interest of continuity, a representative who designates an alternate will keep his or her alternate fully informed of the progress of the planning process. Alternates are expected to respect the process and these procedural rules.
4. Notwithstanding paragraphs 10 and 11, the Steering Committee, acting in good faith, reserves the right to reach consensus on decisions in the absence of any representative or designated alternate.

Working Groups

1. The Steering Committee may create working groups to address particular issues or perform specific tasks.
2. The composition of working groups will be determined the Steering Committee, and may include persons other than representatives.
3. Working groups are expected to respect the process and these procedural rules. Other terms of reference for working groups will be established by the Steering Committee on an "as and when needed" basis.

4. Working groups will report their findings and recommendations to the Steering Committee.

Facilitator

1. A facilitator selected by the representatives will support the Steering Committee. The facilitator's responsibilities are defined in Appendix B.

Project Manager

1. A District of Saanich staff member (the "Project Manager") will coordinate the work of the Steering Committee. The Project Manager will:
   - oversee the work of the Consultant
   - report to the Steering Committee on a regular basis regarding the Consultant's progress and study expenditures
   - seek Steering Committee approval in the event changes to the scope of the Consultant's work are required
   - generally ensure that communication is maintained between the Consultant and the Steering Committee.

Decision-Making

1. The representatives will make decisions by consensus.
2. Consensus means an agreement that all of the representatives can live with. The representatives may not agree with every aspect, but taken as a whole, a decision based on consensus satisfies the major interests and concerns of each representative to the extent that all can support it.
3. All agreements reached during discussion of an issue are tentative pending consensus on the total package of agreements necessary to resolve the issue, unless the representatives explicitly agree otherwise on a specific item.
4. When the representatives reach a consensus on the resolution of an issue, it is understood that some representatives will have to take the agreement back to their constituencies or to a higher decision-making authority for ratification. Representatives will not agree to anything that they do not believe will be supported by their constituencies, and it is understood that agreement obliges representatives to strongly represent the benefits of the agreement to their constituents.
5. An agreement ratified pursuant to paragraph 22 will constitute a consensus recommendation of the Steering Committee.
6. Should the representatives reach a consensus on a set of recommendations that resolves most but not all of the issues that are being addressed, they will actively seek agreement on a statement describing the areas of disagreement, any lack of information or data that prevents such agreement and, where

possible, a process for achieving agreement on such issues. With respect to the issues on which a representative withholds agreement, that representative is responsible for explaining how its interests are adversely affected or how the proposed agreement fails to meet those interests. The representative withholding agreement must propose alternatives and the other representatives must consider how all interests may be met. If agreement is still not reached, the concerns of all representatives expressed in writing will be included in a report by the facilitator to the Saanich Municipal Council and other approving authorities for consideration.

Negotiating Principles

1. The representatives will seek integrated outcomes based on interests and concerns rather than positions and demands. An integrated outcome is one in which the representatives work together — integrating their resources, creativity and expertise.
2. The representatives will fully explore all the matters at issue with a view towards seeking an outcome that accommodates the interests of all concerned. In that regard, representatives will seek to:
   - clearly articulate the interests of their constituents
   - listen carefully, ask pertinent questions and educate themselves regarding the interests of other representatives whether or not they are in agreement with them, and
   - identify solutions that meet the interests of the other representatives as well as their own.
3. Representatives will allow each other the freedom to test ideas without prejudice to future discussion or negotiations and will not hold tentative ideas or exploratory suggestions against those who made them.
4. Representatives may transmit sensitive or confidential information to the facilitator, in which case it will be treated as confidential. The parties recognize the special nature of the facilitator's role and undertake not to seek or compel the testimony of the facilitator or the production of his personal notes or work papers in connection with any administrative or legal process, except as may be jointly agreed by the representatives and the facilitator.
5. Representatives will raise any matter they perceive to be in violation of these procedural rules or of good faith negotiations.

Meeting Procedures

1. Each meeting of the Steering Committee will be scheduled at least 1 month in advance. Meetings will begin and end as scheduled.

2. A meeting agenda together with supporting material and the facilitator's summary notes from the previous meeting will be circulated at least 5 business days prior to the meeting. Agenda material not circulated within this time frame may be dealt with at the meeting by agreement of the Steering Committee, which agreement shall not be unreasonably withheld. The agenda may be annotated, identifying the issues to be discussed, the purpose of the discussion and other related information. The Steering Committee will have an opportunity to review and amend the agenda at the beginning of each meeting.
3. Discussion at the Steering Committee will be limited to representatives, unless otherwise agreed by the representatives.
4. The facilitator will record the consensus decisions of the representatives and keep summary notes of the proceedings that highlight such matters as the area of discussion, tasks to be undertaken and any emerging areas of agreement. In addition, each representative may make his or her own written record of meetings.

Interim Work

1. Regular drainage maintenance work will occur during the IWMP process. Representatives will inform the Steering committee in advance about maintenance and any other drainage and runoff work they become aware of in the drainage basin.

Information

1. The Steering Committee will jointly identify:
   - the information it needs to address issues and make informed decisions
   - persons with the necessary expertise and experience to respond to information needs.
2. Representatives agree to share information necessary to make informed decisions in matters related to the process.

Relations with the Public and Media

1. Meetings of the Steering Committee are open to the public including the media. The media are asked to indicate their presence. Both the public and the media are expected to respect the proceedings and these procedural rules.
2. The Steering Committee retains the right to close meetings or parts of meetings to the public and the media if it is demonstrably necessary.
3. Representatives agree that their representations to the media will be respectful of other representatives and supportive of the process. Representatives are

- encouraged not to characterize the positions or suggestions of other representatives in their discussions with the public or the media.

Milestones and Completion Dates

1. The Steering Committee will establish periodic assessment points, in the form of either dates or completion of tasks, at which points the representatives will evaluate the progress of the Steering Committee towards fulfilling its purpose and by consensus agree whether or not to continue. Where appropriate, these milestones will be coordinated with the Consultant's work schedule.
2. The Steering Committee will meet as required to conclude its shared decision-making process by ______________, 1999 and secure ratification by ______________, 1999.

Amendment

1. The Steering Committee retains the right to manage its own process and to amend the terms of this agreement.

The representatives and the facilitator agree to be bound by the terms of this agreement dated January 14, 1999.

Agricultural Land Commission	Community Member
Camosun College	Community Member
Department of Fisheries and Oceans	Community Member
District of Saanich	Community Member
Ministry of Agriculture	Community Member

Ministry of Environment, Lands and Parks	Community Member
Saanich Peninsula Agricultural Strategy Committee	Community Member
Strawberry Vale Ratepayers' Association,	Community Member
First Trestle Residents' Association	Victoria Natural History Society
SWANS	Facilitator

Appendix A

Responsibilities of the Representatives

The responsibilities of the representatives include:

- working to build trust, seek common ground, clarify and facilitate productive communication
- shifting from positions to interests and encourage others to do so
- looking for mutually acceptable outcomes
- clarifying and asserting their interests (or the interests of those they represent) and listening while others do the same
- negotiating with other representatives toward consensus
- representing the work of the negotiating group to their constituencies and the public in the spirit of collaboration
- ensuring communication flow between their constituencies and the negotiating group
- negotiating in good faith, offering relevant information
- reading and keeping up to date on information being exchanged
- communicating any problems to the negotiating group and the facilitator
- coming to negotiating meetings prepared
- participating in working groups
- responding to the media in a way that does not characterize the views of the other representatives.

Appendix B

Facilitator's Responsibilities

The facilitator's responsibilities include working with the representatives to:

- establish a framework for problem-solving negotiation, including defining of goals, clarification of issues, the development and expression of interests (and conversion of positions to interests), formation of options, consensus decisions and packaging of agreements
- identify principles and criteria to guide shared decision-making
- establish realistic and attainable meeting objectives
- establish and maintain a productive and supportive tone for the process
- focus procedural and substantive discussion
- ensure that representatives communicate effectively with each other
- ensure that areas of misunderstanding or confusion are clarified, and that information flow is accurate and constructive
- ensure that procedural rules are followed
- record the consensus decisions of the parties
- coordinate sub-committees or working groups
- help the parties reach consensus, and ensure closure on issues
- assist representatives in discussions with their respective constituencies in a way that maintains flow of information and facilitates commitment to decisions
- initiate and manage between-meeting contacts among representatives in a manner that moves negotiations forward.

Facilitation is a process in which a person who is acceptable to all members of the group, substantively neutral, and has no decision making authority intervenes to help a group improve the way it identifies and solves problems and makes decisions, in order to increase the group's effectiveness.

The facilitator does not make decisions, pass judgement or impose a solution on the parties. He remains impartial in all contacts with representatives and does not advance the interests of one representative over another. The facilitator works for and reports to the parties.

In a complex, multiparty process the roles of mediator and facilitator are often combined. A mediator is a neutral third party whose primary role is to assist the parties in finding a mutually derived and mutually acceptable settlement of their differences through problem-solving negotiation.

APPENDIX C

DURRELL CREEK

INTEGRATED WATERSHED MANAGEMENT PLAN

HYDROLOGIC AND HYDRAULIC MODELLING

Prepared for:

The Corporation of the District of Saanich
777 Vernon Avenue
Victoria, B.C. V8X 2W7

Prepared by:

northwest hydraulic consultants ltd
2-40 Gostick Place
North Vancouver, B.C.
V7M 3G2

March 2000

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1. INTRODUCTION

1.1 Overview

This Appendix describes the hydrologic and hydraulic analysis completed as part of the development of an Integrated Watershed Management Plan for Durrell Creek. The main task was the development of linked hydrologic and hydraulic models of the Durrell Creek Watershed. The linked models were operated to characterize existing conditions and predict the effect that urbanization, stream diversions, and the Interurban Road culvert have had on discharges in Durrell Creek and water levels in the Durrell Creek Valley

1.2 Objectives

The key issues that are to be addressed by the hydrologic and hydraulic models are:

- Determine whether flooding has increased in the Durrell Creek Valley floodplain over the last 50 years in terms of height of floodwaters and duration of water on the land and, if it has, state the reasons why.

- Estimate water levels and provide floodplain mapping for the 10-, 25- and 200-yr instantaneous discharges in Durrell Creek. This information is provided for the existing watershed boundary as well as for those boundaries that existed prior to diversion(s).

- Define existing summer and winter base flow elevations adjacent to agricultural lands in the watershed. Also, determine the duration of flooding over specific field levels for the current watershed, with and without diversions.

- Determine and evaluate what, if any, hydrologic or hydraulic improvements may be required in order to meet freeboard requirements over base flow water levels for agricultural drainage. Specifically, determine the effect of culvert modifications at Interurban Road and Wilkinson Road on water levels for specific return periods (10-, 25- and 200-yr) and on the duration of flooding over specific field levels.

2. WATERSHED CHARACTERISTICS

2.1 Physiography and Watershed Boundaries

The Durrell Creek Watershed lies in the Saanich Peninsula north of Portage Inlet and just south of Elk-Beaver Lake and Prospect Lake (Figure 1). The Saanich Peninsula is part of the Nanaimo Lowland (Holland 1976) which consists of rolling low hills separated by broad valleys. Near Durrell Creek, the bedrock consists of metamorphic gneiss, quartzite, metavolcanics and argillite (Santos 1998). Deep organic or bog deposits cover the bedrock in the valley bottom; thin tills cover the bedrock on shallow slopes, with bedrock exposed on hilltops and steep slopes.

The watershed contains two distinct topographies; the flat, broad valley floor and the surrounding bedrock hills from which the principal headwaters of Durrell Creek originate. Elevations in the basin range from a minimum of about 9 m on the flat valley floor to a maximum of about 125 m in the hills in the northwest of the watershed.

Durrell Creek is a tributary of the Colquitz River and it flows roughly east to west. Its watershed has an area of about 5.3 km^2. For this project, the Durrell Creek watershed was divided into 8 sub-watersheds (Figure 2). The sub-basin boundaries were drawn to coincide with the confluence of tributaries, existing storm drainage boundaries, major road crossings, and other watershed features.

The watershed and sub-basin boundaries were delineated and verified based on the following:

- Previous boundaries drawn by the District of Saanich or by Hoel Engineering Ltd (1996).
- Storm drainage maps provided by the District of Saanich (scale 1; 5,300)
- Watershed divides as shown on topographic maps provided by the District of Saanich (Scale 1: 5,000)
- Field verification of direction of flow in streams and ditches by **nhc** staff
- Discussions with District of Saanich staff and **PGL** staff

2.2 Climate and Hydrology

2.2.1 Climate

The Atmospheric Environment Service (AES) reports precipitation and temperature for several climate stations, with reasonably long-term records, within the District of Saanich and Victoria (Table 1). The Saanich Densmore station is nearest to the Durrell Creek watershed but was inactive throughout the mid 1970's and 80's and was ultimately decommissioned in 1992. The Saanich Dominion Astrophysical Observatory, which is the next nearest station, has a long record of daily precipitation and temperature; unfortunately, the record ends in 1977.

Saanichton CDA and Victoria International Airport are to the north, Saanich Dominion Astrophysical Observatory is just north, Victoria Highland is to the east, and Victoria-Gonzales Heights is to the southeast (Figure 1). Near Victoria, precipitation totals decline broadly from west to east (M. Miles and Associates Ltd 1994). Saanichton CDA, Victoria International Airport and Saanich Dominion Astrophysical Observatory have similar precipitation normals; Victoria Highland is greater; Victoria – Gonzales Heights is much less. The normal annual precipitation over Durrell Watershed is thought to be close to that at Saanichton CDA, Victoria International Airport and Saanich Dominion Astrophysical Observatory, or about 850 to 900 mm.

Saanichton CDA is thought to be most representative of Durrell Creek, for operating stations with long term records, based on a review of climate normals published by Environment Canada for 1951 through 1980. According to that publication, normal annual precipitation at Saanichton CDA was about 6% less than that at Saanich Densmore, 2% less than at Saanich Dominion Astrophysical Observatory and nearly the same as at Victoria International Airport. By way of comparison, the station at Victoria Gonzales Heights received about 26% less annual precipitation than Saanichton CDA on average.

The following climate synposis is based on the daily precipitation record (1915-Present) and published temperature normals (1951-80) for Saanichton CDA.

Temperature Regime

Mean monthly temperatures at Saanichton CDA range from 5.6°C in January to 16.5°C, in July. The normal annual temperature is 9.6°C. The extreme recorded temperatures are 34.4 °C in July and -13.9 °C in December.

Precipitation Regime

The mean annual precipitation at Saanichton CDA is 835 mm based on an 82-year record of annual totals from 1915 to 1998 (Figure 3). The high and low extremes for the period of record are 1186 mm, which occurred in 1990 and 511 mm, which occurred in 1929.

Most precipitation falls from November through February when average monthly totals range from 93 to 152 mm. The driest months are July and August, when monthly totals average 19 and 25 mm. Snowfall accounts for about 4.5 % of total annual precipitation and occurs mainly from December through March.

The annual precipitation at Saanichton CDA shows both a trend to increasing totals over time and an irregular pattern of very wet periods separated by 10 to 15 years of more normal totals. An analysis of trends in precipitation by M. Miles and Associates (1994) for long-term stations near Victoria, showed a statistically significant increase in precipitation at Saanichton CDA, Shawnigan Lake, and Cowichan Bay Cherry Point. No trend was detected at Victoria – Gonzales Heights; a weak trend was observed at Victoria International Airport. Annual precipitation at Saanichton CDA appears to have increased about by 20% over the period of record.

In recent years, annual precipitation has been unusually high. It has exceeded the 1000-mm mark for each year from 1995 to 1998.

Figure 4 provides a plot of the annual maximum daily precipitation. The mean for the record is 45.3 mm, while the maximum of 82.3 mm occurred in 1955; the minimum of 27.4 mm occurred in 1969. Above average annual maxima have occurred throughout the 1990's. Saanichton CDA shows considerable variability in annual maxima but no trend to greater amounts. M. Miles and Associates Ltd (1994) were unable to detect a trend in annual maxima at any of the stations near Victoria.

Figures 5 and 6 show total precipitation in April and May, at the start of the growing season, and in September and October, at the end of the growing season. There is a very clear trend to greatly increased rainfall in April and May over the past 15 years. Unusually large totals were recorded in 1985, 1994 and 1997, which exceeded any previously recorded. On the other hand, there is no evidence of increased precipitation in September and October, and totals may have been less than in past years. Large totals in 1997, and again in 1998, may have hampered harvesting (Figure 6).

As part of our analysis of the Saanichton CDA records, we prepared frequency curves of total precipitation over durations of 2-, 5-, 10- and 30-days. Separate curves were developed for the growing season (April through September) and the dormant season (October through March). These curves, together with a summary table, are included as a separate Appendix 1 at the end of this Appendix.

2.2.2 Hydrology

The Water Survey of Canada has never operated a streamflow gauge on Durrell Creek, nor has there ever been a gauge operated by any other group or agency.

There has, however, been a streamflow gauge in operation on the Colquitz River since February 1976. The gauge was originally located at Hyacinth Avenue ('Colquitz River at Hyacinth Avenue', WSC 08HA037). In 1981, the gauge was moved a short distance downstream to its present location at Violet Avenue ('Colquitz River at Violet Avenue', WSC 08HA047).

A summary of the gauging records for the Colquitz River is provided in Table 3. The mean annual discharge for the period of record is approximately 0.36 m^3/s. Monthly averages range from a high of 1.03 m^3/sec in January, to a low of 0.04 m^3/s, which occurs in both August and September. The highest mean daily flow on record is 16.7 m^3/s, which occurred on November 23, 1990. The corresponding instantaneous peak was 17.1 m^3/s, which had an estimated return period of 25 years.

Figures 7 and 8 provide hydrographs of average daily discharge and stage respectively, for the Colquitz River at the mouth of Durrell Creek. Daily discharges at this location were derived from the Water Survey of Canada records by reducing them by the ratio of watershed areas at the two sites. Daily water levels were subsequently calculated from the discharges, using a local stage-discharge relationship calculated from the HEC-2 Model of the Colquitz River (KPA 1993). A summary of flows and water levels from the two plots is as follows:

Period	Avg. Daily Flow (m^3/s)	Avg. Daily Water Level (m, GSC)
May– Oct	0.07	8.5
Nov– Apr	0.70	8.9
Dec – Feb	0.90	9.0
Annual	0.36	8.8

Figure 9 shows the variation in annual discharge, discharge over the growing season and discharge in April and May on the Colquitz River since 1976. All these flows have been much higher in the past ten years than they were earlier in the record. An unusually large annual discharge occurred in 1990; very high flows in April and May occurred in 1991 and again in 1996.

The historical trends of discharge in the Colquitz River are worth addressing since the water levels in the Colquitz River have historically had a direct impact on flooding in Durrell Valley. Prior to installing the WSC gauges, development throughout the Colquitz watershed may have increased peak flows. Development has also resulted in the construction of bridge and culvert crossings along the river, many of them downstream of Durrell Creek. The flow in some reaches of the river has been restricted, resulting in higher water levels during extreme floods, increased siltation and growth of vegetation within the channel. As a result of the channel capacity being diminished, the water levels associated with annual floods have presumably been rising.

The Colquitz River is regulated by a dam at the outlet of Elk and Beaver Lakes. The dam was built more than 50 years ago as part of the water supply for Victoria. The dam has a licensed storage of 2,800 acre-feet and is now operated by the Capital Regional District. It is operated to store water in the spring, starting in January, for base flow fisheries releases during the drier summer months. Removal of the stop logs by vandals has resulted in large releases during the early summer in past years. The dam and its associated storage is expected to have some dampening effect on flood peaks in the Colquitz River although the extent to which it reduces flood peaks has not been investigated thus far.

2.3 Soils and Surficial Geology

Information concerning the soils and surficial geology of the Durrell Creek basin was obtained from the sources listed below. A soils map of the basin, prepared by Pottinger Gaherty Environmental Consultants Ltd (PGL), is provided in Figure 10.

- "Geology, Saanich Sheet", Canada Dept. of Mines, Map 72A, 1914
- "Superficial Geology, Saanich Sheet", Canada Dept. of Mines, Map 71A, 1915

- "Surficial Geology, Saanich Sheet", Canada Dept. of Mines, Map 73A, 1915
- "Soil Survey, Southeast Vancouver Island and Gulf Islands, British Columbia", Day, J.H, Farstad, L. and Laird, D.G., Canada Dept. of Agriculture, 1959.
- "Surficial Geology of the Victoria Area", Blyth, H.E. and Rutter, N.W., B.C. Ministry of Energy, Mines and Petroleum Resources, Geological Survey Branch, Map 92B/6, 1993

Much of the Durrell Creek valley floor is made up of poorly drained soils whose parent materials are mostly organic deposits, but in some cases are marine, glaciomarine or glaciolacustrine in origin. The dominant soil types are Metchosin Muck and Cowichan-Saanichton Clay loam mixture (Figure 10). Due to their high organic content and resistance to drought, these two soils are usually well suited for agriculture for the full length of the growing season. Adequate field drainage is required during periods of rainfall as the hydrologic response of these soils is extremely slow.

In upland areas, the soils tend to be moderately to well-drained, with high permeability. However, there are a few wetland areas located to the west and northwest, where soil characteristics are similar to those on the valley floor. For the most part, the dominant soil types are gravelly clay loams belonging to the Cadboro and Shawnigan Series and others that are generically classified as either "Rough Mountainous Land" or "Rough Stony Land" (Day et al 1959). Colluvial and morainal parent materials tend to dominate, though in most cases (the eastern portion of the basin being an exception) their depths are shallow and the underlying material is bedrock. The areas overlying bedrock are expected to have an especially fast hydrologic response, with runoff occurring primarily as shallow sub-surface flow between the interface of the soil layer and the underlying bedrock and then as surface flow as the soil reaches saturation. Groundwater flow throughout the watershed is assumed to be minimal.

2.4 Land Use and Cover

In past fifty years, most development in Durrell Creek watershed has taken place along its eastern boundary. Most of the development has consisted of adding single family residences adjacent to Interurban Avenue and Wilkinson Road. Major developments included the construction of Camosun College, and the upgrading of B.C. Hydro's Goward Substation and the Wilkinson Road Penitentiary.

Despite urbanisation around the boundaries of the watershed, most of the valley floor remains dedicated to agriculture (most notably Courtland and Hastings Flats) and lies within the Agricultural Land Reserve (ALR).

Land-use and cover in the Durrell Creek basin has been classified by sub-basin into the following categories for the HSPF hydrologic model (**nhc** 1998; Tables 4a to 4e):

- Forest
- Grassland/ agricultural
- Low density, single family residential

- Medium density, single family residential
- High density, single family residential
- Commercial/ industrial
- Pavement (multi-lane roadways)

Low density single family residential (LDSFR) was defined as less than one house for every 2 acres (less than one house per hectare); medium density single family residential (MDSFR) was defined as one house per acres (2 houses per hectare) to four houses per acre (8 houses per hectare). High density single family residential (HDSFR) was defined as more than four houses per acre (more than 8 houses per hectare) and includes condominium and townhouse complexes. Commercial/Industrial uses include shopping centres, colleges and universities, and industrial developments.

Current land use for the basin was defined using digital 1:5,000 scale cadastral drawings supplied by the District of Saanich. The current land use map was then used as a template for determining land use in earlier decades, with past land use interpreted from inspection of air photos, as summarised below:

- 1950's land use was determined using 1956 air-photos (scale 1: 30,000)
- 1960's land use was determined using 1964 air-photos (scale 1: 15,000)
- 1970's land use was determined using 1975 air-photos (scale 1: 30,000)
- 1980's land use was determined using 1988 air-photos (scale 1: 15,000)

The results of the land use analyses are provided in Tables 4a through 4e and the corresponding land use maps are shown in Figures 11a through 11e.

For each land use class listed above, the HSPF model assumes that a percentage of its total area is impervious. The impervious area is further broken down into an effective portion, which contributes runoff directly to drainage system, and an ineffective portion that is assumed to have the same drainage characteristics as the surrounding pervious land (Table 5). The breakdown of the total area for each land use class into pervious and impervious area is provided in Table 5.

2.5 Diversions into Durrell Creek Watershed

Santos (1998) and Hoel Engineering Ltd (1996) discuss the diversion of Porters (Francis King Park) Creek into the Durrell Valley. They report that this creek originally flowed south along the alignment of Charlton Road, under Burnside Road, before eventually discharging into Portage Inlet. The topographic maps prepared from the 1956 air photos for the District of Saanich show the creek as draining along this path to Portage Inlet. However, inspection of the 1956 air photos show a connection of the creek to Durrell Creek; this connecting channel is also visible on the 1946 air photos, suggested the diversion may have begun very early in the last century. It is possible that water flowed in both directions in early years, before it was all diverted into Durrell Creek.

Porters Creek, which has a drainage area of about 1.1 km^2, accounts for roughly one-fifth of the current watershed area of Durrell Creek. It has been designated as Sub-basin B4 in Figure 2.

As well as Porters Creek, residents and committee members have reported potential diversions from the area near the BC Hydro Goward Substation, near Strawberry Vale School, and along Hector Road west of Interurban Road. These diversions and their potential effect on hydrology and hydraulics are discussed in Appendix D "Specific Information Required by the Municipality."

The potential effect of the Porters Creek diversion on the hydrology and hydraulics of Durrell Creek are discussed in detail in this Appendix.

2.6 Overview of Hydrology and Hydraulics

Colquitz River Backwater

Under existing conditions, the magnitude and duration of dormant season flooding in the lower reaches of Durrell Creek is primarily controlled by the time-variant backwater imposed by the Colquitz River. In extreme cases, flow reversals may occur within Durrell Creek as a result of rapidly rising water levels on the Colquitz River. These backwater effects may extend as far upstream as the fields between Granville Street and Charlton Road, and they extend throughout the agricultural lands known as Courtland and Hastings Flats.

Interurban Road and Wilkinson Road Culverts

The Interurban Road culvert is a circular concrete culvert with a diameter of 1.65 m (65 inches). The culverts upstream invert elevation is El. 9.44m (GSC), which is about 0.3 m above the ditch invert immediately upstream and more than 1.2 m above the ditch invert on the west side of Courtland Flats. The Interurban Road culvert controls drainage of upstream agricultural lands during the growing season.

The Wilkinson Road culvert is a 1.5 m by 3.0 m, concrete box culvert, located roughly 250 m upstream of the Colquitz River. The upstream and downstream inverts of the culvert are 8.66 m and 8.55 m (GSC) respectively. The cross-sectional area of the culvert is roughly twice that of the upstream channel, which would indicate that the structure has little effect on flood levels upstream. The bed of the Colquitz River is at about 8 m and water levels in the Colquitz River are typically above the downstream invert during the dormant season (see **Section 2.2.2**).

Other Culverts

The culvert beneath Hastings Street controls water levels and drainage throughout the southern portion of Hastings Flats. The bottom of this culvert is at an elevation of about El. 9.6 m, which is about the same as the average ditch invert elevation in the area. During the site inspection, the entrance to this culvert appeared to be at least partially clogged with vegetation and silt.

The Granville Street culvert is above typical flood levels on the Courtland and Hastings Flat (Figure 13). However, during extreme floods, backwater through this culvert from the Colquitz River could flood portions of the fields to the east of Granville Street. The District of Saanich plans to replace and upgrade the Granville Street culvert.

There are several small culverts, designed to provide drainage throughout the valley floor, which are either collapsed, poorly positioned or overgrown with vegetation. Regular inspection and maintenance of all of these culverts should be thought of as a key component of flood control in the valley and drainage improvement on agricultural lands.

3. HYDROLOGIC MODEL DEVELOPMENT

3.1 General

The Hydrologic model used for this project was the U.S. Environmental Protection Agency's (EPA) Hydrologic Simulation Program - FORTRAN (HSPF) model, version 11.0. HSPF is a conceptual, deterministic hydrologic model, capable of providing continuous simulation of streamflow and other hydrologic processes. A general discussion of model development follows; more detailed descriptions of HSPF are included in the references listed at the end of this Appendix.

The development of a hydrologic model begins with the creation of a watershed data management file (*.wdm). While HSPF is responsible for the generation and analysis of the various time series, the storage and management of the data is accomplished by a separate program known as ANNIE (as developed by the U.S.A.C.E.). Once the *.wdm file is created in ANNIE, it can be used to store precipitation and evaporation data as well as any streamflow data available for calibration purposes. The next step involves the creation of a land-segment input file (LANDSEG), within which the user can specify up to 100 pervious land-types (PERLNDs) and one impervious land-type (IMPLND). PERLNDs are defined on the basis of cover (forest, grass etc.), soil type and surficial geology. Each land-type is assigned a unique set of user-defined parameters. Once the LANDSEG file is complete, it is used as a driver for runoff simulation. HSPF uses the information contained in the LANDSEG file in physically based soil moisture algorithms, with the climate data, to compute continuous sequences of runoff for each land-type.

Runoff from the various land-types is then hydraulically routed through representative stream reaches in HSPF though the creation of a RCHRES input file. A separate RCHRES file is created for each sub-basin or group of sub-basins discharging into a particular reach. If the natural channel system is too intricate to be modelled accurately using HSPF alone, a link can be created with an independent hydraulic model better suited for the purpose. Hydraulic modelling for the project is discussed in greater detail in Section 4.

The Durrell Creek Watershed Model is set up to provide continuous hydrologic simulation for the period from July 1, 1964 through December 31, 1997. However, since the hydraulic modelling portion of the model depends on the water level in the Colquitz River, stream discharges and water levels are only predicted for the period that begins on January 1, 1976, when gauging records began on the Colquitz River.

3.2 Definition of Pervious and Impervious Land-segments

For the purposes of hydrologic modelling, the following seven land-types were defined:

- Poorly drained land with a grass cover (PDG).
- Poorly drained land with a forest cover (PDF).
- Moderate to well-drained land, overlying bedrock, with a grass cover (WDBG).
- Moderate to well-drained land, overlying bedrock, with a forest cover (WDBG).

- Moderate to well-drained land with a grass cover (WDG).
- Moderate to well-drained land with a forest cover (WDF).
- Impervious land (IMP)

A map showing the areal coverage of each pervious land-type is provided in Figure 12.

3.3 Model Parameters for the Land-segments.

The model parameters used in this study were adopted from on the results of extensive, basin-scale hydrologic modelling in Western Washington conducted by both the King County Division of Surface Water Management and the U.S. Geological Survey (USGS). Work by the USGS (Dinicola 1990) led to the development of regional model parameters for the Puget Sound according to soil type, surficial geology and land cover. The use of these regional parameters greatly improves the reliability of model results for watersheds with ungauged streams where direct calibration of the parameters is not possible.

Land-segments designated as poorly drained (PDG, PDF) have been assigned the set of regional parameters developed for saturated soils. Well drained land-segments (WDG, WDF) were assigned parameters developed for Till-like soils. Lastly, well-drained segments overlying bedrock were also assigned Till-like parameters but with slight adjustments to account for increased sub-surface runoff, reduced groundwater input, and other factors. A comprehensive listing of the parameters is provided in Table 6.

3.4 Hydrometeorlogic Data

Precipitation

The hHourly precipitation data used in the Durrell Creek Watershed Model is from Victoria International Airport (AES Sta. No. 1018620), and is available for a 22-year time span from July 1, 1964 to December 31, 1997[1]. The record is of fairly good quality, although it does contain some 60 to 70 days worth of missing data. Missing data has been filled in using either hourly or daily observations from other nearby gauges.

According to published climate normals (1951-80), Victoria International Airport receives 5 to 6 % less precipitation on an average annual basis than the local station at Saanich Densmore. However, the difference is not consistent from one year to the next and the Airport received more precipitation than Saanich Densmore for several of the years of overlapping record. Therefore, for modelling purposes, we have used the records from the Victoria International Airport to model precipitation over Durrell Creek without applying an adjustment factor.

Evaporation

Daily pan evaporation data for the HSPF model were obtained from Vancouver UBC (AES Sta. No.1108487, 1962-1990) and Saanichton CDA (AES Sta.No.1016940, 1970-

[1] At the time of modelling, hourly data for 1998-99 had not yet been verified by AES Canada, and therefore was not used in the model. Once the data becomes officially available it can be incorporated.

Present). The UBC record is thought to be of better quality, but it was discontinued in 1990. The two records were combined to obtain a continuous record of daily evaporation, from July 1,1964 through December 31,1997.

4. HYDRAULIC MODEL DEVELOPMENT

4.1 Durrell Creek Survey

nhc surveyed Durrell Creek on April 29 and 30, 1999. Channel bed, channel bank and floodplain elevations were surveyed at 15 cross-sections, starting downstream near the Wilkinson Road culvert and ending upstream near the Granville Street culvert above Hastings Flats. The survey covered a total distance of roughly 1.4 km. A plan view of the cross-section locations is shown on Figure 2 and the long profile of Durrell Creek is shown on Figure 13.

In addition to the cross-sections, individual elevation points were surveyed within and around the perimeter of the agricultural fields, along the inverts of secondary field drainage ditches, along the tops of major roadways and at the inverts of culverts located along the principal drainage path.

All data points collected during the survey were later referenced to District of Saanich geodetic benchmarks No. 79H8866 and 74H2189.

4.2 Event Modelling with HEC-RAS

A simplified analysis of Durrell Creek was initially set up using HEC-RAS, a one-dimensional backwater model developed by the U.S. Army Corps of Engineers. The model was created using the channel, floodplain and profile geometry (including culverts) surveyed in late April. A few cross-sections were added through interpolation in order to better define the principal storage areas upstream of Interurban Road. Manning roughness coefficients were assigned to each cross-section based on field observations and previous experience. Channel roughness typically ranged from 0.035 to 0.05, though some heavily overgrown sections were assigned values as high as 0.09; Floodplain roughnesses varied between 0.03 (cultivated fields) and 0.12 (dense bank-side brush or tree cover).

Water levels upstream of the Wilkinson Road culvert were adopted as the initial or downstream boundary condition for the HEC-RAS model. A continuous time series of water levels was developed at this location by simply adding 0.35 m to Colquitz water levels at the mouth of Durrell Creek (see **Section 3.3.2**). The value of 0.35 m was adopted from inspection of HEC-2 water surface profiles of Jail Creek (KPA 1993).

4.3 Continuous Modelling with ROUTE

Detailed hydraulic modelling for the project was completed by ROUTE, an unsteady reservoir routing program developed by Dr. Evan Twombly at **nhc**'s Seattle office. The program was designed to produce long-term continuous time-series of both stage and discharge from simulated reservoirs using a standard routing equation of the form:

$$I_i + I_{i+1} + \left(\frac{2S_i}{t} - O_i\right) = \frac{2S_{i+1}}{t} + O_{i+1}$$

Where:

I_i = Inflow at time, i
I_{i+1} = Inflow at time. i + 1 (one time-step later)
S_i = Reservoir Storage at time, i
S_{i+1} = Reservoir storage at time, i + 1
O_i = Reservoir outflow at time, i
O_{i+1} = Reservoir outflow at time, i + 1
t = Time-step interval, 1 hour (typically)

The reservoir routing method is an ideal way of simulating the hydraulics of Durrell Creek because of the backwater effects from the Colquitz River and Interurban Road culvert that regulate flood storage in the system and because floods pass slowly through Durrell Creek watershed. Although the UNET unsteady flow model was originally proposed for the project, ROUTE was ultimately selected after consideration of the following points:

- ROUTE was specifically designed to transfer data to and from ANNIE, the data management system used by HSPF. Consequently, time and money could be saved by not reformatting data files each time a link is required between HSPF and the hydraulic model.

- ROUTE's algorithms handle the time variation of only three variables: depth, flowrate and volume. Consequently, it has the ability to perform continuous simulations over very long periods of time, with basic computer hardware and memory requirements. UNET, on the other hand is best-suited to simulating individual storm events using flow variables that change with respect to both time and space. As a result, UNET requires better hardware performance than ROUTE and often experiences memory problems (system crashes) when performing simulations for periods longer than a few months.

- ROUTE software is generally more stable than UNET. Furthermore, when instabilities do occur in ROUTE, they are easily diagnosed and fixed (often by simply reducing the time-step of the simulations) due in large part to our familiarity with, and access to, the program code.

4.3.1 Model Operation

At time t_0, the program begins filling the first reservoir in the system with an inflow time-series from one or more HSPF RCHRES. For each successive time-step in the operation, the program calculates and records a new water level and outflow for the reservoir, thereby generating two new time-series. Water level calculations are based on a user-defined stage-volume (S-V) relationship and outflows are based on a user-defined headwater-discharge-tailwater (H-Q-T) relationship. By way of the H-Q-T, the outflow from a reservoir is both a function of the water level in that reservoir and the water level downstream of it. The rating tables, that define the S-V and H-Q-T relationships, are included in the program's input file.

Like most unsteady flow models, ROUTE has the ability to model flow reversals, which occur when downstream water levels exceed upstream water levels. They are generally short-lived, lasting just long enough to re-establish either a constant or downstream sloping water surface profile along the stream. Flow reversals are assumed to be a common occurrence in Durrell Creek, because rapidly rising flood levels in the Colquitz River tend to overwhelm those in Durrell Creek. When ROUTE encounters a flow reversal, it simply performs its calculations using the H-Q-T tables in reverse order until a constant water level is achieved.

4.3.2 Model Development and Hydraulic Routing Schematic

The ROUTE model of Durrell Creek consists of two reservoirs. Reservoir #1 (upstream) represents the agricultural area known as Hastings Flats and it is fed by HSPF-generated runoff from sub-basins B3 through B7. During the summer months when water levels are low, the Hastings Flats area may seem ill defined as a typical level-pool reservoir because the water surface has a definite downstream gradient (conversely, the water surface through Courtland Flats is nearly level all year round). However, we have maintained the reservoir assumption within ROUTE by relating storage in the Hastings Flats area to the water level at a specific point, which has been established at cross-section 13.5.

Reservoir #2 represents the area upstream of Interurban Road known as Courtland Flats. This reservoir is fed by runoff from sub-basins 1,2 and 8 as well as the outflow from reservoir #1. Although runoff from sub-basin 1 would naturally enter the system downstream of Interurban Road, we have included it as an input to Reservoir #2. This occurs because of the difficulties in defining a reservoir downstream of Interurban Road; there is no clearly defined H-Q-T relationship between this area and the Colquitz River. We do not expect the predicted water levels or discharges to be greatly affected by this assumption. It will provide conservative water levels upstream of Interurban Road by including runoff that actually is discharged downstream of the culvert.

The S-V and H-Q-T rating tables for both reservoirs were defined using the HEC-RAS model described earlier. This was accomplished by fixing the tailwater level downstream of each reservoir and then having the model calculate headwater levels for a range of flows. This was then repeated for a range of tailwater levels.

A schematic drawing of the Durrell Creek hydraulic model is included in Figure 14.

5. MODELLING SCENARIOS

Long-term records of water levels and discharges were calculated for seven separate scenarios, developed to address the objectives outlined in Section 1. Each simulation was calculated for the climate and Colquitz River water levels over the 22 years from January 1976 through December 1997, at an hourly time-step.

The seven scenarios examine the effect of land use changes over the past fifty years, the diversion of Porters Creek, and the Interurban Road culvert on water levels and discharges in Durrell Creek Valley. Data limitations prevented the examination of long term changes in climate on water levels and discharge. Hourly climate data is only available since 1964; water levels in Colquitz Creek are only available since 1976. However, the long term changes can be roughly predicted from the variation of climate at the Saanichton CDA AES station, as described in **Section 2.1**.

The seven modelling scenarios are as follows:

5.1 Scenarios 1 through 5 – Land Use

The first five scenarios evaluate the effect of land use changes over the past fifty years on water levels and discharges. The scenarios are defined as follows:

Scenario 1:	Current land use
Scenario 2:	1980s land use
Scenario 3:	1970s land use
Scenario 4:	1960s land use
Scenario 5:	1950s land use

In order to isolate the effect of land use changes from one scenario to the next, other key components of the model such as evaporation and precipitation inputs, sub-basin boundaries and the hydraulic routing module remained unchanged. Consequently, comparing the model results from one scenario to an earlier one shows how increases in impermeable area and the loss of forest and grass cover have affected agricultural drainage and flooding.

5.2 Scenario 6 – Porters Creek Diversion

Scenario 6 calculates water levels and discharges in Durrell Creek with sub-basin B4 removed from the model, simulating the diversion of Porters Creek to Portage Inlet. Diverting Porters Creek sub-basin results in the flow from about 1.1 km^2 of mostly forested and agriculture or grassed fields no longer contributing to Durrell Creek.

The diversion scenario was calculated only for the current land use. We did not feel that it was worthwhile analysing other past land use patterns as the Porters Creek sub-basin has undergone little commercial or housing development over the past fifty years.

The effect of Porters Creek on water levels and discharges can then be evaluated by comparing Scenario 6 to Scenario 1, which predicts the water levels and discharges for current land conditions. As above, other key components of the model such as evaporation and precipitation inputs and the hydraulic routing module remained unchanged. Consequently, comparing the two scenarios shows only the effect of the diversion on agricultural drainage and flooding for the 22-year record of climate and Colquitz River water levels.

5.3 Scenario 7 – The Interurban Road Culvert

Scenario 7 assesses how lowering the Interurban Road culvert would improve agricultural drainage during the growing season. This scenario lowers the Interurban Road culvert by more than 0.7 m, which we assumed would have more effect than changing its size or shape. The headwater-discharge-tailwater (H-Q-T) rating table for reservoir #2 in the hydraulic routing module was modified to reflect the change in culvert elevation. Scenario 7 is based on current land use and current watershed boundaries (i.e. Porters Creek was not diverted).

The effect of the Interurban Road culvert on water levels and discharges can then be evaluated by comparing Scenario 7 to Scenario 1, which predicts the water levels and discharges for current land conditions. As above, other key components of the model such as evaporation and precipitation inputs and watershed boundaries remained unchanged. Consequently, comparing the two scenarios shows only the effect of the culvert elevation on agricultural drainage and flooding for the 22-year record of climate and Colquitz River water levels.

The watershed model is by no means limited to these seven scenarios. The various components of the model can be modified as required in order to address other issues that arise during the development and implementation of the IWMP. Also, the evaporation, precipitation and Colquitz water level time-series can be easily extended as more data becomes available from the respective agencies.

6. LIMITATIONS OF THE LINKED WATERSHED MODEL

Below is a brief summary of the limitations involved in this study as they pertain to the hydrological and hydraulic analyses.

- The record of stage and discharge record for the Colquitz River is fairly short, extending from 1976 to the present. The short record has limited our ability to assess the combined, long-term impact of climate with the effect of land use changes, diversions, and culvert installation. The short record on the Colquitz River also prevents us from defining the historic floodplain for Durrell Creek and increases the statistical uncertainty of our estimate of the 200-year flood from Durrell Creek.

- The transfer of Colquitz River discharges and water levels from the gauge at Violet Avenue to the mouth of Durrell Creek, as described in Section 2, was fairly crude. Discharge, and water levels, are based on daily records and do not take into account hourly water level fluctuations. However, this does not greatly affect the hydraulic analysis, due to the slow passage of flood waves through both the Colquitz River and Durrell Creek.

- The lack of calibration of soil moisture and runoff parameters may limit the accuracy of the HSPF discharge calculations. However in a low-gradient, backwater-controlled system like Durrell Creek, further fine-tuning of these parameters would not be expected to greatly alter the predicted flows and water levels.

7. LAND USE, DIVERSIONS AND THE INTERURBAN ROAD CULVERT

This section discusses the effect of the seven scenarios described previously on peak flows, extreme water levels and the duration of flooding on Courtland and Hastings Flats.

7.1 Hydrological Regime

7.1.1 Predicted Annual and Seasonal Flows

Table 7 provides a summary of mean daily flows for existing conditions in Durrell Creek; the average annual flow hydrograph is included on Figure 15. The quoted discharges are averages for each day over the entire 22-year modelling period. A summary of the hydrology for existing conditions follows:

- Average flow throughout the growing season (May - Sep) - 0.07 m^3/s
- Average flow throughout the dormant season (Oct - Mar) - 0.21 m^3/s
- Maximum monthly average flow (Nov) - 0.28 m^3/s
- Minimum monthly average flow (Jul) - 0.05 m^3/s
- Average annual flow - 0.14 m^3/s

7.1.2 Predicted Peak Flows

Predicted annual maximum instantaneous flows for Durrell Creek are presented in the lower half of Table 7. The maximum predicted instantaneous flow was 3.1 m^3/s, which occurred in 1990; the minimum was 1.09 m^3/s, which occurred in 1994. As indicated below, and in Table 9, the flow in 1990 has return period of greater than 25 years.

A flood frequency analysis has been performed on the set of annual peak instantaneous flows fitting a Log-Pearson Type III probability distribution to the data. The fitted frequency curve is shown in Figure 16. Estimated instantaneous flows at return periods of 2, 10, 25, 50, 100, and 200 years are shown in bold-faced type in Table 9. Selected instantaneous flows at key return periods for existing conditions are as follows:

- 10-year – 2.3 m^3/s
- 25-year – 2.8 m^3/s
- 200-year – 3.9 m^3/s

7.1.3 Effect of Land Use

Figure 17 provides flood frequency curves for the five different land use scenarios, based on a Log-Pearson Type III probability distribution fit to the data. Table 9 summarizes the predicted instantaneous flows for return periods of 2, 10, 25, 50, 100, and 200 years for each scenario. Except for a very small increase in the 50-year flood, the impact of land use on peak flows has been negligible.

7.1.3 Effect of Porters Creek Diversion

Figure 18 compares flood frequency curves for existing conditions and for existing conditions with Porters Creek diverted. The peak instantaneous flows for return periods of 2, 10, 25, 50, 100, and 200 years are summarized on Table 9. The diversion of Porters Creek would result in a reduction of about 0.2 m^3/s in peak flows with a return period of two years or more. A larger reduction, of up to about 0.5 m^3/sec (about a 50% reduction) occurs for the 1-year flow. The 1-year peak flow represents a common event that would be exceeded at least once a year.

7.1.4 Effect of Modifying the Culvert at Interurban Road

Figure 18 also compares flood curves for existing conditions and for existing conditions with the Interurban Road culvert lowered by 0.7 m. The peak instantaneous flows for return periods of 2, 10, 25, 50, 100, and 200 years are summarized on Table 9. Comparison of the two flood frequency curves shows that lowering the culvert actually causes a slight increase of about 0.1 m^3/s in peak flows over the range of return periods. This is because for a given water level at Interurban Road that is imposed by the Colquitz River, the lower culvert is able to pass more flow due to the increased headwater depth.

7.2 Water Level Regime

In the following discussion, all water levels are in metres above geodetic datum and are reported to the nearest 0.1 m (10 centimetres).

7.2.1 Predicted Annual and Seasonal Water Levels

A summary of mean daily water levels at Courtland and Hastings Flats for existing conditions in Durrell Creek is provided in Table 8. The average annual stage hydrographs for the two Flats are shown in Figures 19 and 20, respectively. The reported water levels in the two figures are averages of the all the water levels on each day over the entire 22-year modelling period. A summary of the water level regime follows:

Courtland Flats

- Average water level throughout the growing season (May - Sep) – 9.5 m
- Average water level throughout the dormant season (Oct - Mar) – 9.7 m
- Maximum monthly average water level (Nov) – 9.8 m
- Minimum monthly average water level (Jul-Aug) – 9.5 m
- Average annual water level – 9.6 m

Hastings Flats

- Average water level throughout the growing season (May - Sep) – 9.7 m
- Average water level throughout the dormant season (Oct - Mar) – 9.9 m
- Maximum monthly average water level (Nov) – 10.0 m
- Minimum monthly average water level (Jun - Sep) – 9.7 m
- Average annual water level – 9.8 m

7.2.2 Predicted Maximum Water Levels and Floodplain Boundaries

Predicted annual maximum water levels for Durrell Creek are presented in the lower portion of Table 7. During extreme floods, water levels are assumed to be constant throughout the valley floor, therefore no distinction is made between Courtland and Hastings Flats. The predicted maximum daily water level is 11.6 m, which occurred in 1990; the predicted minimum is10.3 m, which has occurred several times.

A frequency analysis was performed on the annual maximum water levels, by fitting a Log-Pearson Type III probability distribution to the plotted data. The fitted curve is shown on Figure 21. Estimated maximum water levels for return periods of 2, 10, 25, 50, 100, and 200 years are shown in bold-faced type in Table 10. Selected maximum water levels at various return periods follow:

- 10-year – 11.3 m
- 25-year – 11.5 m
- 200-year – 12.1 m

The boundaries for the 10-, 25- and 200-year floodplains were interpolated between the contours shown on topographic maps provided by the District of Saanich. Figure 24 shows the boundaries for existing conditions, based on the above water levels and not including a freeboard. The area within each of the boundaries represents the land that would be inundated by water during each of the three events.

7.2.4 Effect of Land Use Changes

Figure 22 provides water level frequency curves that show the effect of land use on extreme water levels for five scenarios. Estimated extreme water levels for return periods of 2, 10, 25, 50, 100, and 200 years, for each land use scenario, are shown in Table 10. Table 9 provides the peak flow for various return periods for each of the land use scenarios. The effect of altered land use on maximum water levels has been negligible.

The estimated extreme water levels for Scenarios 2 through 5 are indistinguishable from those for existing conditions (Scenario 1) consequently their floodplain boundaries would be the same. The floodplain boundaries for previous land uses are not shown separately.

7.2.5 Effect of Porters Creek Diversion

Figure 23 compares water level frequency curves for existing conditions and for existing conditions with Porters Creek diverted. Table 10 summarizes extreme water levels for return periods of 2, 10, 25, 50, 100, and 200 years for both conditions. Diverting Porters Creek would reduce extreme water levels by about 0.1 m for return periods of 25 years or less. At greater return periods, the diversion has no effect on extreme water levels.

The estimated extreme water levels following diversion of Porters Creek are nearly indistinguishable from those for existing conditions, consequently their floodplain boundaries would be the same. The floodplain boundaries with the diversion are not shown separately.

7.2.6 Effect of Modifying the Culvert at Interurban Road

Figure 23 also compares water level frequency curves for existing conditions and existing conditions with the culvert at Interurban Road lowered by 0.7 m. Table 10 summarizes extreme water levels for return periods of 2, 10, 25, 50, 100, and 200 years for both conditions. Lowering the Interurban Road culvert reduces water levels by about 0.1 to 0.2 m for frequent floods, those with a return period of 2-years or less. During large, or infrequent, floods, lowering the culvert has no effect on extreme water levels.

7.3 The Duration of Flooding

The duration of flooding on the Courtland and Hastings Flats has been calculated for each modelling scenario. The flood duration curves for the different scenarios are compared in Figures 25 through 30; Tables 11a and 11b summarize the results separately for Courtland and Hastings Flats.

The duration of flooding is expressed as the fraction of time that water levels are equal to, or exceed, various elevations over the 22-year modelling period. For instance, water levels exceed 9.0 m 100% of the time on Courtland Flats, for Scenarios 1 through 6 (Table 11a). The water levels in Tables 11a and 11b are quoted to 4 decimal places in order to define durations for extreme water levels; this should not be interpreted as reflecting the level of accuracy of the analyses. Also, note that the scale of the x-axis varies in Figures 25 through 30; this allows greater detail on the left side of the plots.

7.3.1 Effect of Land Use Changes

Modelling results for the various land uses over the past five decades, as expressed by Scenarios 1 through 5, show a small, but consistent, increase in the duration of flooding at moderate elevations with the most recent land use patterns (Tables 11a and 11b).

7.3.2 Effect of Porters Creek Diversion

Tables 11a and 11b compare the duration of flooding for existing conditions (Scenario 1) and existing conditions with Porters Creek diverted (Scenario 6). The diversion would slightly reduce flooding on Courtland Flats. The time that water levels exceed elevations of 9.6 m would be reduced from 41% of the year (150 days) to 35% of the year (128 days). The time that they exceed 10.0 m would be reduced from 7% of the year (27 days) to 5% of the year (18 days).

The diversion would have a similar effect on the duration of flooding on Hastings Flats. The time that water levels exceed 9.8 m would be reduced from 34% of the year (125 days) to 27% of the year (99 days), the time that they exceed 10.2 m would be reduced from 5% of the year (19 days) to 3% of the year (11 days).

7.3.3 Effect of Lowering the Culvert at Interurban Road

Tables 11a and 11b compare the duration of flooding for existing conditions (Scenario 1) and existing conditions with the Interurban Road culvert lowered by 0.7 m (Scenario 7). Lowering the culvert has a large effect on the duration of flooding on Courtland Flats. The time that water levels exceed elevations of 9.6 m is reduced from 41% of the year (150 days) to 10% of the year (37 days). The effect is smaller at higher elevations. The time that water levels exceed elevations of 10.0 m is reduced from 7% of the year (27 days) to 2% of the year (10 days).

At Hastings Flats, lowering the Interurban Road culvert provides a much smaller reduction in the duration of flooding. Lowering of the Hastings Street culvert and drainage improvements on Hastings Flats and Durrell Creek would be required to achieve the same reduction in the duration of flooding there.

8. COMPLIANCE WITH ARDSA DRAINAGE CRITERIA

The ARDSA regional drainage requirements for agricultural areas are as follows:

- During base flow conditions a freeboard of 1.2 m from the water level in the stream (Durrell Creek) to the lowest point in the field is usually required, though freeboard of as low as 0.9 m may be acceptable.
- Remove the estimated runoff from the 10-year, 2-day summer storm, within 2 days in the growing season.
- Remove the estimated runoff from the 10-year, 5-day winter storm, within 5 days during the dormant season.

8.3.1 Freeboard Above Base Flow Levels

Based on our 1999 surveys, field elevations at Courtland Flats range from 9.6 m to 9.9 m, with an average of about 9.7 m. At Hastings Flats, field elevations range from 10.0 m to 10.4 m and they average about 10.2 m. Given the level of accuracy of the survey, and the narrow range of field elevations, we have assumed that the average levels reasonably represent the low points of the respective fields.

Winter base flow discharges were calculated from a unit base flow of 75 m^3/day/ha, as recommended by ARDSA. Water levels were then calculated from the linked hydrology and hydraulic model. Summer base flows are those that typically occur during July or August. Water levels at summer base flow are just over the invert of the Interurban Road culvert on Courtland Flats. Increases or decreases in the summer base flow would have little or no effect on the base flow water level.

The following table compares base flow water levels to field elevations.

	Field Level m (GSC)	Base Water Level, m (GSC) Growing Season	Dormant Season
Courtland Flats	9.7	9.5	9.7
Hastings Flats	10.2	9.7	9.9

Freeboard over summer base flow is about 0.2 m on Courtland Flats and about 0.5 m on Hastings Flats. Both are well below the recommended minimum freeboard of 1.2 m, indicating that field drainage is impeded for the existing conditions in the Durrell Creek Valley. Lowering of the culverts under the Interurban Road and Hastings Street would be required to provide minimum freeboard elevations of 0.9 m.

8.3.2 Drainage of the 10-year, 2-Day Rainstorm– Summer

The 10-year, 2-day rainfall total was estimated from a frequency analysis of daily precipitation at the Saanichton CDA climate station (see Appendix 1). Daily rainfalls at Saanichton CDA were used for the analysis instead of Victoria International Airport because of its longer record. The total two-day precipitation was 44.9 mm.

For modelling of the flow and water elevation hydrographs in Durrell Creek, a 2-day summer storm with a similar total rainfall was selected from the hourly record at Victoria Airport. The chosen storm occurred between September 1st and 3rd, 1983 and had a total accumulation of 45.2 mm (see Figures 31 and 32).

Predicted water elevation hydrographs for the September 1983 storm on both the Courtland and Hastings Flats are presented in Figures 31 and 32, respectively. Both figures present water elevations for existing conditions, for existing conditions with the diversion of Porters Creek, and existing conditions with the Interurban Road culvert lowered by 0.7 m.

- For existing conditions at Courtland Flats, water levels rise over the minimum field elevation of 9.7 m rapidly to about 10.3 m, and then remain above the minimum field elevation for about 4 days. Elevations decline slowly to base flows over an additional two days. The two-day drainage criterion for the 10-year return period summer storm is not met.

- At Courtland Flats, diverting Porters Creek out of the watershed reduces the peak water level to an elevation of 10.2 m and reduces the duration of water levels about minimum field elevation by about 12 hours. Lowering of the culvert dramatically reduces the duration of flooding. Water levels rise to a lower peak, drop below minimum field elevations within 2 days, then continue to decline to the new lower base flow elevation set by the lowered culvert invert. The lowered culvert meets the two-day drainage criterion for summer storms.

- For existing conditions at Hastings Flats, water levels rise over the minimum field elevation rapidly, reaching a maximum water level of over 10.4 m. Elevations decline reasonably rapidly, dropping below the minimum field elevation in about 2.33 days. They then return to base flows over about two days, further impeding drainage. Hastings Flats do not meet the two-day summer drainage criterion.

- At Hastings Flats, diverting Porters Creek out of the watershed slightly reduces the peak water level and reduces the duration of water levels exceeding minimum field elevations to about 1.75 days. The diversion of Porters Creek would significantly reduce the runoff entering Hastings Flats, resulting in reduced flood levels and flood duration.

- The water level hydrograph if the Interurban Road culvert is lowered is similar to that for diverting Porters Creek, however water levels return to base flow elevations quicker. Lowering of the Hastings Street culvert and improvements to Durrell Creek, in conjunction with lowering the Interurban Road culvert, would further reduce the duration of summer flooding on Hastings Flat.

8.3.3 Drainage of the 10-year, 5-Day Rainstorm - Winter

The 10-year, 5-day winter storm at Saanichton CDA was estimated to be 124.0 mm (see Appendix 1). For modelling of the flow and elevation hydrographs in Durrell Creek, a winter summer storm with a similar total rainfall was selected from the hourly record at Victoria Airport. The chosen storm occurred between January 14th and 19th, 1986 and had a total accumulation of 122.5 mm, with much of the rainfall in the final two days (Figures 33 and 34).

Predicted water elevation hydrographs for the January 1986 storm on both the Courtland and Hastings Flats are presented in Figures 33 and 34, respectively. Both figures present water elevations for existing conditions, for existing conditions with the diversion of Porters Creek, and existing conditions with the Interurban Road culvert lowered by 0.7 m.

- For existing conditions at Courtland Flats, water levels rise above minimum field elevations at the start of the storm, rise to a peak elevation of 10.9 m, and remain above minimum field elevations eight days after the start of the storm. The main volume of runoff associated with the event appears to be removed in about 5 days. However, water levels remain above field elevations because of high water levels on the Colquitz River and the winter drainage requirements are not met.

- At Courtland Flats, the diversion of Porters Creek has little effect on the water level hydrograph, reducing water levels from a few cm to about 20 cm at the peak. Water levels remain above field elevations. With the lowered culvert, water levels are below minimum field elevations for the first part of the storm, rise rapidly to 10.8 and then decline to about minimum field elevations within five days. Water levels remain at about field elevations because of high water levels on the Colquitz River, preventing field drainage.

- For existing conditions at Hastings Flats, water levels rise to just below minimum field elevations just after the start of the storm, rise to a peak elevation of about 11.0 m, and return to minimum field elevations after four days. Water levels remain near minimum field elevations, preventing field drainage.

- At Hastings Flat, the diversion of Porters Creek reduces flood levels by 10 cm throughout the storm, but does not affect the duration of flooding. Lowering the culvert at Interurban Road has little or no effect on flood levels at Hastings Flats. Lowering of the Hastings Street culvert and deepening of Durrell Creek, in conjunction with lowering the Interurban Road culvert, would be required to reduce the duration of winter flooding on Hastings Flats.

The reader should bear in mind that the above results are for a particular combination of summer or winter storm precipitation and water levels on Colquitz Creek. The same storms, with different tailwater levels, may produce entirely different patterns of flooding.

9. SUMMARY

It seems most likely that only small changes have occurred in the extreme water levels recorded in Durrell Creek Valley over the past fifty years. Urbanization in Durrell Watershed, diversion of Francis King Creek, and installation of the Interurban Road culvert all have insignificant effects on extreme water levels. Water levels in the Colquitz River are the most important determinant of extreme water levels in the Durrell Creek Valley. Extreme water levels in the Colquitz River may have increased slightly over the past fifty years from increased discharges as a result of development in the Colquitz watershed and higher water levels for extreme floods from development along the Colquitz River. On the other hand, storage operation in Elk and Beaver Lakes may have helped mitigate the potential increases.

On the other hand, the duration of flooding is thought to have increased. Climate change, with higher annual totals and greater precipitation in April and May, accompanied by higher discharges and water levels in Colquitz River, since the mid-1980's is thought to have increased the duration of flooding. This has not been tested directly by the model because we do not have a long-term record of water levels in the Colquitz River.

Urbanization in the Durrell Watershed has almost no effect on the duration of flooding in the valley bottom; the re-diversion of Porters Creek would have a small effect on reducing the duration of flooding, should it occur. Lowering of the Interurban Road culvert would potentially have the greatest effect on the duration of flooding, significantly shortening the period of time that water levels rise about field elevations on Courtland Flats. Lowering of the Hastings Street culvert and improvements to Durrell Creek would be required to achieve the same effect on Hastings Flats.

ARDSA drainage criteria for freeboard and duration of flooding are not met on the Courtland or Hastings Flats for existing conditions. Lowering of the Interurban Road culvert provides the only significant improvement in drainage. It would meet freeboard criteria through the middle of the growing season, and would meet the summer storm drainage criteria on Courtland Flats, lowering of the Hastings Street culvert and improvements to Durrell Creek would be required to achieve the same effect on Hastings Flats. Neither lowering the culvert, nor re-diversion of Porters Creek, meets the ARDSA winter drainage criteria.

10. REFERENCES

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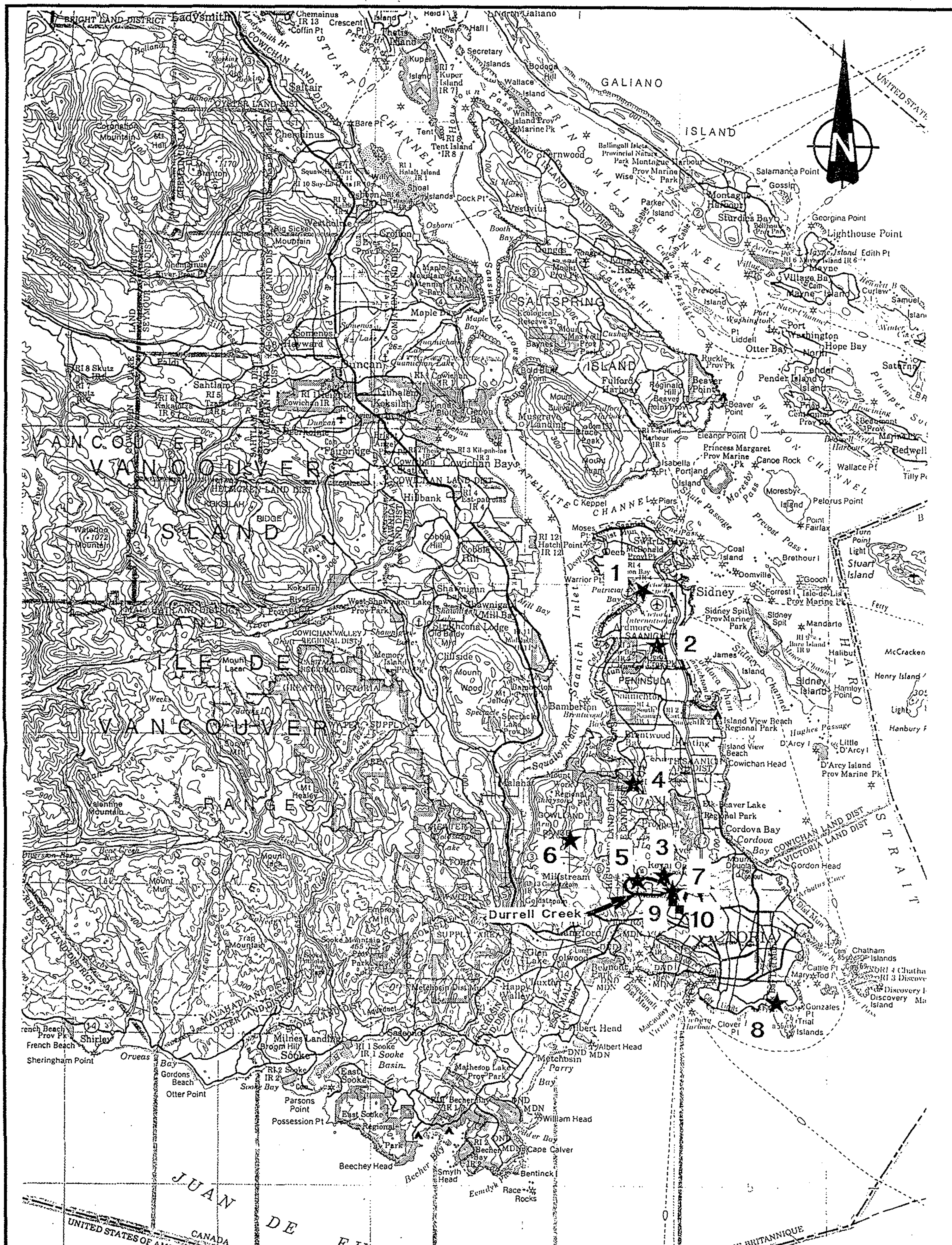


LOCATION KEY

★ AES Station ■ WSC Station

1. AES Climate Station - 1018620 - Victoria Int'l Airport (01/58 - Present)
2. AES Climate Station - 1016940 - Saanichton CDA (03/14 - Present)
3. AES Climate Station - 1016942 - Saanich Denmore (12/65 - 02/92)
4. AES Climate Station - 10169DK - Saanich Dom. Astro. Obs. (12/16 - 06/77)
5. AES Climate Station - 1018605 - Victoria Francis Park (09/89- Present)
6. AES Climate Station - 1018616 - Victoria Highland (07/61 - Present)
7. AES Climate Station - 1018617 - Victoria Holland 2 (08/60 - Present)
8. AES Climate Station - 1018610 - Victoria Gonzales Heights (01/1898 - Present)
9. WSC Gauging Station - 08HA037 - Colquitz River at Hyacinth Ave. (01/76 - 09/81)
10. WSC Gauging Station - 08HA047 - Colquitz River at Violet Ave. (09/81 - Present)

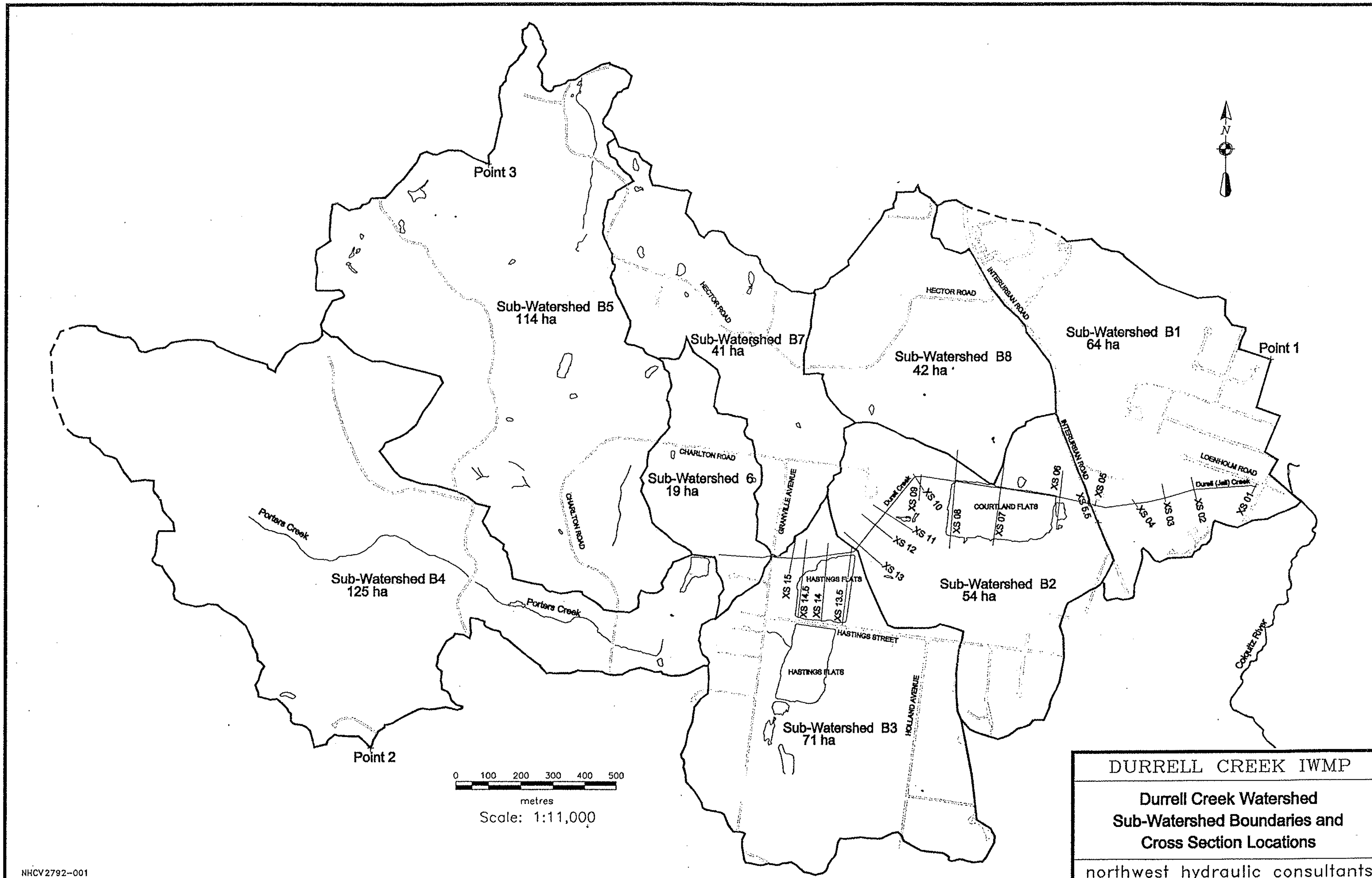
SCALE 1: 250,000

DURRELL CREEK IWMP

Durrell Creek
Location Map

northwest hydraulic consultants

Figure 1



DURRELL CREEK IWMP

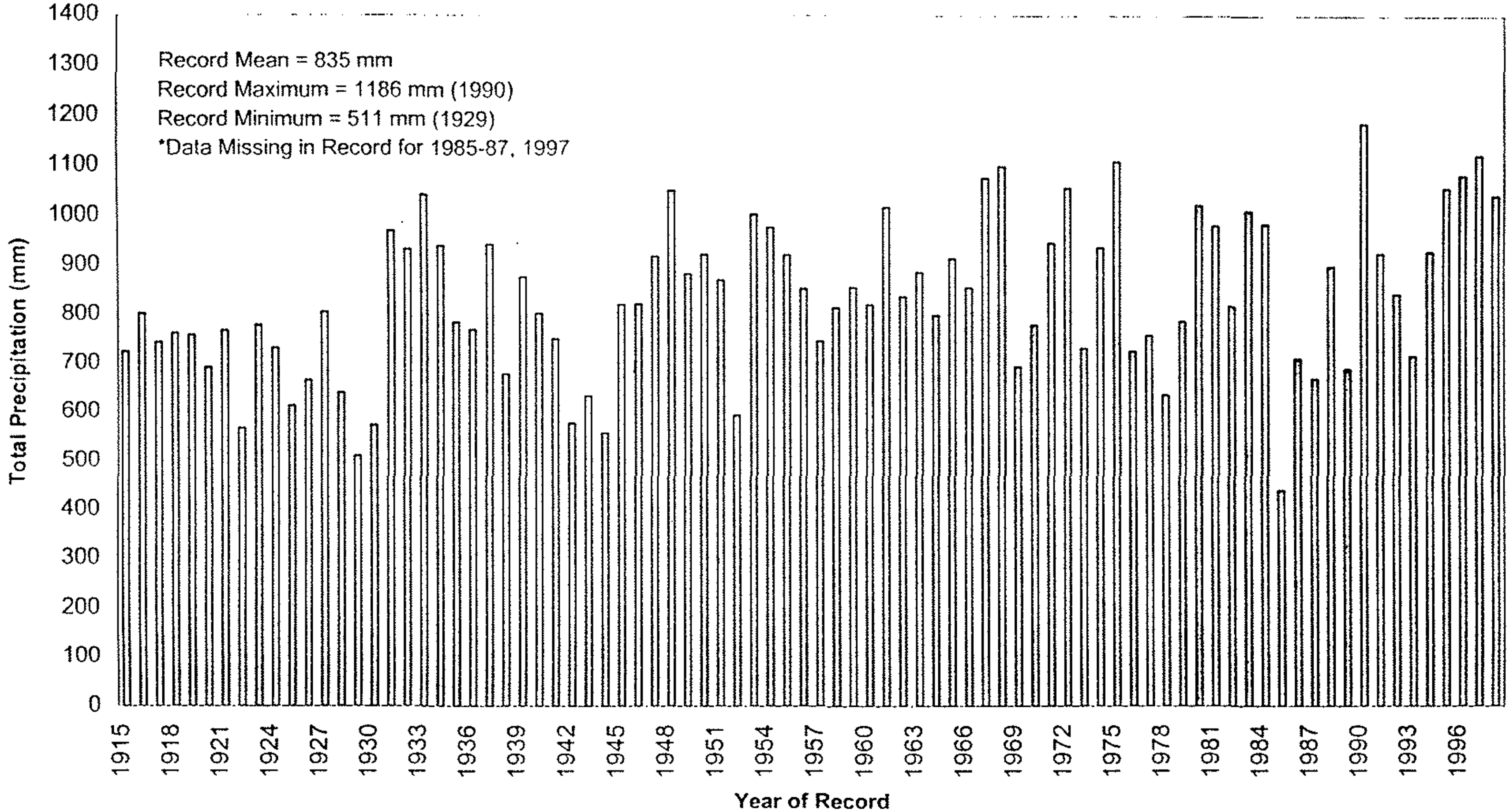
Durrell Creek Watershed Sub-Watershed Boundaries and Cross Section Locations

northwest hydraulic consultants

NHCV2792-001

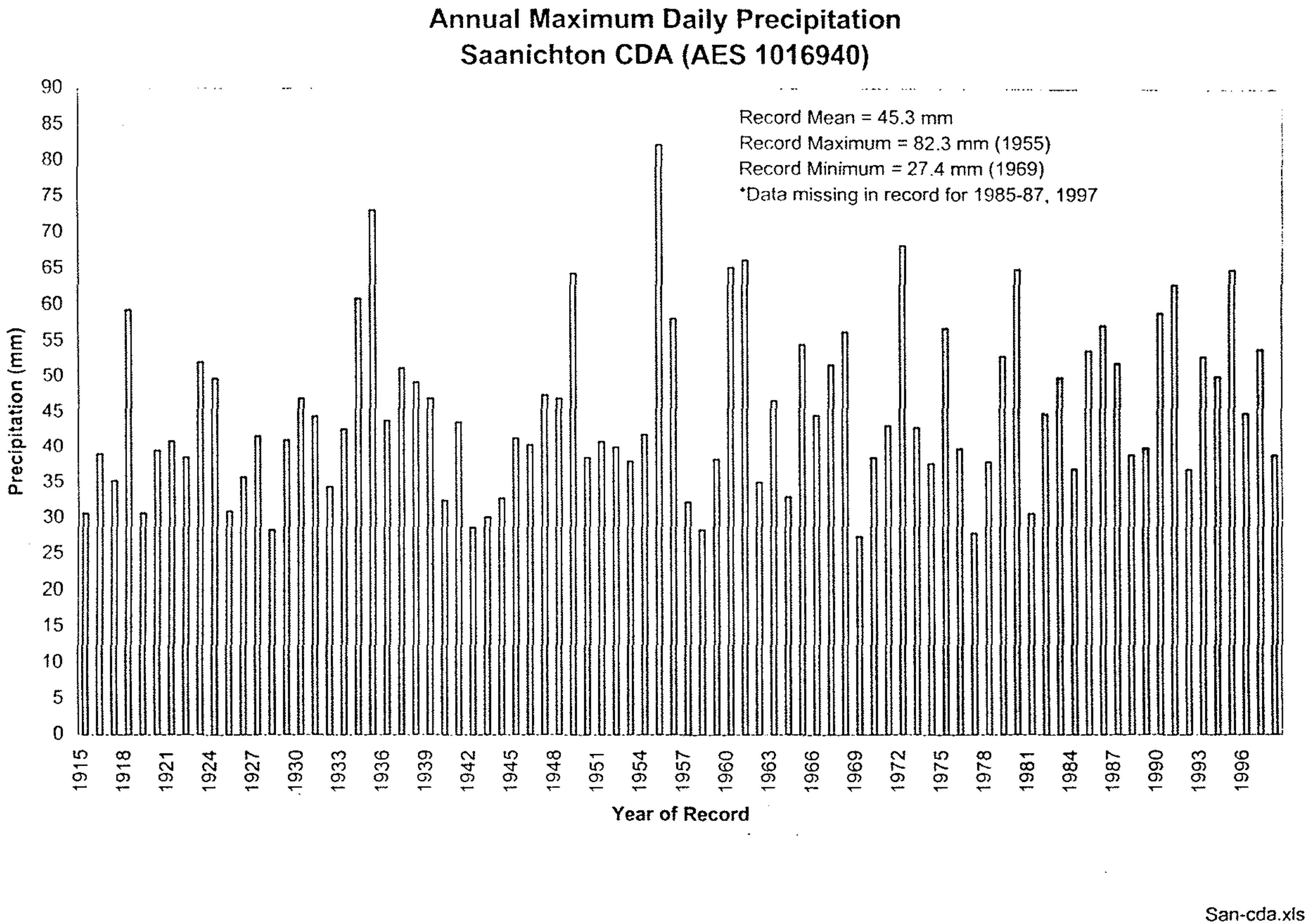
Figure 2

Annual Precipitation Totals
Saanichton CDA (AES 1016940)



San-cda.xls

Figure 3



Annual Maximum Daily Precipitation
Saanichton CDA (AES 1016940)
Record Mean = 45.3 mm
Record Maximum = 82.3 mm (1955)
Record Minimum = 27.4 mm (1969)
*Data missing in record for 1985-87, 1997
Precipitation (mm)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
1915 1918 1921 1924 1927 1930 1933 1936 1939 1942 1945 1948 1951 1954 1957 1960 1963 1966 1969 1972 1975 1978 1981 1984 1987 1990 1993 1996
Year of Record
San-cda.xls

Figure 4

Annual Total Daily Precipitation in April and May
Saanichton CDA (AES 1016940)

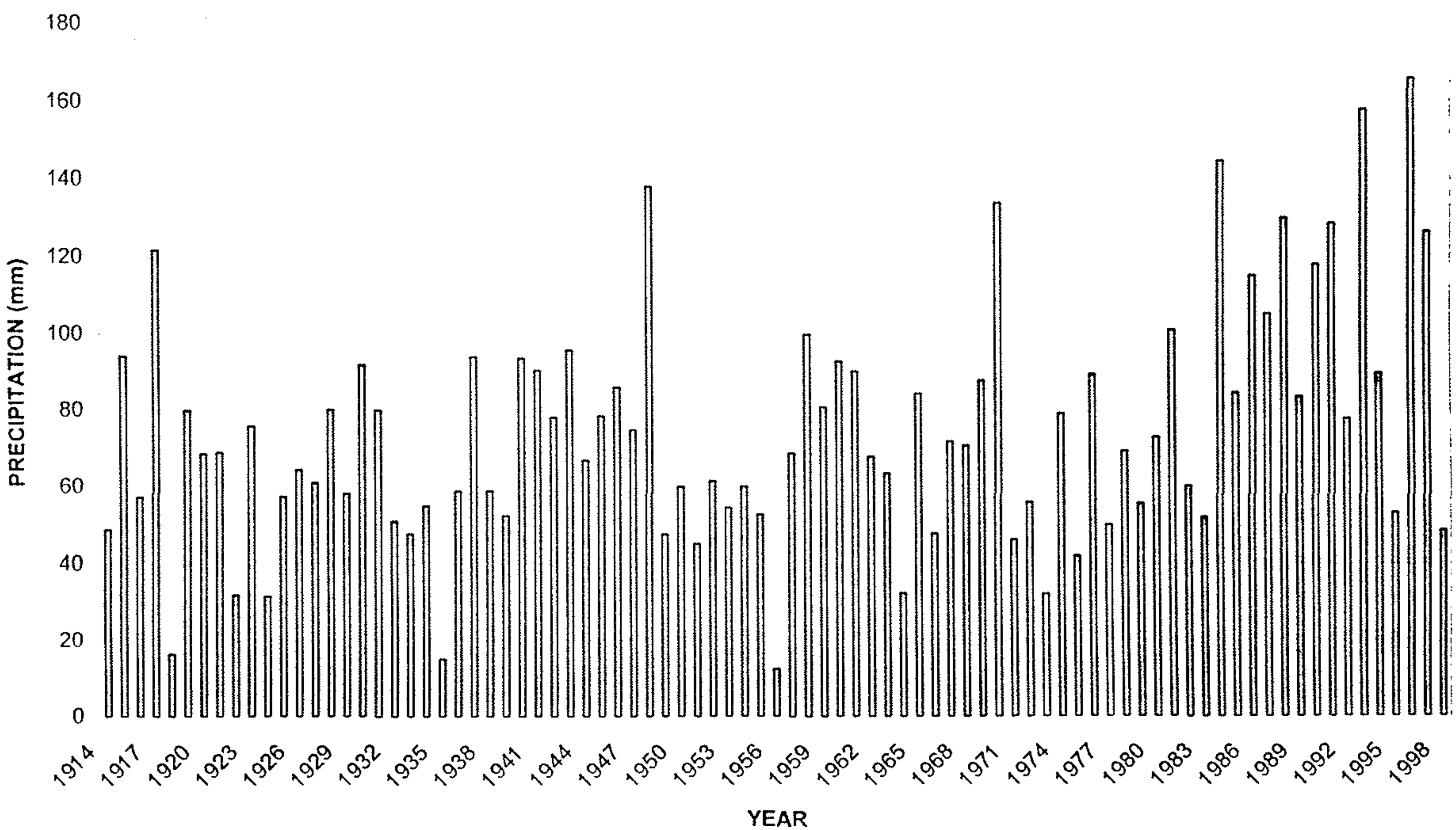
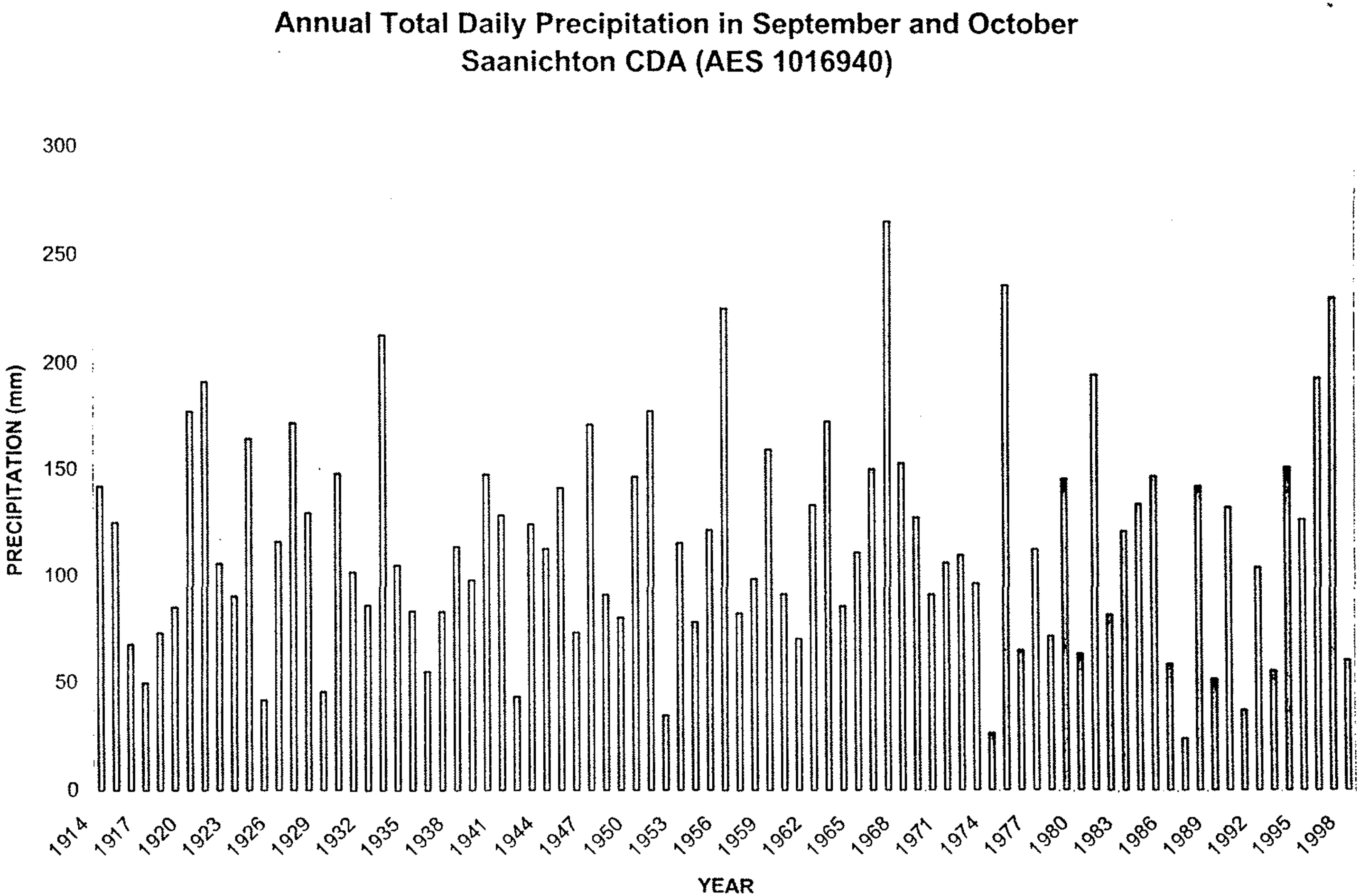


Figure 5

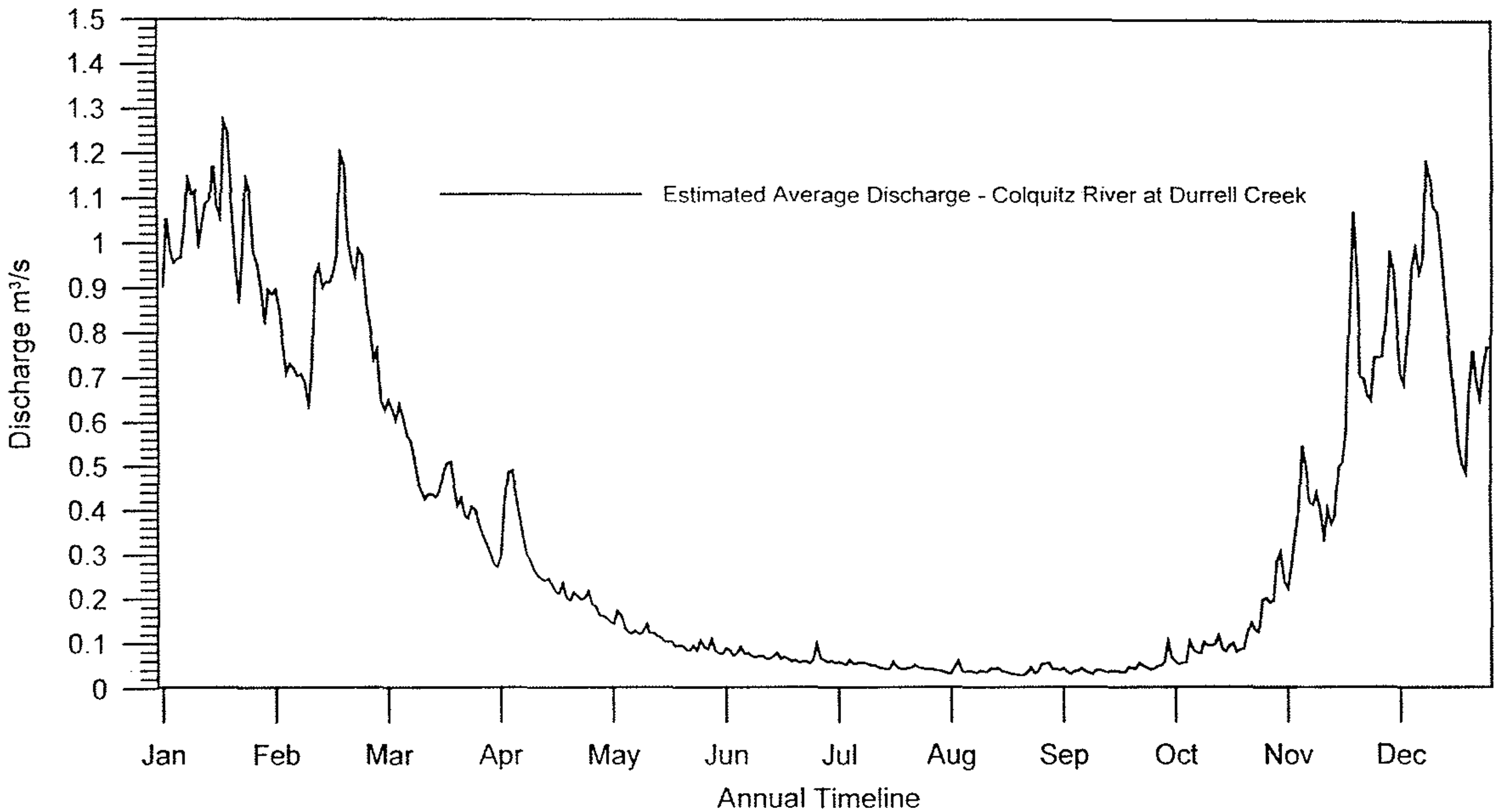
San-cda.xls



San-cda.xls

Figure 6

Average Annual Flow Hydrograph
Colquitz River at Durrell Creek
Period of Record: 01-01-1976 through 12-31-1997

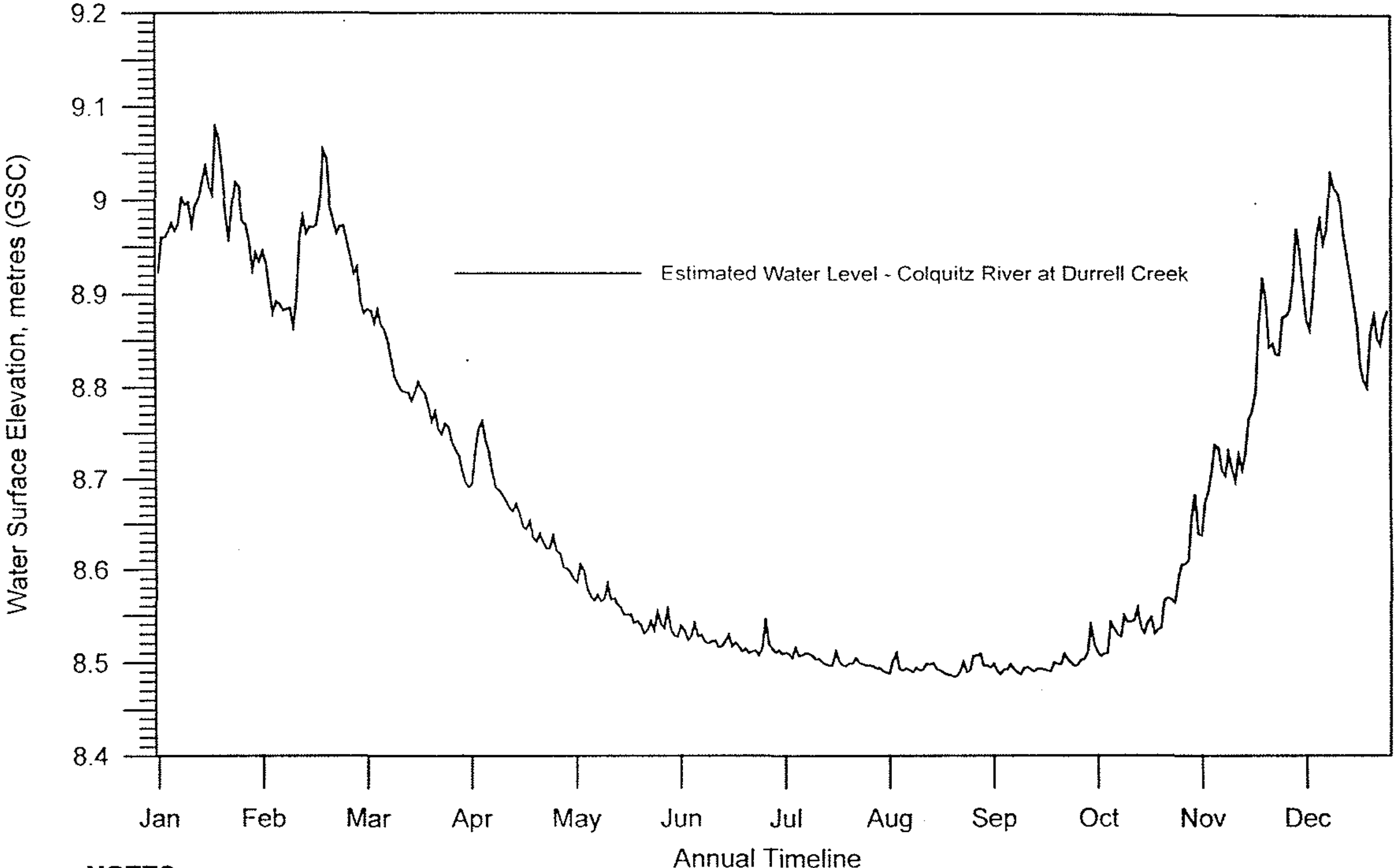


NOTES

1. Discharges are estimated based on the existing daily discharge records at Hyacinth (WSC 08HA037) and Violet Avenues (WSC 08HA047). Discharges were translated to the mouth of Durrell Creek using a ratio of drainage areas.

Figure 7

Average Annual Stage Hydrograph
Colquitz River at Durrell Creek
Period of Record: 01-01-1976 through 12-31-1997



NOTES

1. Water levels are estimated based on the existing daily discharge records at Hyacinth (WSC 08HA037) and Violet Avenues (WSC 08HA047) Discharges were translated to the mouth of Durrell Creek using a ratio of drainage areas. Water levels were then calculated based on a local rating curve from an existing HEC-2 model of the Colquitz River (KPA, 1993)

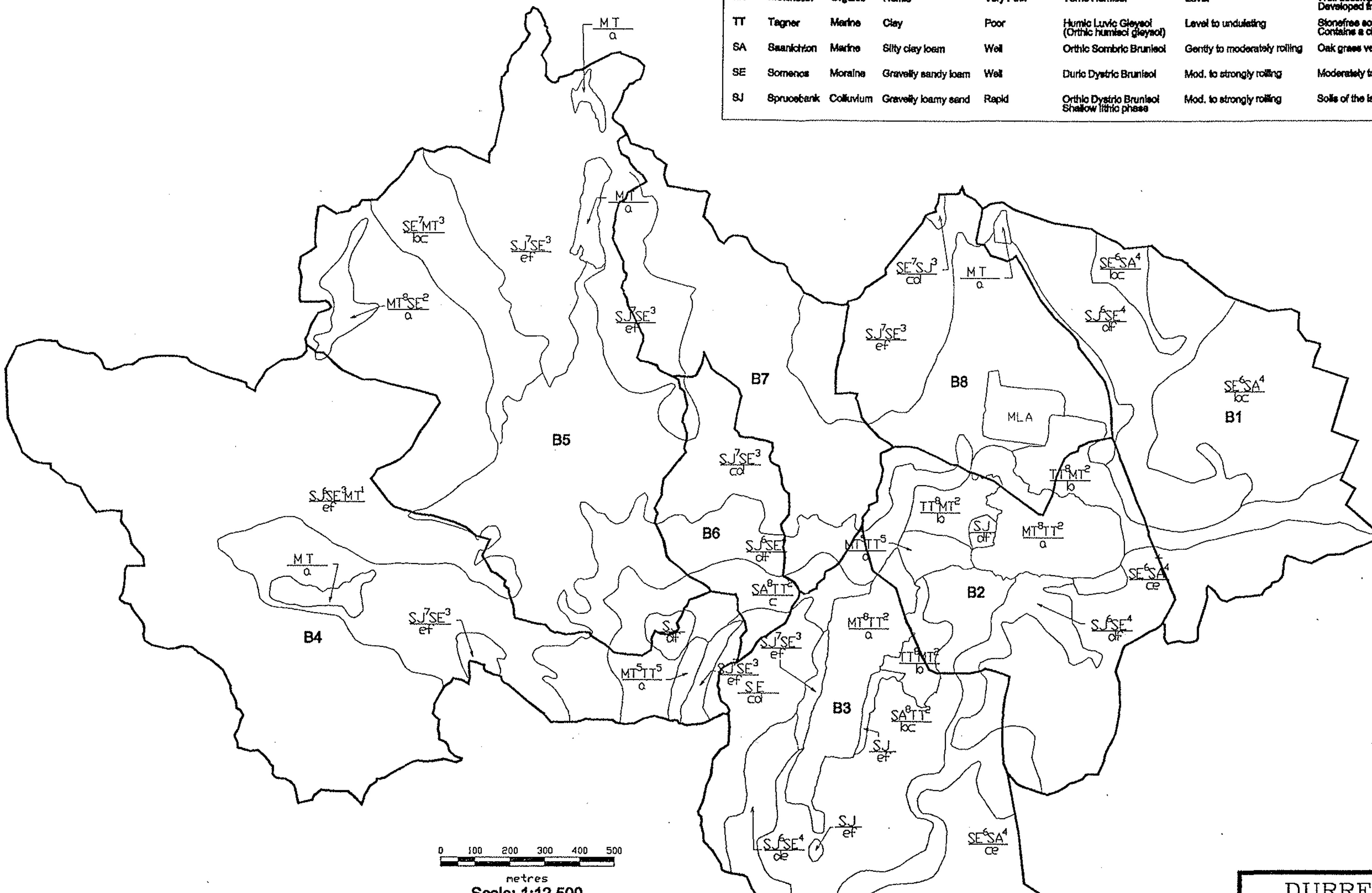
Figure 8

Variation of Dicharge in the Colquitz River
Over the Period Record

Colq.xls

Figure 9

Symbol	Name	Material	Most Common Texture	Most Common Drainage	Most Common Soil	Topography	Comments
MT	Metchosin	Organic	Humic	Very Poor	Terric Humisol	Level	Well decomposed organic material 40-160 cm depth Developed from mosses, sedges and other hydrophytic vegetation
TT	Tagner	Marine	Clay	Poor	Humic Luvic Gleysol (Orthic humisol gleysol)	Level to undulating	Stonefree soils on level topography Contains a clay accumulation horizon 30 - 50 cm thick (Bt)
SA	Saanichton	Marine	Silty clay loam	Well	Orthic Sombric Brunisol	Gently to moderately rolling	Oak grass vegetation community
SE	Somenos	Moraine	Gravelly sandy loam	Well	Duric Dystric Brunisol	Mod. to strongly rolling	Moderately to strongly cemented pans
SJ	Sprucebank	Colluvium	Gravelly loamy sand	Rapid	Orthic Dystric Brunisol Shallow lithic phase	Mod. to strongly rolling	Soils of the island intrusions



Scale: 1:12,500

Notes

Soils classification and mapping provided by Pottinger-Gaherty Environmental Consultants Ltd.

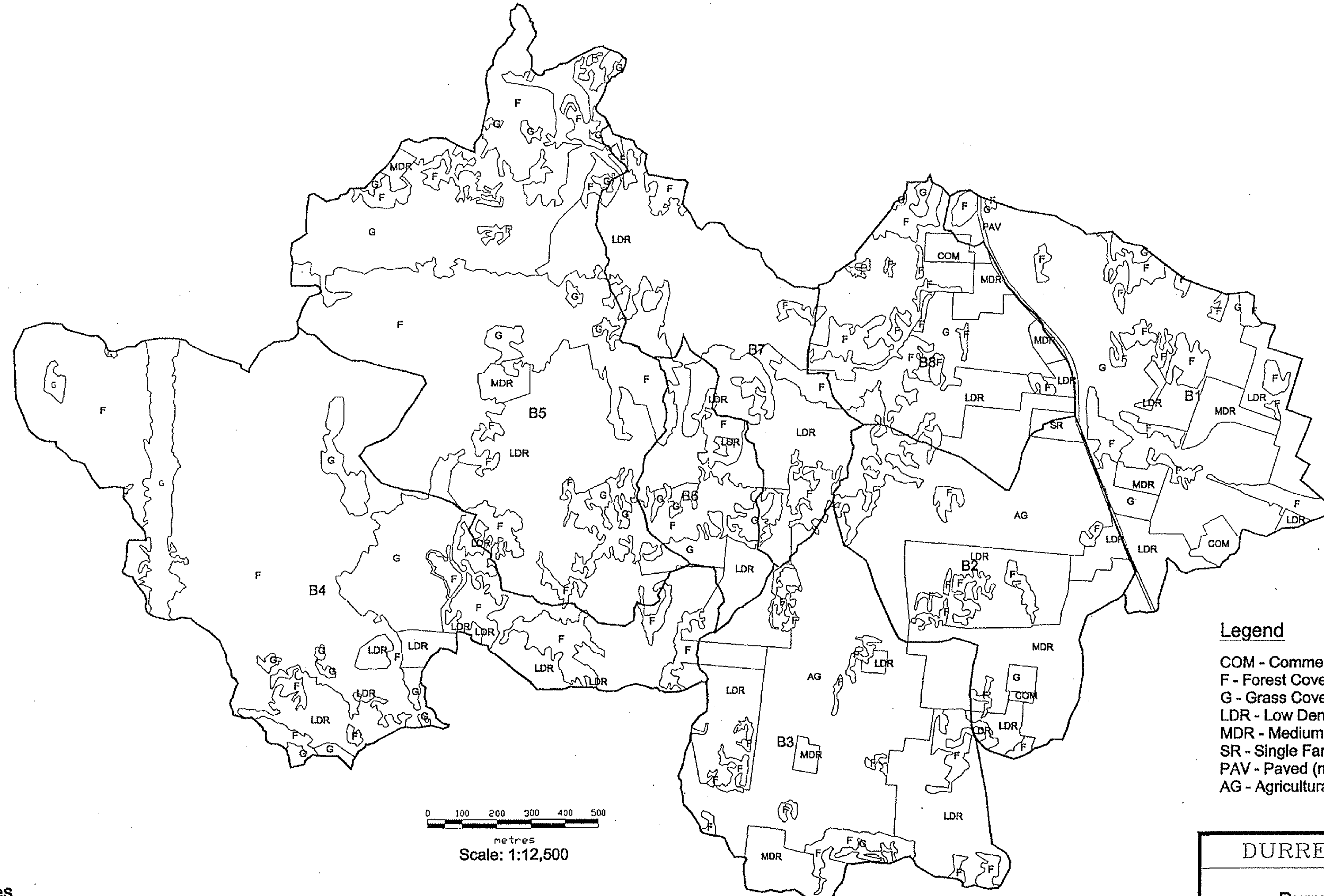
NHCV2792-sol

DURRELL CREEK IWMP

Durrell Creek Watershed
Soils Classification
(by Pottinger-Gaherty Ltd.)

northwest hydraulic consultants

Figure 10



Legend

COM - Commercial/ Industrial
F - Forest Cover/ No development
G - Grass Cover/ No development
LDR - Low Density Residential
MDR - Medium Density Residential
SR - Single Family, High Density Residential
PAV - Paved (major roadways)
AG - Agricultural

Notes

1. Land-use based on analysis of 1956 Airphotos (BC 2042 - Scale 1:30,000)
2. Forest and grass cover copied from district cadastral maps, then adjusted based on analysis of airphotos.

NHCV2792-007a

DURRELL CREEK IWMP

Durrell Creek Watershed

1950's Land-Use Map

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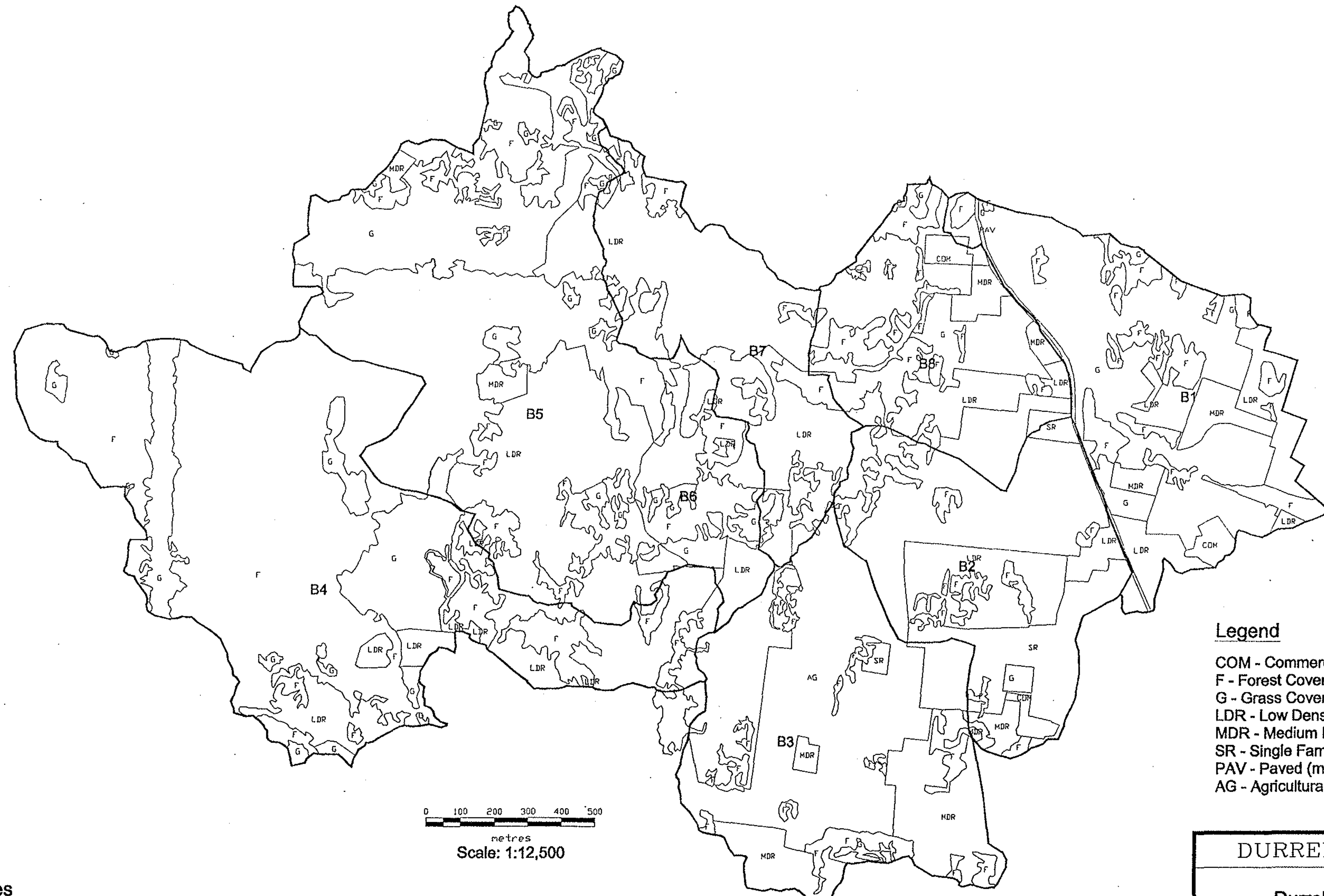
Figure 11a



Legend

COM - Commercial/ Industrial
F - Forest Cover/ No development
G - Grass Cover/ No development
LDR - Low Density Residential
MDR - Medium Density Residential
SR - Single Family, High Density Residential
PAV - Paved (major roadways)
AG - Agricultural

Notes

1. Land-use based on analysis of 1964 Airphotos (BC 5091 - Scale 1:15,840)
2. Forest and grass cover copied from district cadastral maps, then adjusted based on analysis of airphotos.

NHCV2792-007b

DURRELL CREEK IWMP

Durrell Creek Watershed

1960's Land-Use Map

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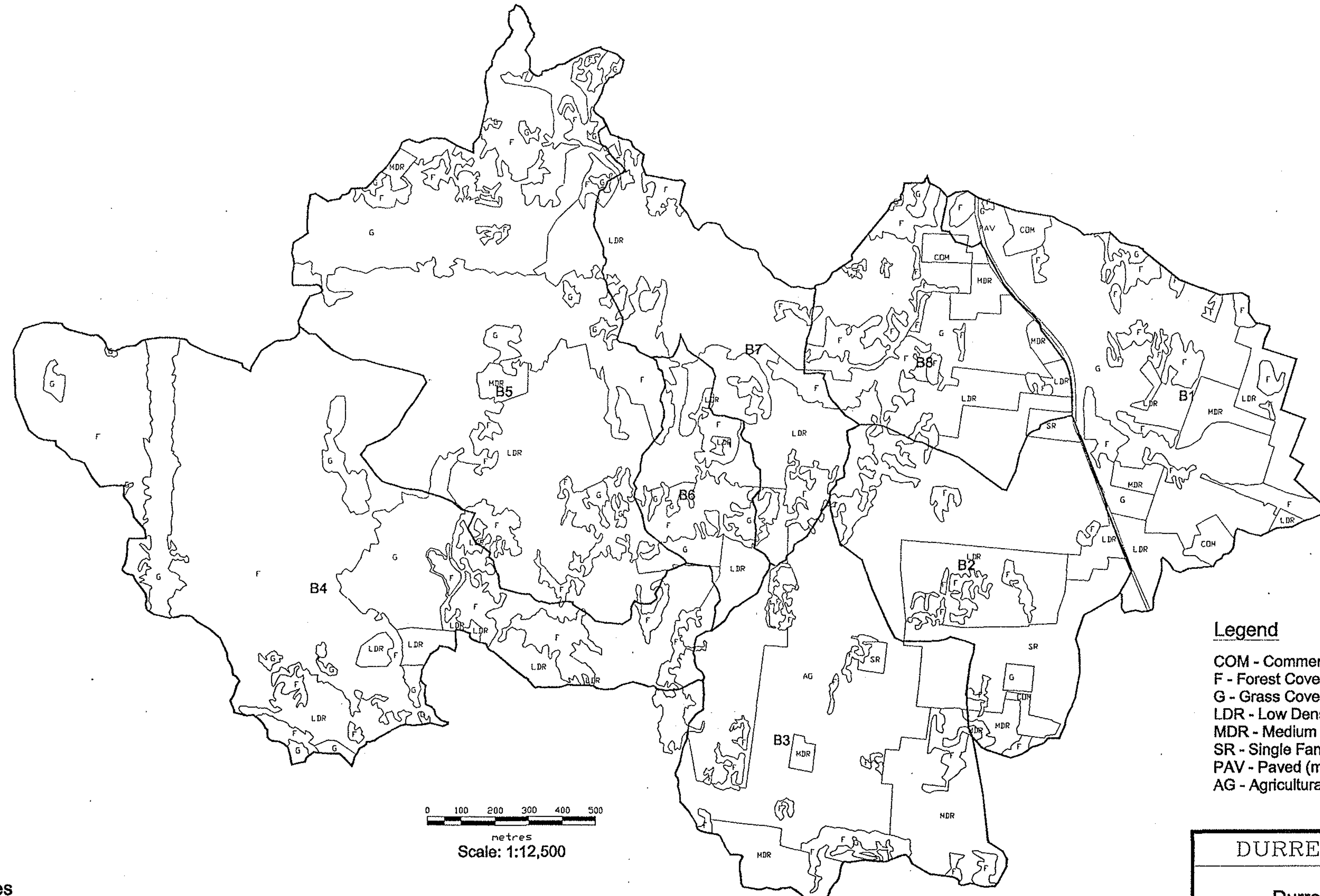
Figure 11b



Legend

COM - Commercial/ Industrial
F - Forest Cover/ No development
G - Grass Cover/ No development
LDR - Low Density Residential
MDR - Medium Density Residential
SR - Single Family, High Density Residential
PAV - Paved (major roadways)
AG - Agricultural

Notes

1. Land-use based on analysis of 1975 Airphotos (BC ? - Scale 1:30,000?)
2. Forest and grass cover copied from district cadastral maps, then adjusted based on analysis of airphotos.

NHCV2792-007c

DURRELL CREEK IWMP

Durrell Creek Watershed

1970's Land-Use Map

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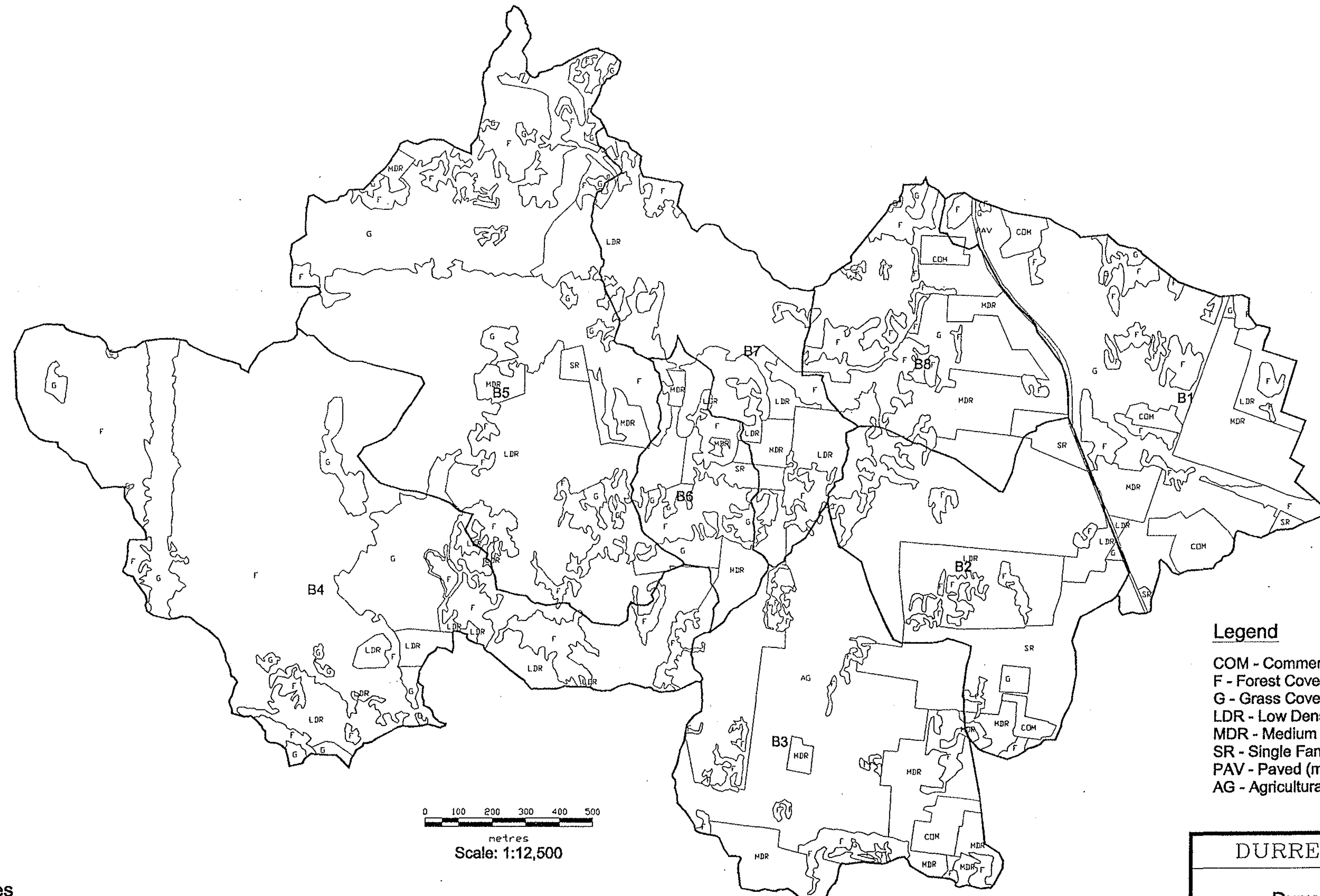
Figure 11c



Legend

COM - Commercial/ Industrial
F - Forest Cover/ No development
G - Grass Cover/ No development
LDR - Low Density Residential
MDR - Medium Density Residential
SR - Single Family, High Density Residential
PAV - Paved (major roadways)
AG - Agricultural

Notes

1. Land-use based on analysis of 1988 Airphotos (PIM 88-001 - Scale 1:15,840)
2. Forest and grass cover copied from district cadastral maps, then adjusted based on analysis of airphotos.

NHCV2792-007d

DURRELL CREEK IWMP

Durrell Creek Watershed

1980's Land-Use Map

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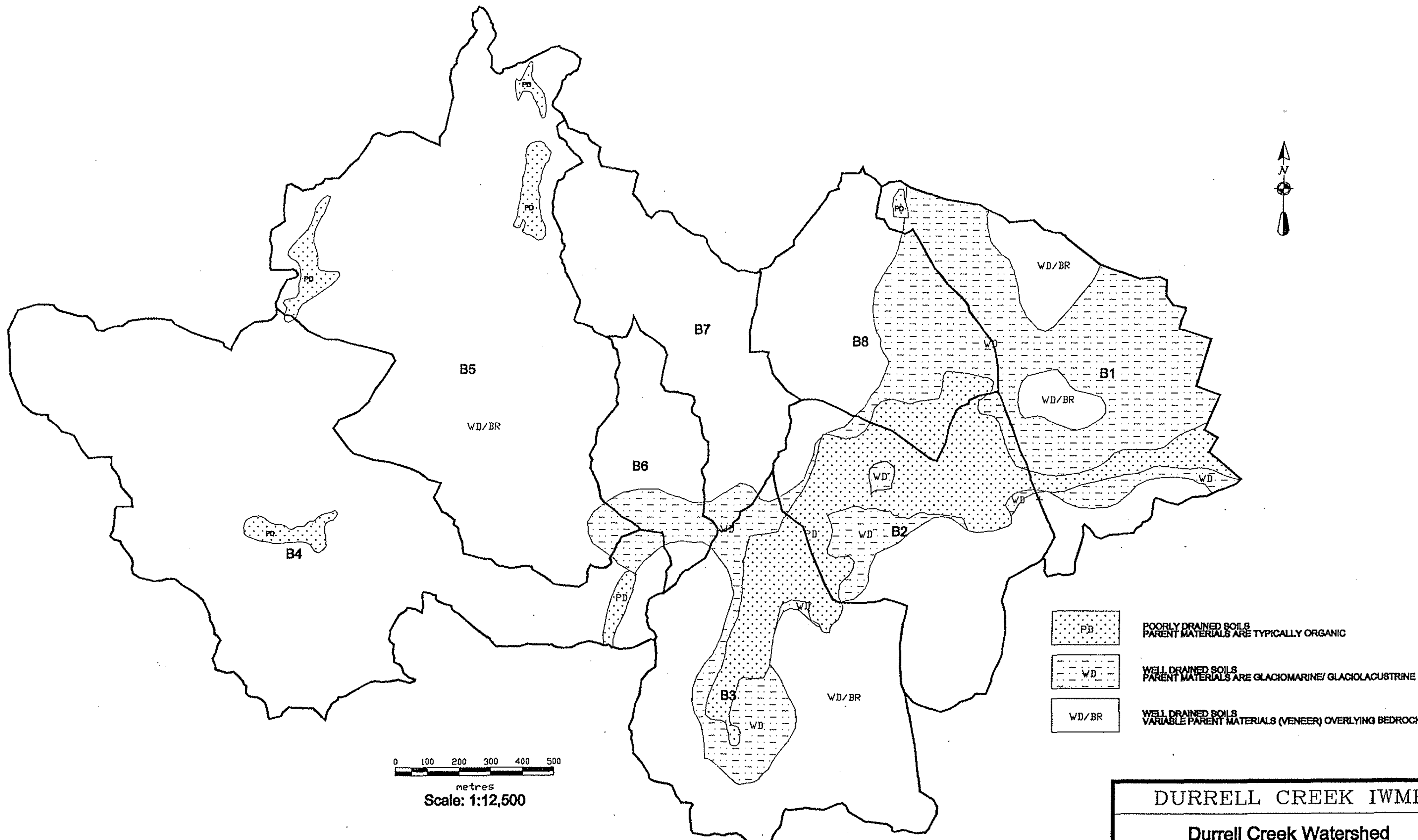
Figure 11d



NHCV2792-008

DURRELL CREEK IWMP

Durrell Creek Watershed
Classification of Pervious Land Segments (HSPF PERLNDs)

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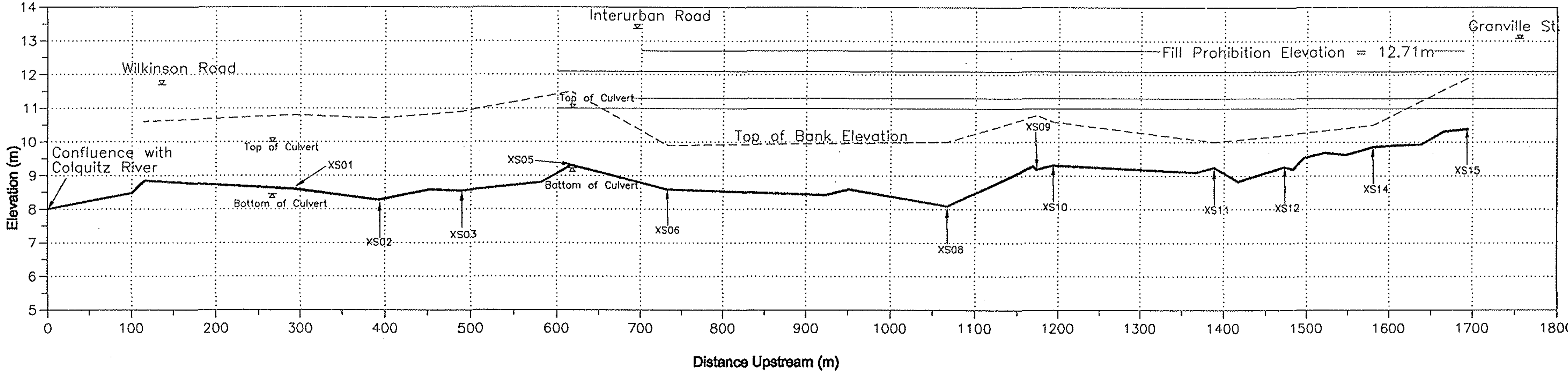
Figure 12



Notes:
1) Profile is based on survey completed April 30/99.
2) Vertical exaggeration in the drawing is 40H:1V.
3) Elevations are referenced to a local UTM benchmark.

Durrell Creek Profile surveyed by nhc
Top of Bank Elevation (m)
Fill Prohibition Elevation (above and below Interurban Rd)
Estimated 10–Year Water Surface
Estimated 25–Year Water Surface
Estimated 200–Year Water Surface

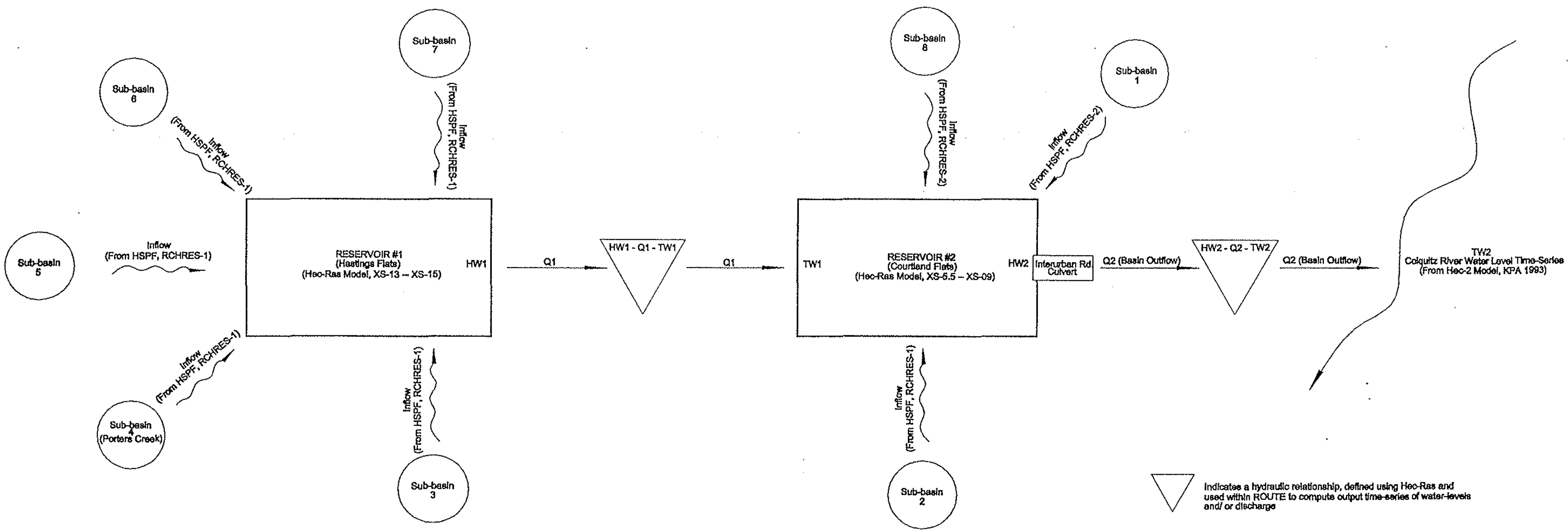
NHCV2792-009

DURRELL CREEK IWMP

Durrell Creek
Longitudinal Profile of the Channel
Wilkinson Road - Granville St.

northwest hydraulic consultants

Figure 13



Notes

1. Hydraulic relationships are reversed within ROUTE when flow reversals are encountered

DURRELL CREEK IWMP

Durrell Creek Watershed Model

Hydraulic Routing Schematic

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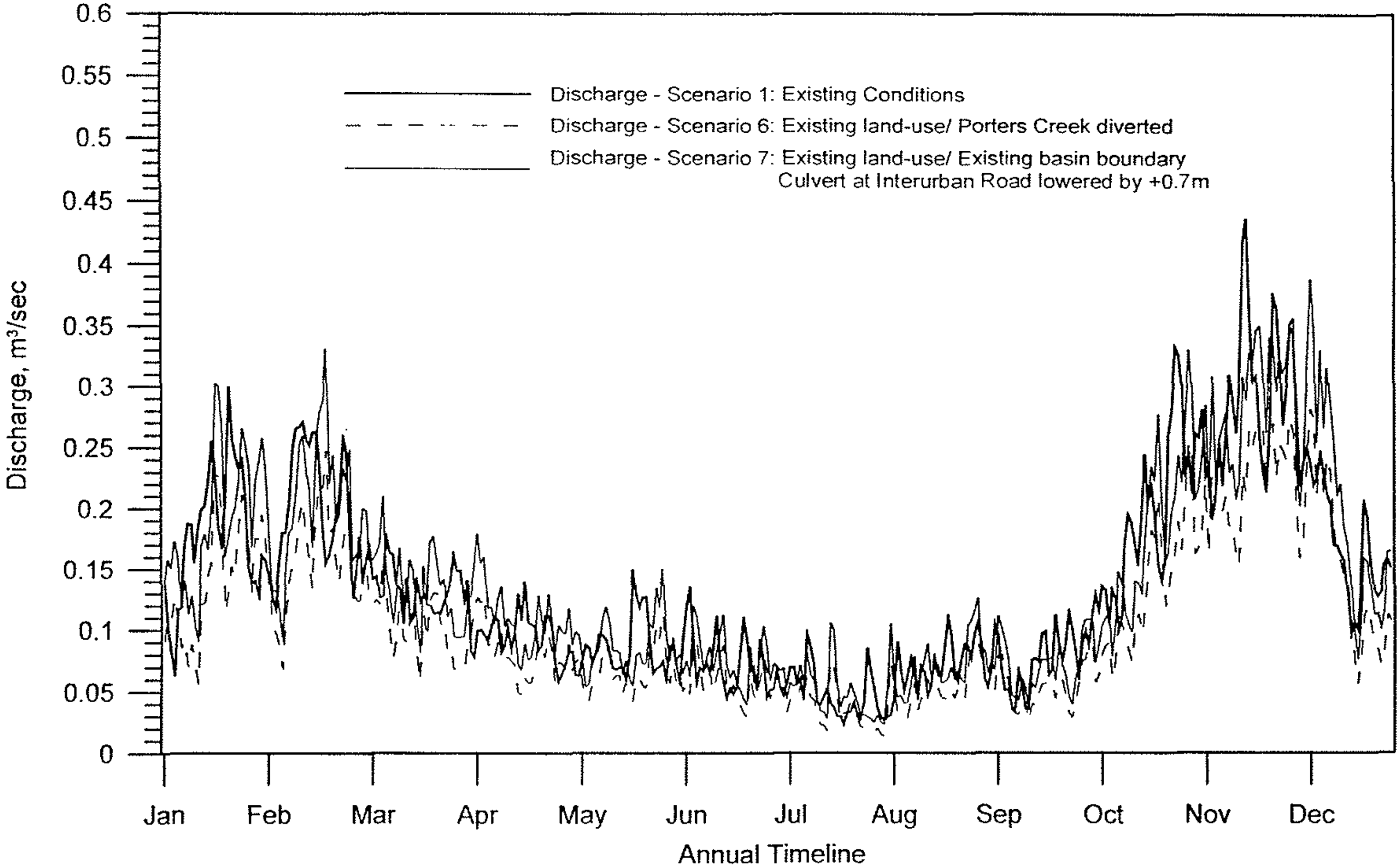
NHCV2792-010

Figure 14

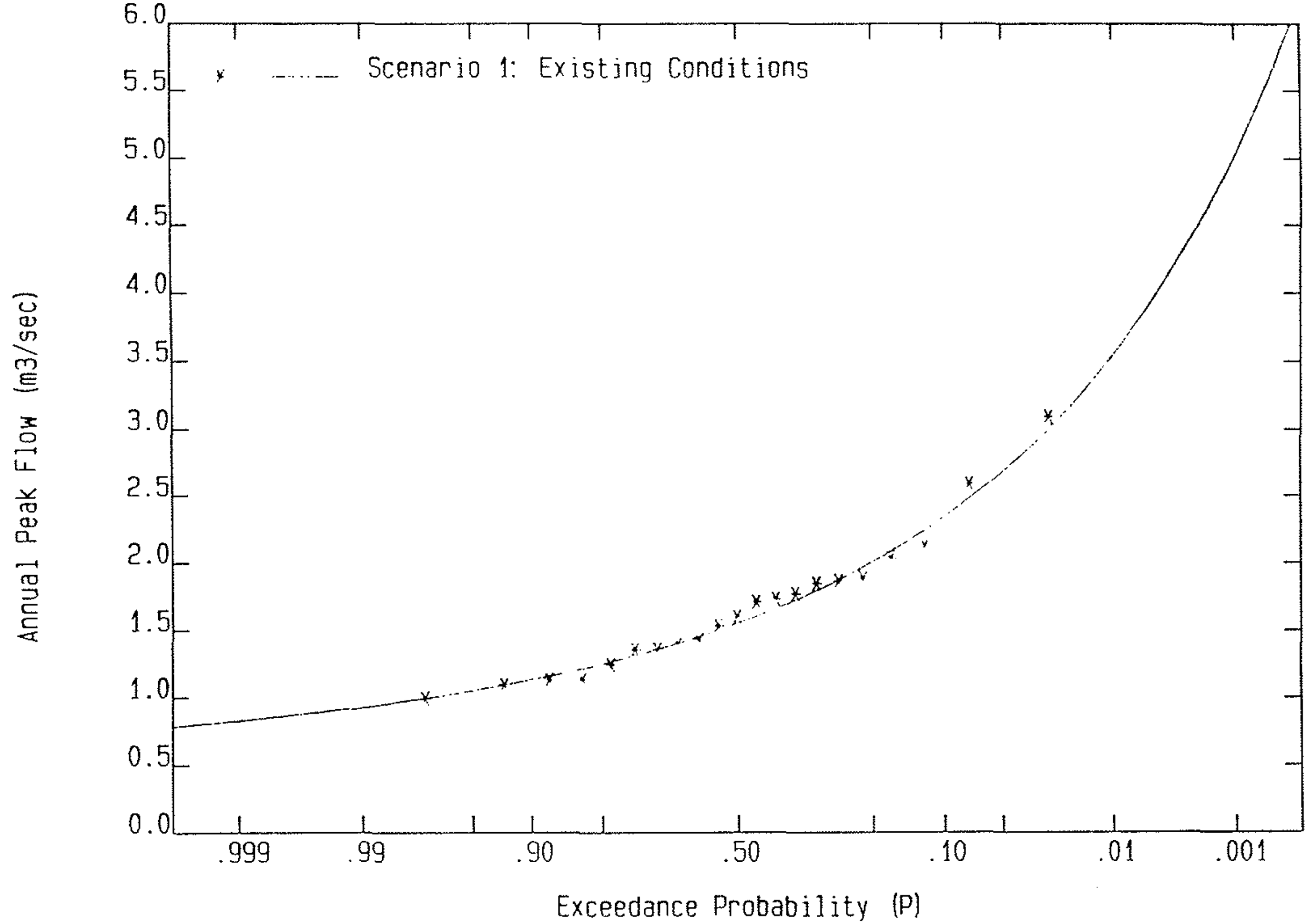
Average Annual Flow Hydrograph - Durrell Creek
Period of Record: 01-01-1976 through 12-31-1997



NOTES

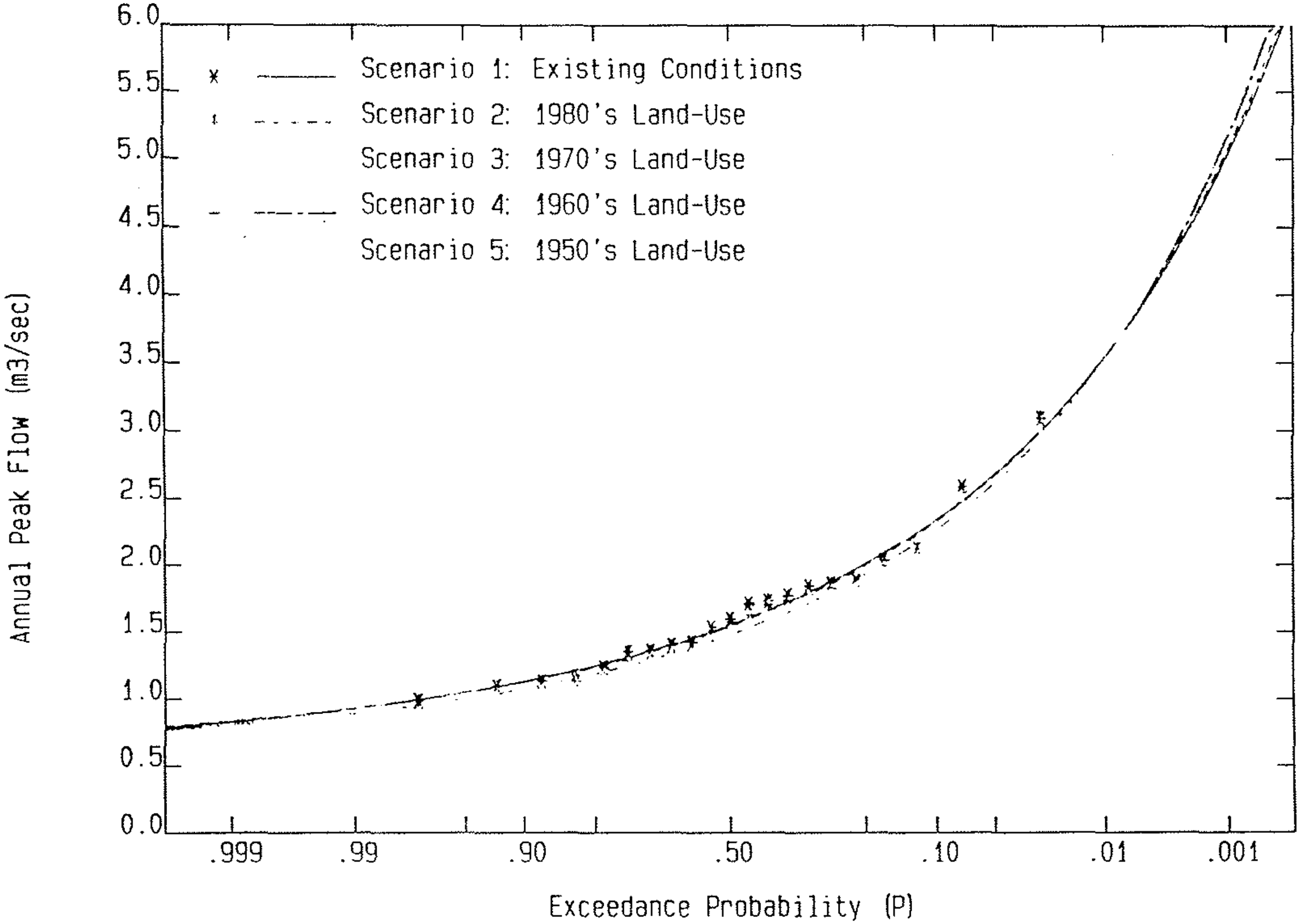
1. Discharges are computed daily averages from the Durrell Creek Watershed Model (HSPF-ROUTE).

Figure 15



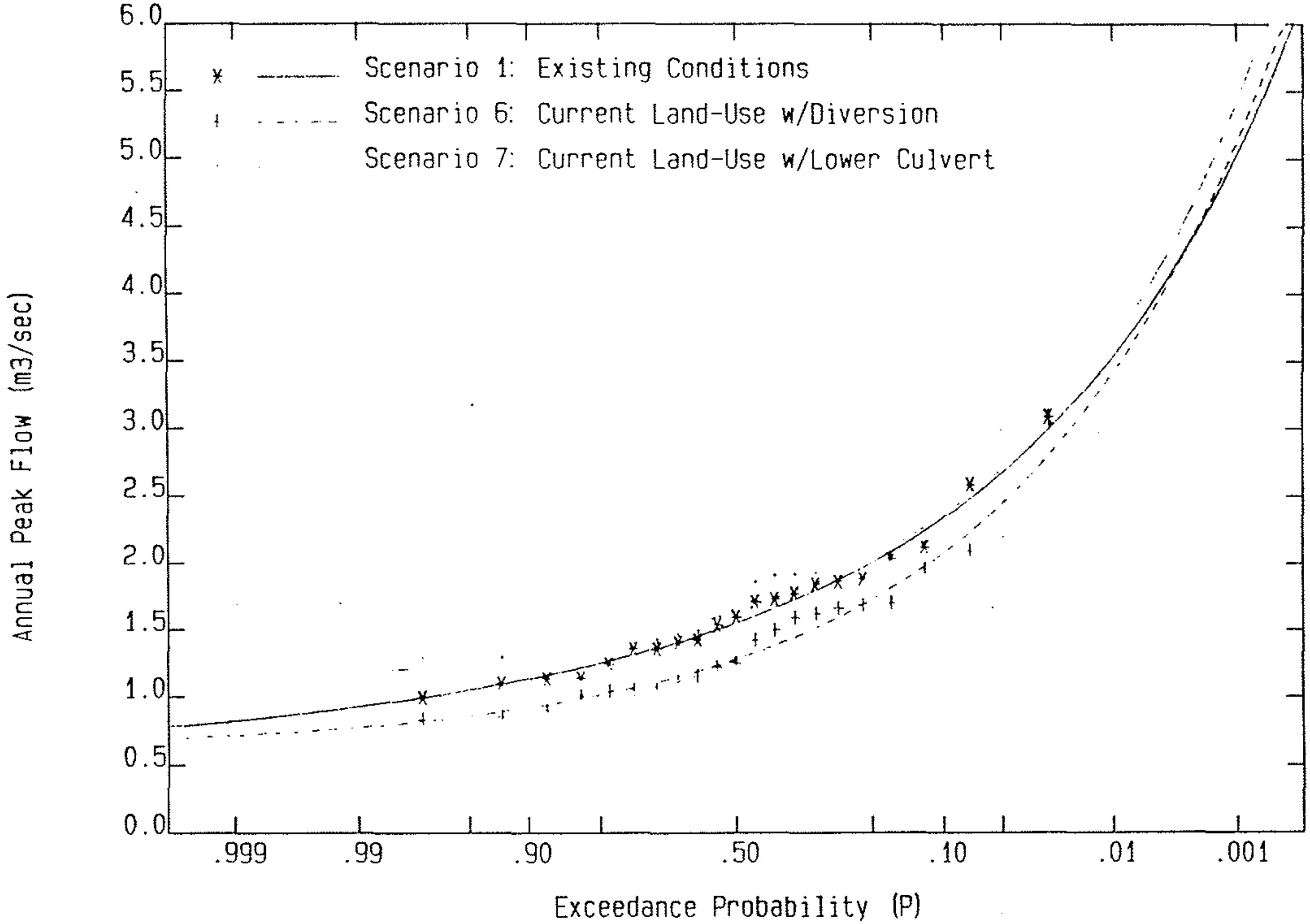
Flow Frequency Curve - Durrell Creek (1976 - 1997)

Figure 16



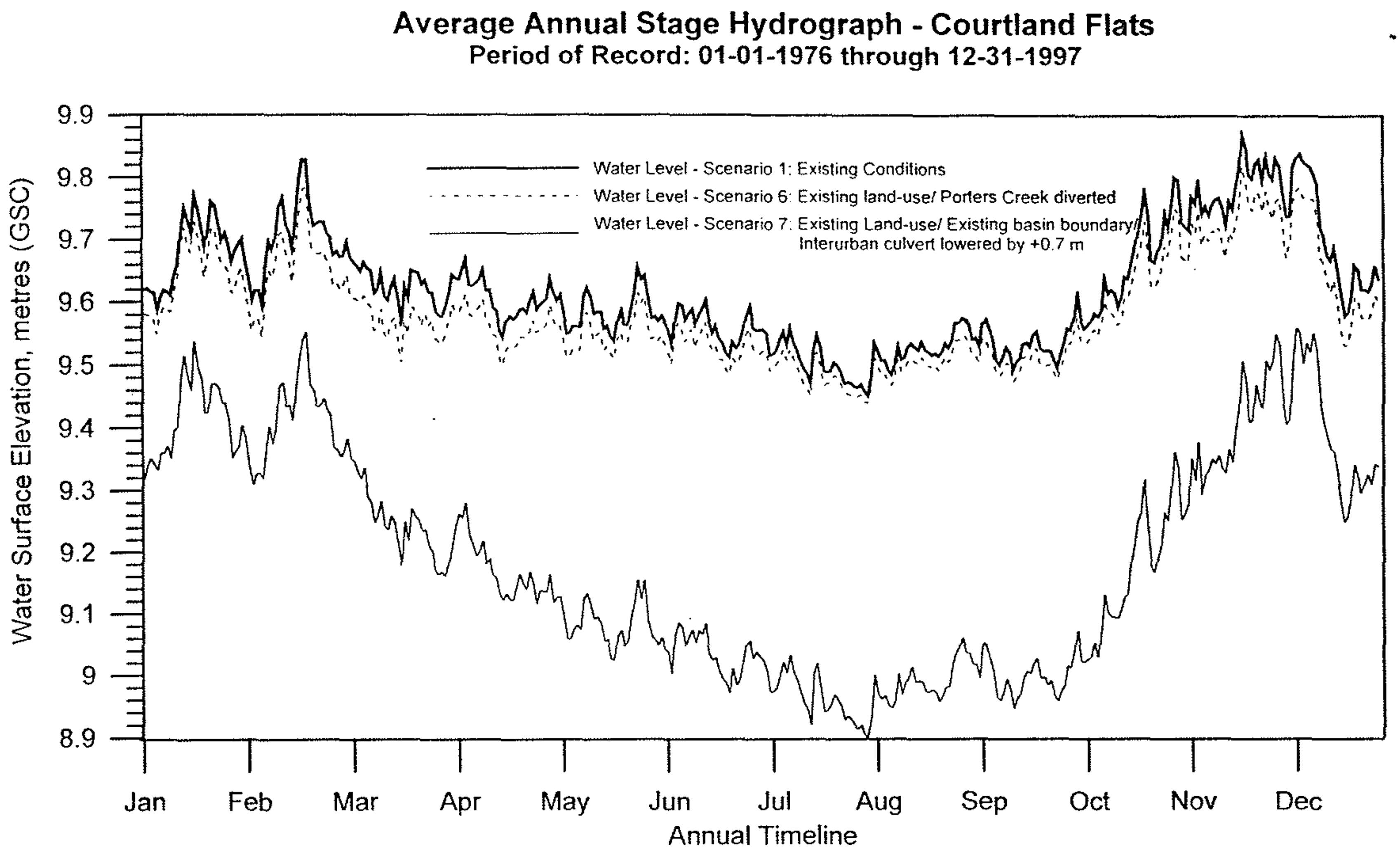
Flow Frequency Curves - Durrell Creek (1976 - 1997)
Effect of Land-Use Changes

Figure 17



Flow Frequency Curves - Durrell Creek (1976 - 1997)
Effects of Diversion of Porters Creek/ Lowering the Culvert at Interurban Road

Figure 18

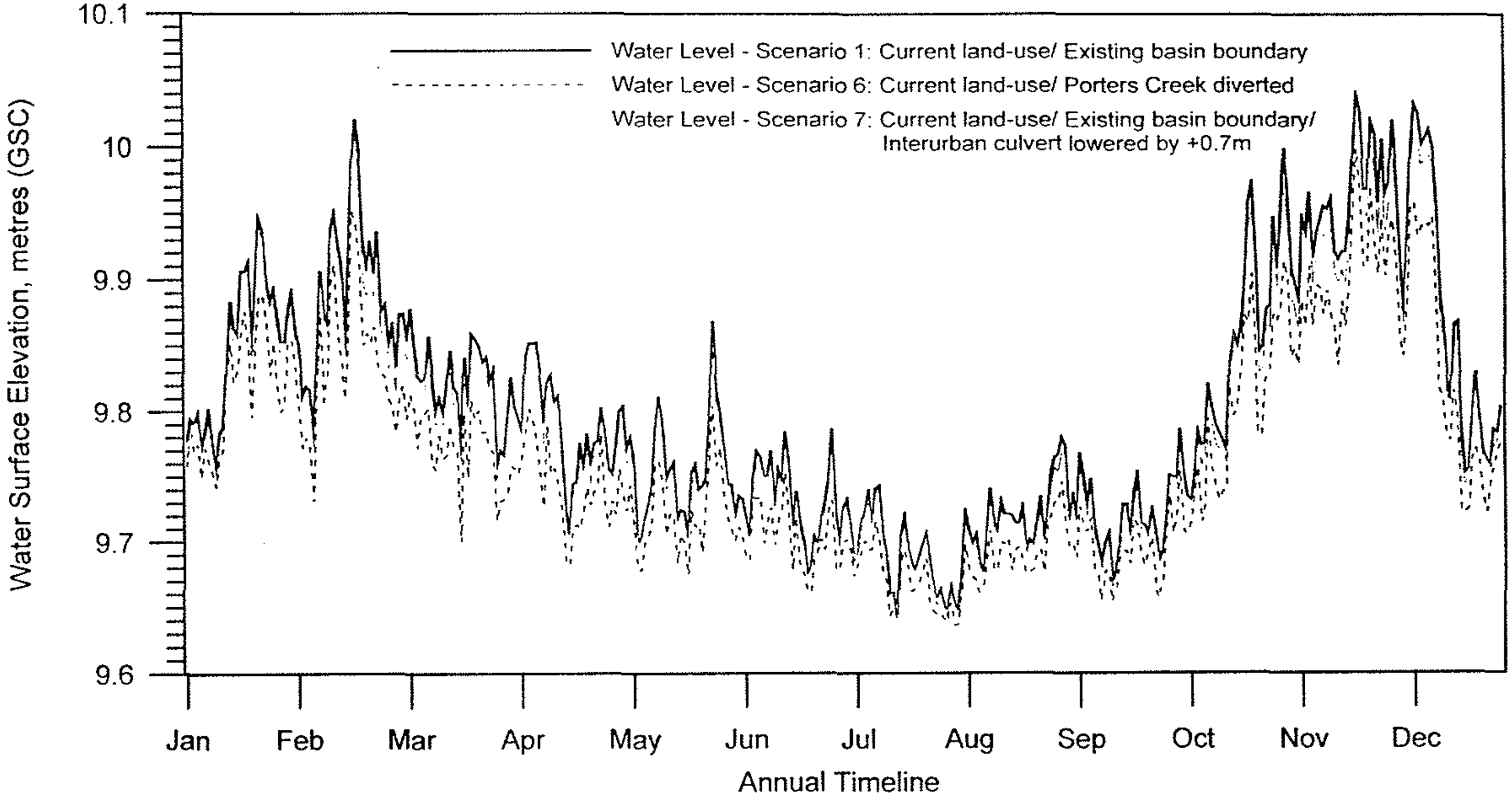


NOTES

1. Water levels are computed daily averages from the Durrell Creek Watershed Model (HSPF-ROUTE).
2. Water levels are considered to be constant along the entire length of channel adjacent to Courtland Flats.

Figure 19

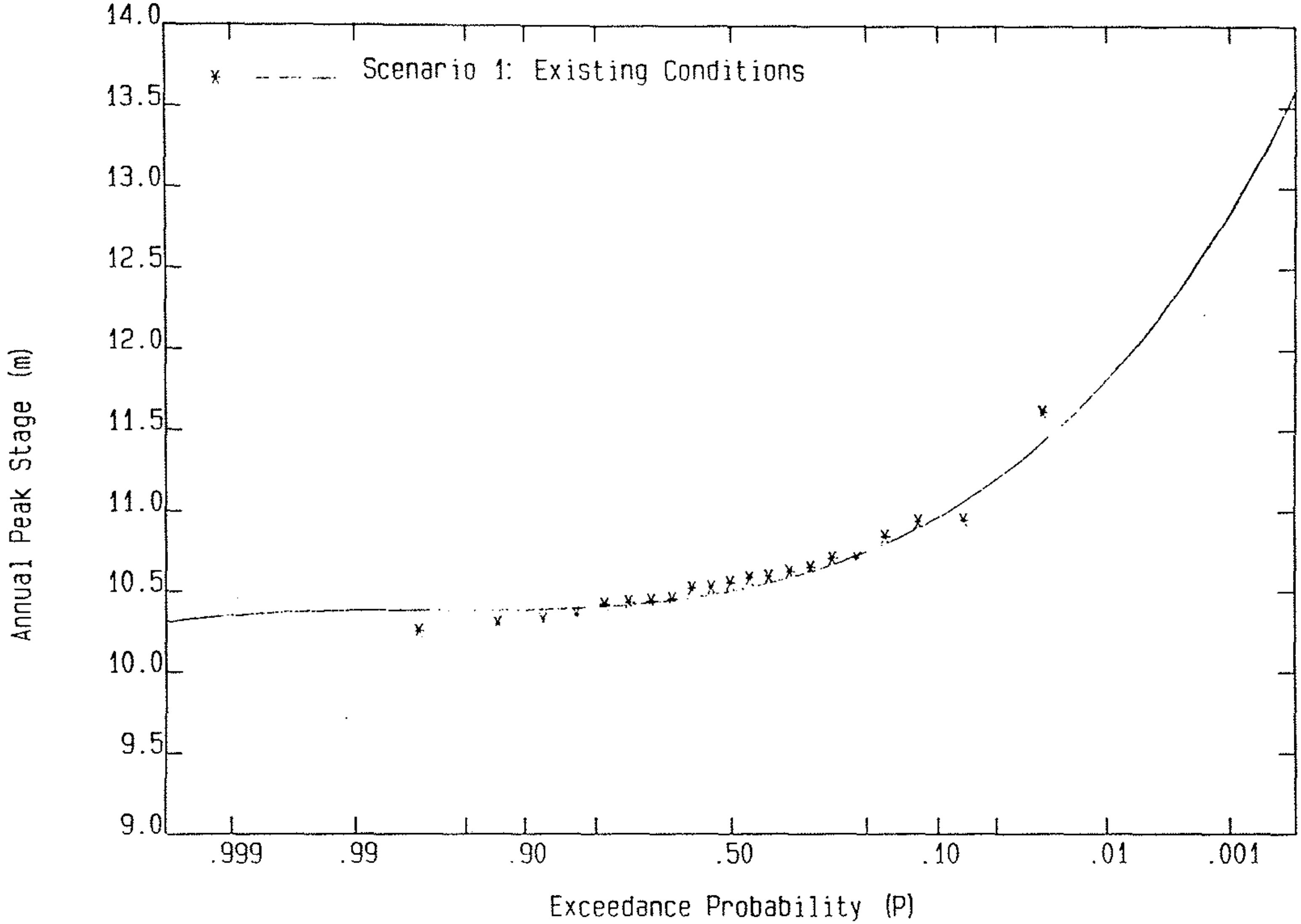
Average Annual Stage Hydrograph at Hastings Flats
Period of Record: 01-01-1976 through 12-31-1997



NOTES

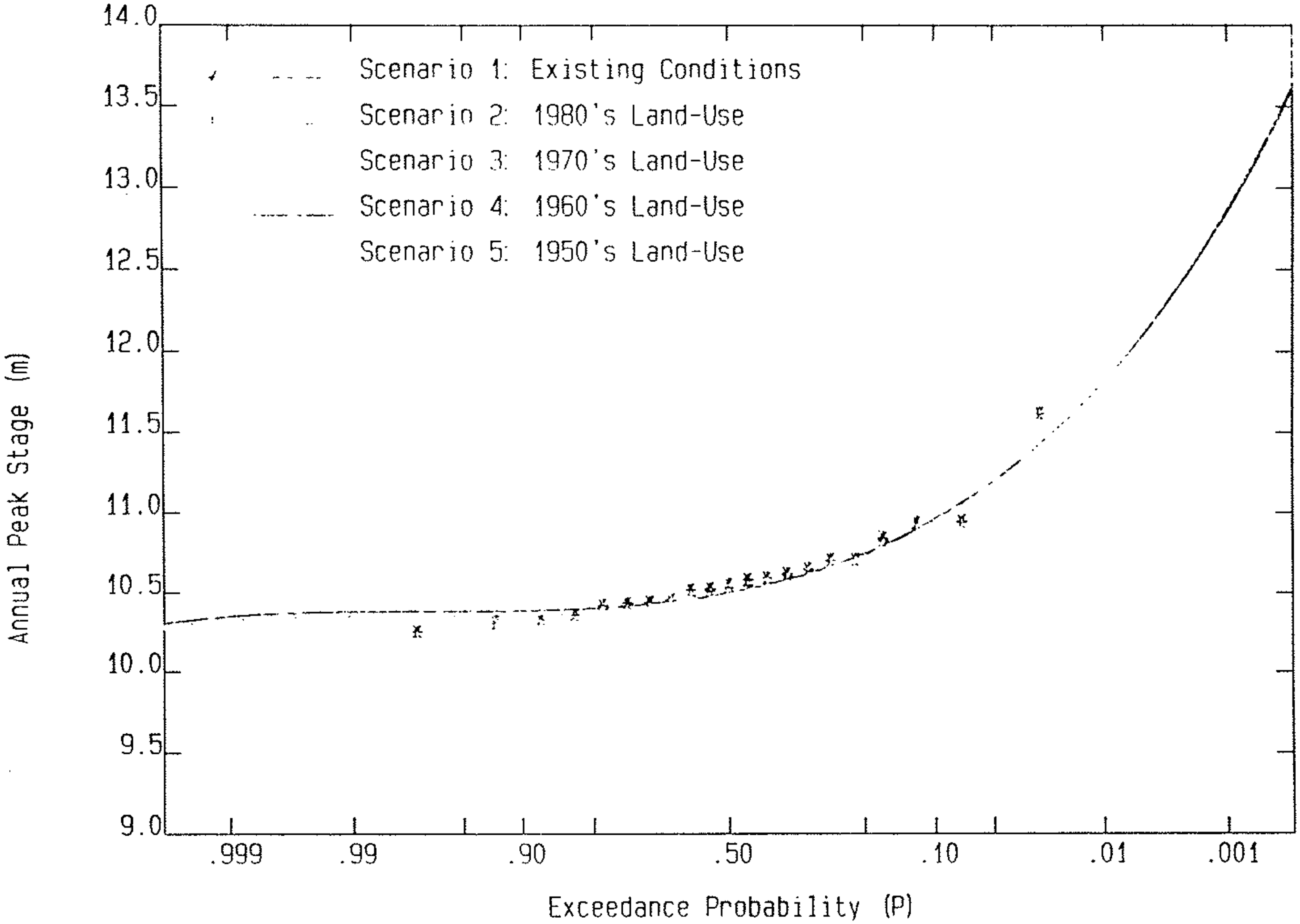
1. Water levels are computed daily averages from the Durrell Creek Watershed Model (HSPF-ROUTE).
2. Water levels are not constant along the channel adjacent to Hastings Flats. The water levels shown above are relative to cross-section 13.5.

Figure 20



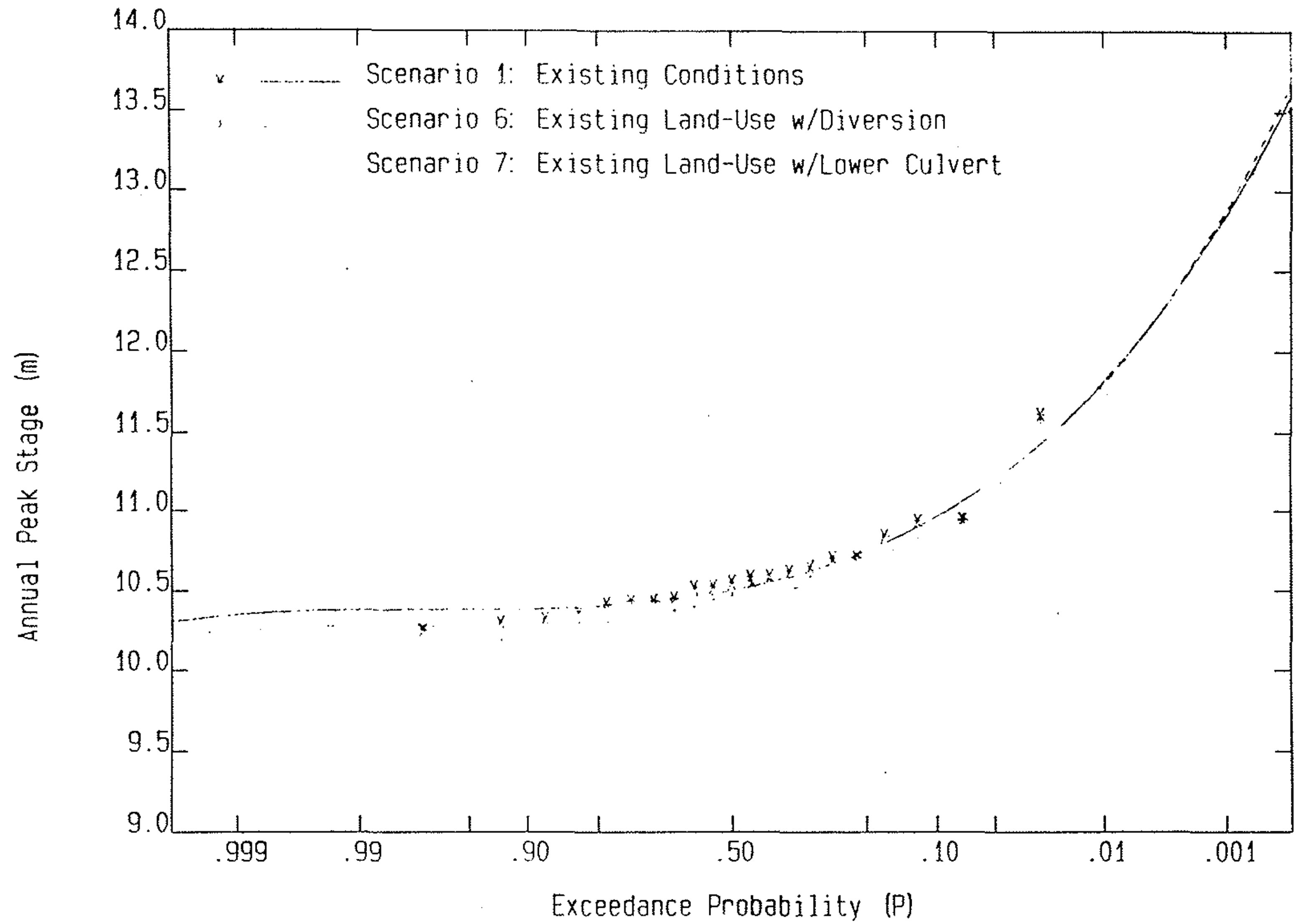
Stage Frequency Curve - Durrell Creek (1976 - 1997)

Figure 21



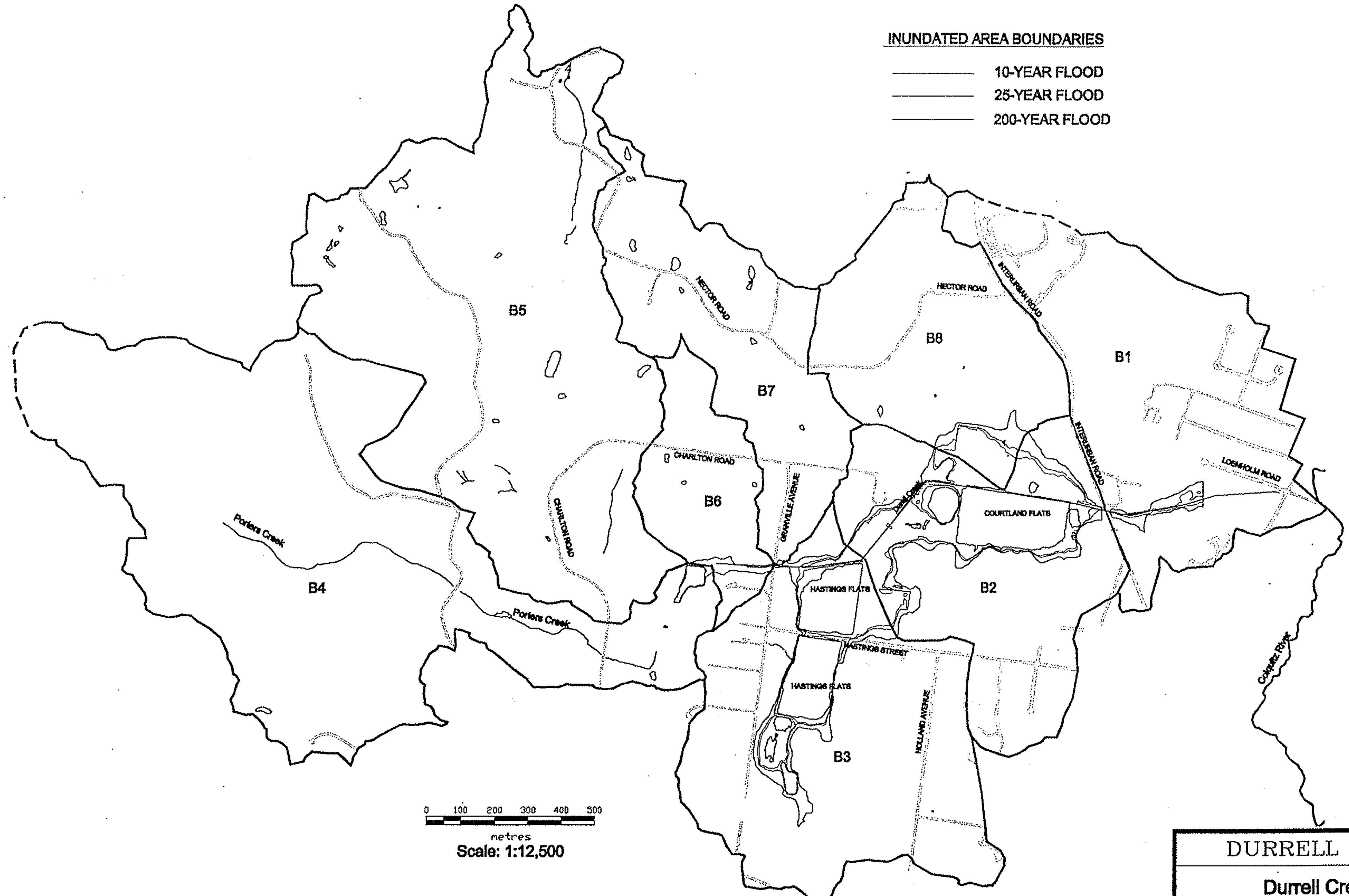
Stage Frequency Curves - Durrell Creek (1976 - 1997)
Effect of Land-Use Changes

Figure 22



Stage Frequency Curves - Durrell Creek (1976 - 1997)
Effects of Diversion of Porters Creek/ Lowering the Culvert at Interurban Road

Figure 23



DURRELL CREEK IWMP

Durrell Creek Watershed
Map of Inundated Area - Existing Conditions
10-Year,25-Year and 200-Year Flood Events

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NHCV2792-fld

Figure 24

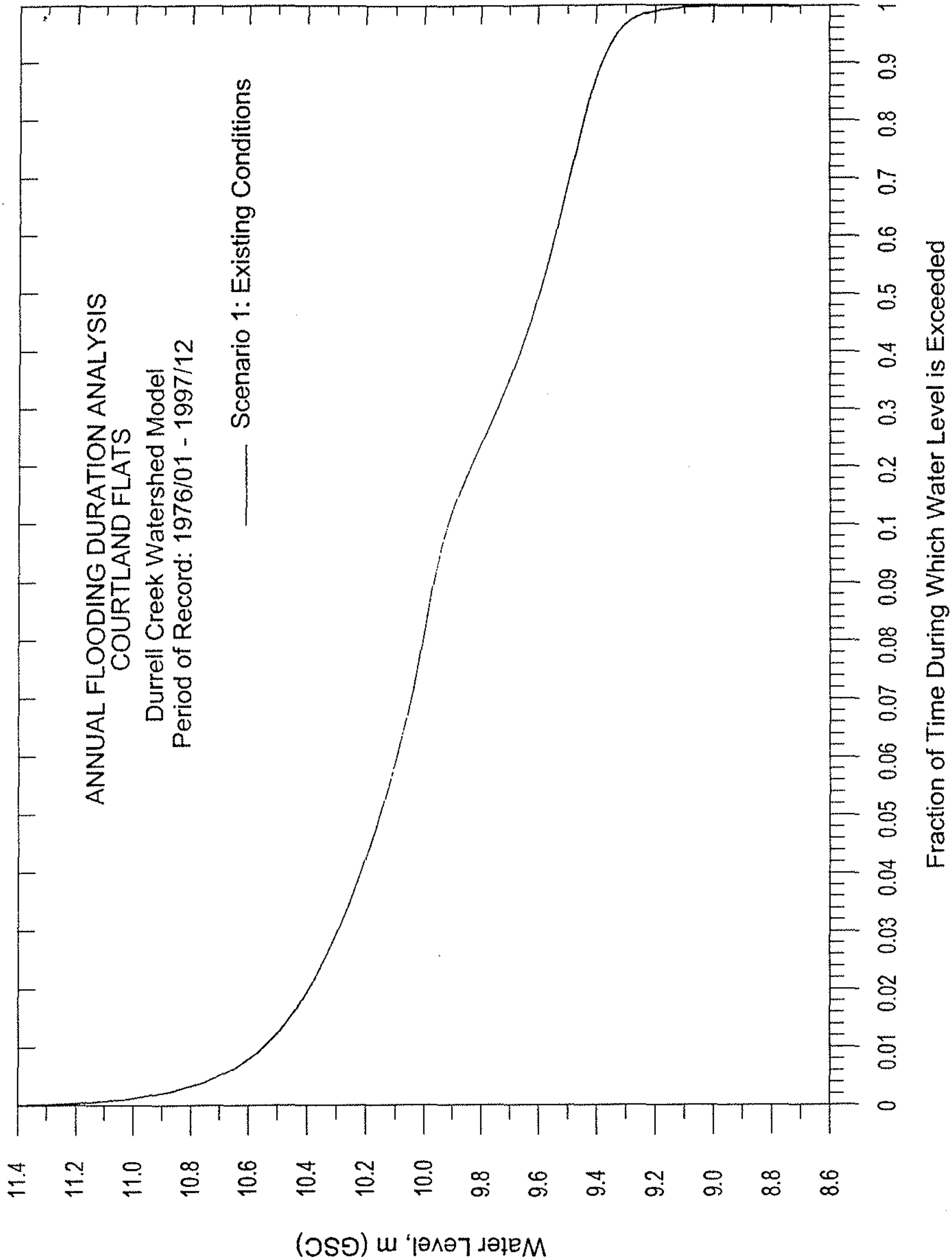

ANNUAL FLOODING DURATION ANALYSIS
COURTLAND FLATS
Durrell Creek Watershed Model
Period of Record: 1976/01 - 1997/12
Scenario 1: Existing Conditions
Water Level, m (GSC)
11.4
11.2
11.0
10.8
10.6
10.4
10.2
10.0
9.8
9.6
9.4
9.2
9.0
8.8
8.6
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Fraction of Time During Which Water Level is Exceeded

Figure 25

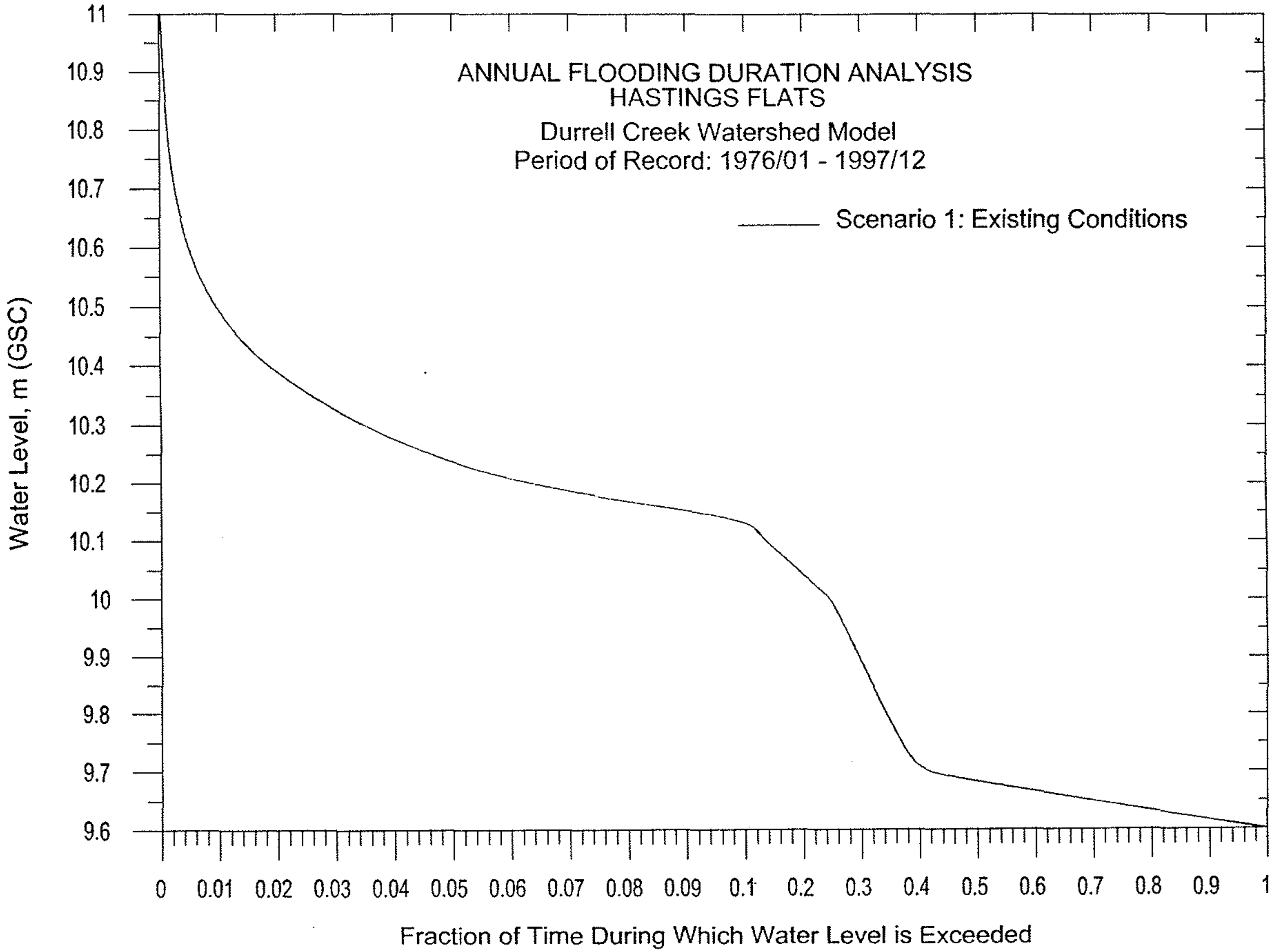

ANNUAL FLOODING DURATION ANALYSIS
HASTINGS FLATS
Durrell Creek Watershed Model
Period of Record: 1976/01 - 1997/12
Scenario 1: Existing Conditions
Water Level, m (GSC)
11
10.9
10.8
10.7
10.6
10.5
10.4
10.3
10.2
10.1
10
9.9
9.8
9.7
9.6
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Fraction of Time During Which Water Level is Exceeded

Figure 26

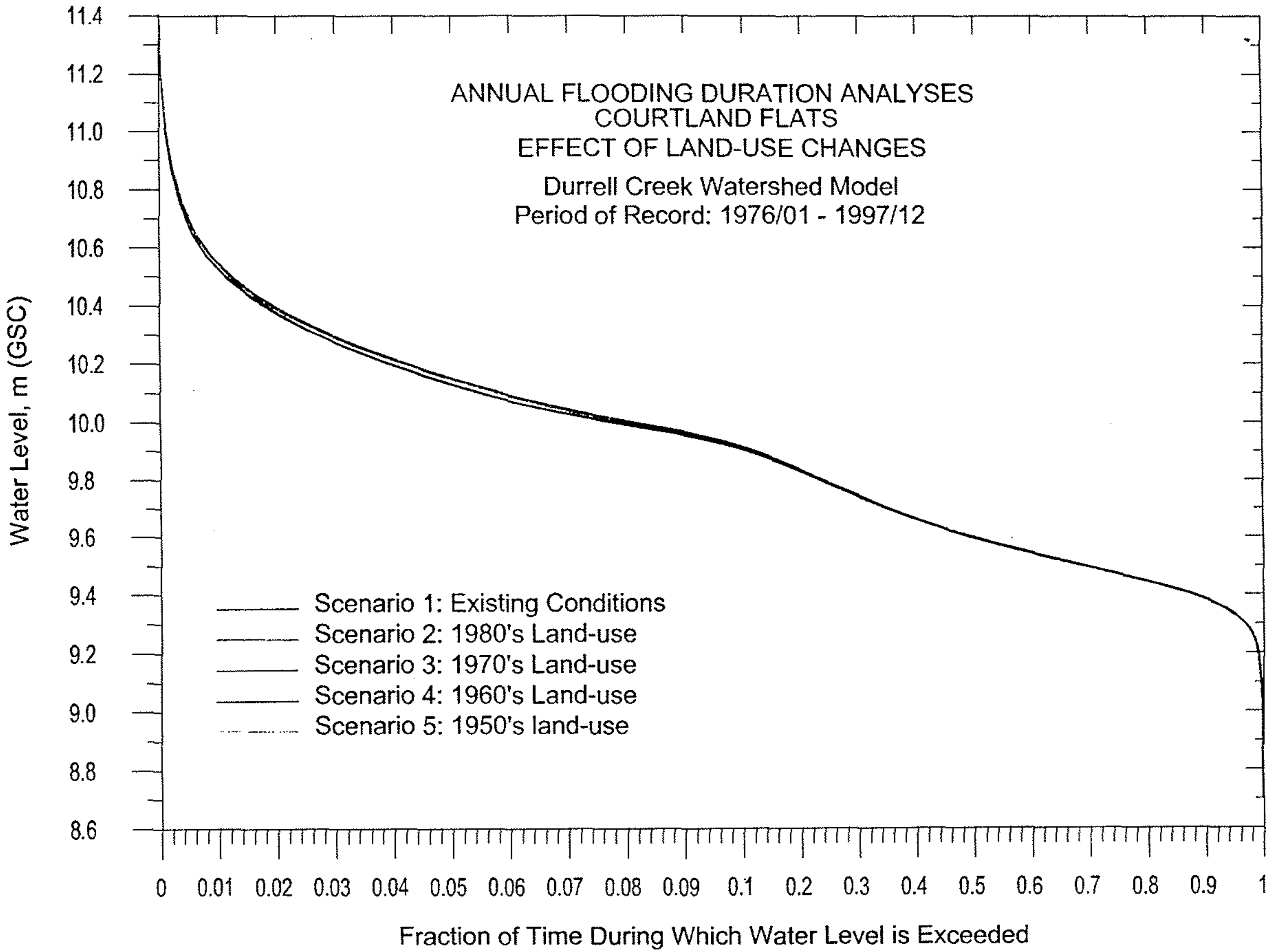

ANNUAL FLOODING DURATION ANALYSES
COURTLAND FLATS
EFFECT OF LAND-USE CHANGES
Durrell Creek Watershed Model
Period of Record: 1976/01 - 1997/12
Scenario 1: Existing Conditions
Scenario 2: 1980's Land-use
Scenario 3: 1970's Land-use
Scenario 4: 1960's Land-use
Scenario 5: 1950's land-use
Water Level, m (GSC)
11.4
11.2
11.0
10.8
10.6
10.4
10.2
10.0
9.8
9.6
9.4
9.2
9.0
8.8
8.6
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Fraction of Time During Which Water Level is Exceeded

Figure 27

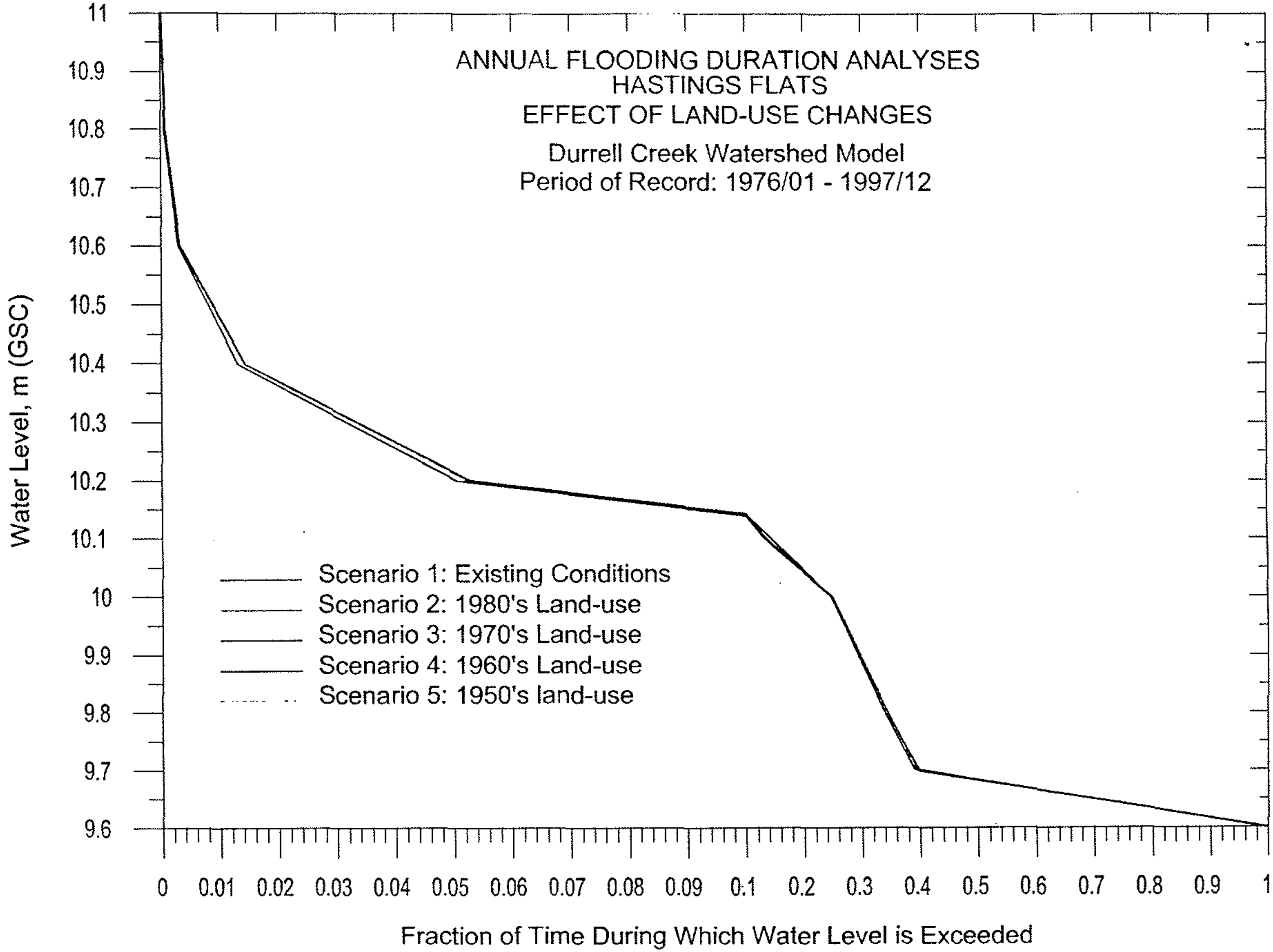
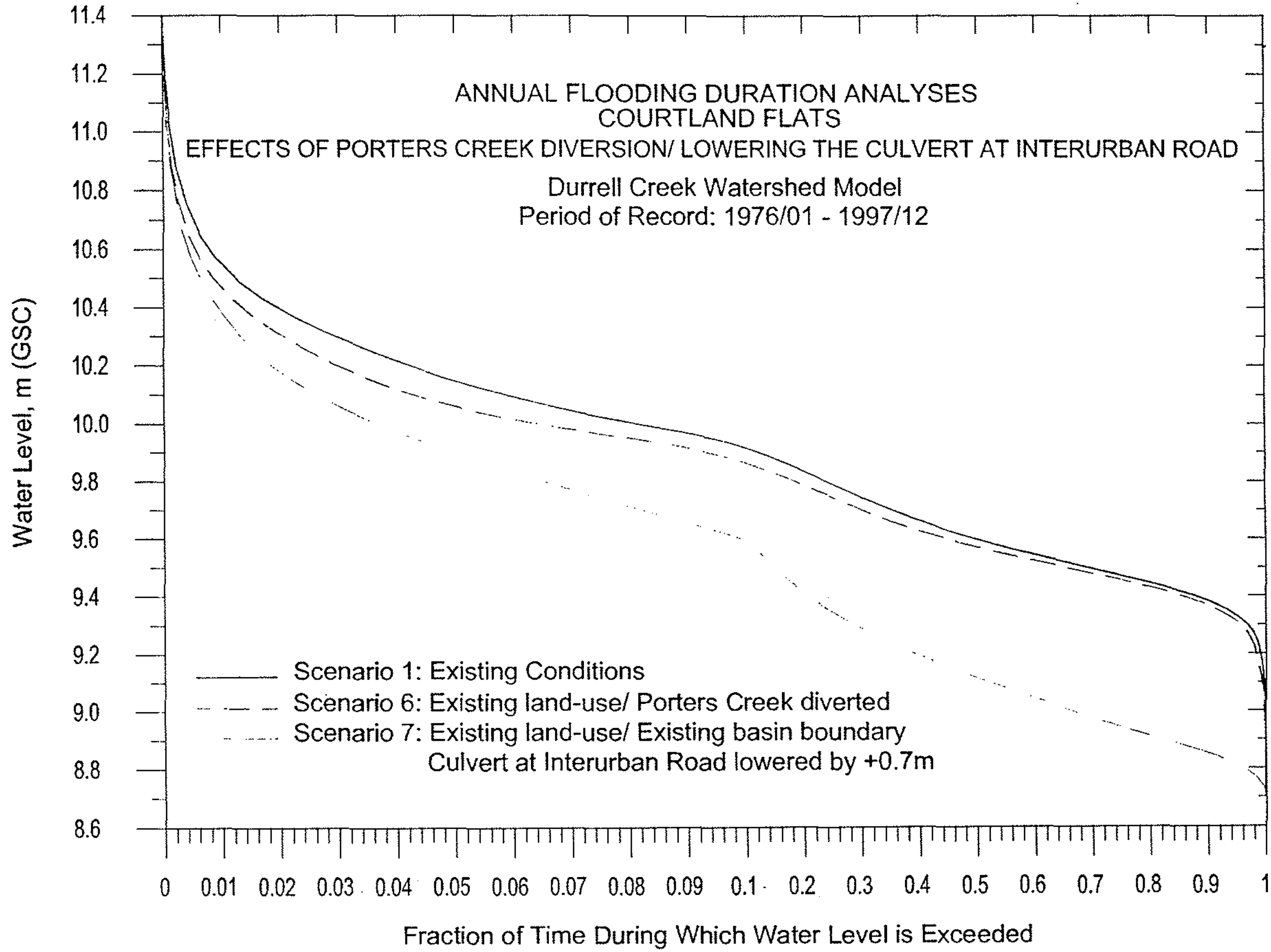

ANNUAL FLOODING DURATION ANALYSES
HASTINGS FLATS
EFFECT OF LAND-USE CHANGES
Durrell Creek Watershed Model
Period of Record: 1976/01 - 1997/12
Scenario 1: Existing Conditions
Scenario 2: 1980's Land-use
Scenario 3: 1970's Land-use
Scenario 4: 1960's Land-use
Scenario 5: 1950's land-use
Water Level, m (GSC)
11
10.9
10.8
10.7
10.6
10.5
10.4
10.3
10.2
10.1
10
9.9
9.8
9.7
9.6
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Fraction of Time During Which Water Level is Exceeded

Figure 28



ANNUAL FLOODING DURATION ANALYSES
COURTLAND FLATS
EFFECTS OF PORTERS CREEK DIVERSION/ LOWERING THE CULVERT AT INTERURBAN ROAD
Durrell Creek Watershed Model
Period of Record: 1976/01 - 1997/12
Scenario 1: Existing Conditions
Scenario 6: Existing land-use/ Porters Creek diverted
Scenario 7: Existing land-use/ Existing basin boundary
Culvert at Interurban Road lowered by +0.7m
Water Level, m (GSC)
11.4
11.2
11.0
10.8
10.6
10.4
10.2
10.0
9.8
9.6
9.4
9.2
9.0
8.8
8.6
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Fraction of Time During Which Water Level is Exceeded

Figure 29

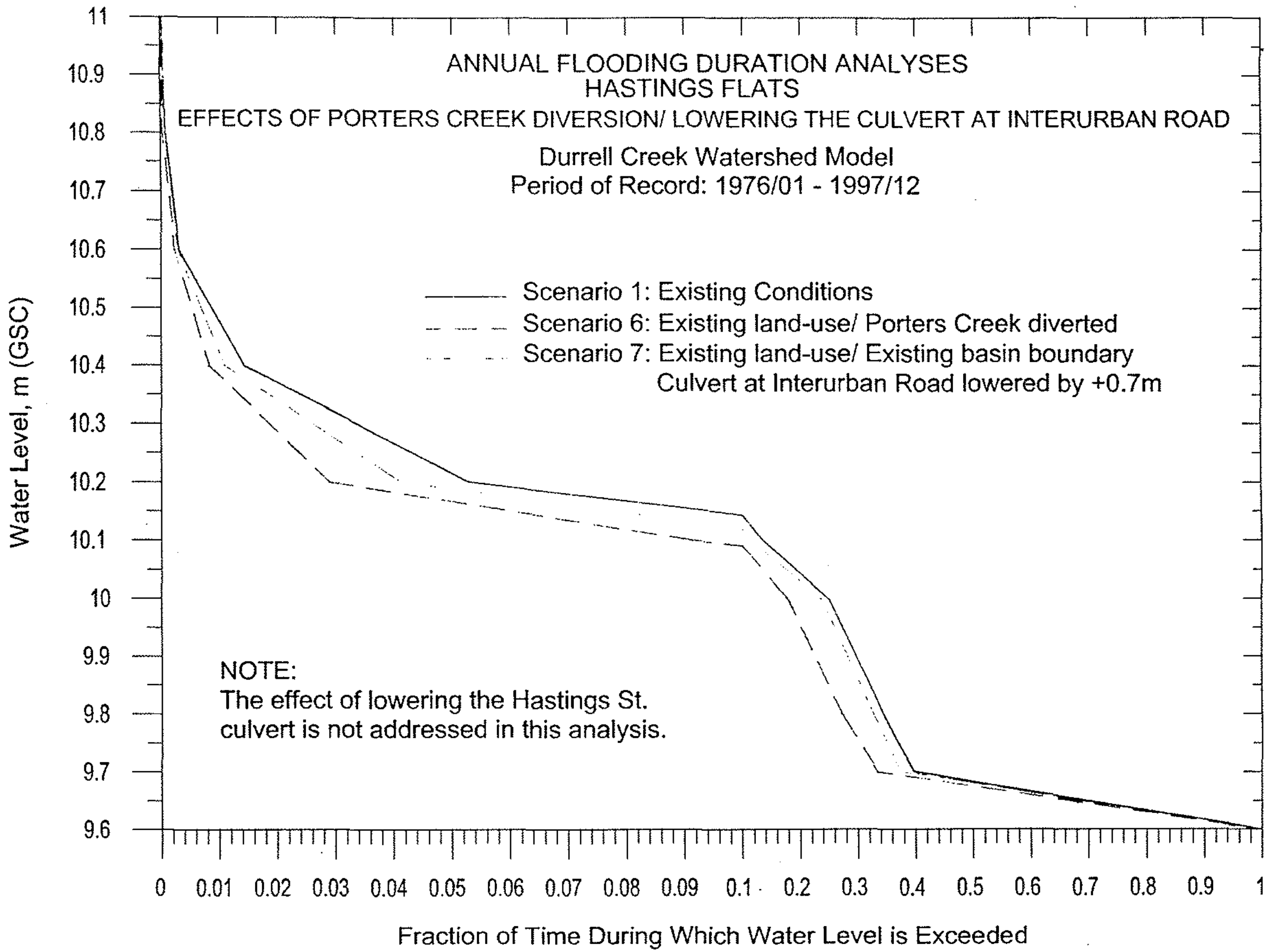

ANNUAL FLOODING DURATION ANALYSES
HASTINGS FLATS
EFFECTS OF PORTERS CREEK DIVERSION/ LOWERING THE CULVERT AT INTERURBAN ROAD
Durrell Creek Watershed Model
Period of Record: 1976/01 - 1997/12
Scenario 1: Existing Conditions
Scenario 6: Existing land-use/ Porters Creek diverted
Scenario 7: Existing land-use/ Existing basin boundary
Culvert at Interurban Road lowered by +0.7m
NOTE:
The effect of lowering the Hastings St.
culvert is not addressed in this analysis.
Water Level, m (GSC)
11
10.9
10.8
10.7
10.6
10.5
10.4
10.3
10.2
10.1
10
9.9
9.8
9.7
9.6
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Fraction of Time During Which Water Level is Exceeded

Figure 30

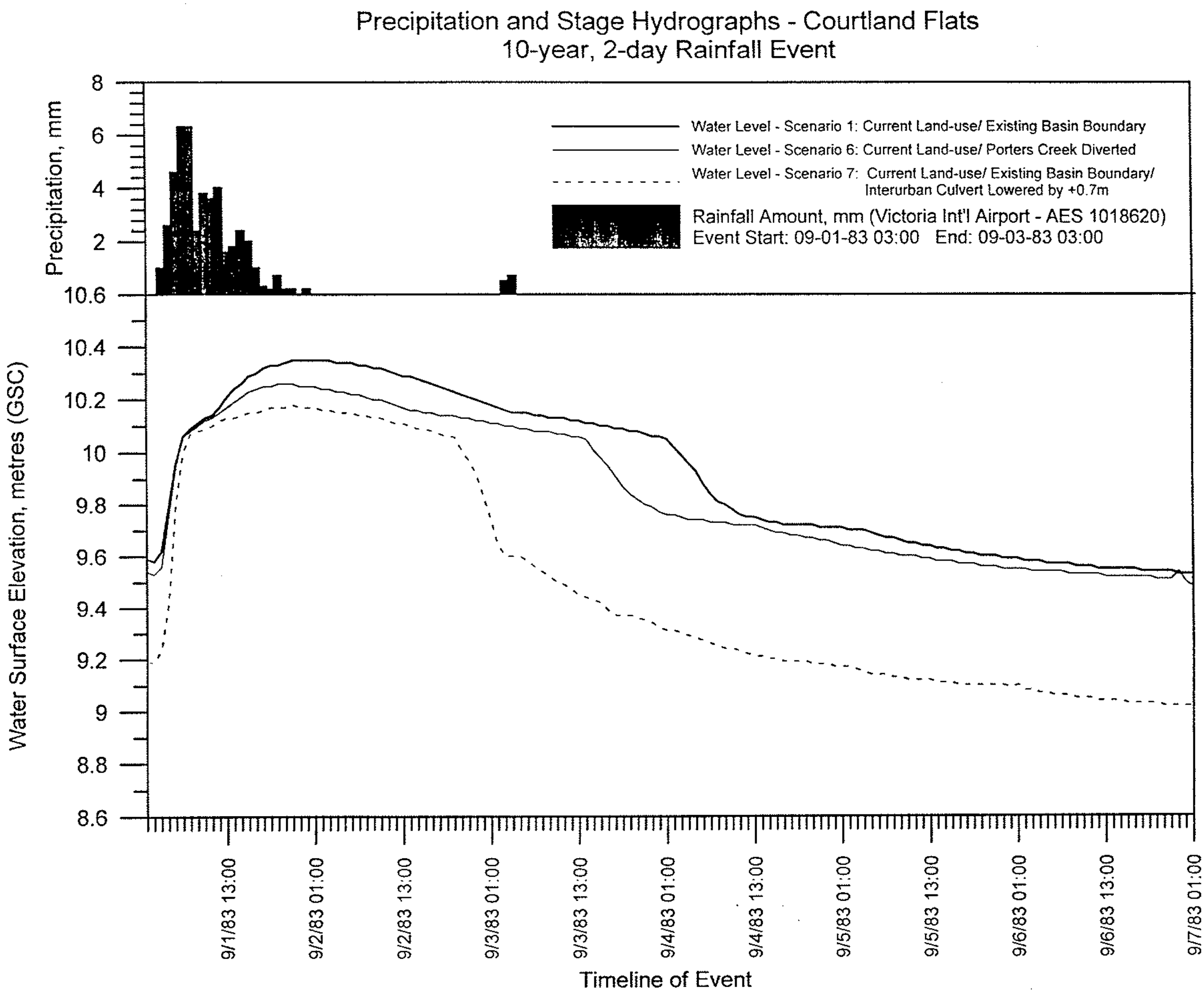

Precipitation and Stage Hydrographs - Courtland Flats
10-year, 2-day Rainfall Event
Water Level - Scenario 1: Current Land-use/ Existing Basin Boundary
Water Level - Scenario 6: Current Land-use/ Porters Creek Diverted
Water Level - Scenario 7: Current Land-use/ Existing Basin Boundary/ Interurban Culvert Lowered by +0.7m
Rainfall Amount, mm (Victoria Int'l Airport - AES 1018620)
Event Start: 09-01-83 03:00 End: 09-03-83 03:00
Precipitation, mm
8
6
4
2
10.6
10.4
10.2
10
9.8
9.6
9.4
9.2
9
8.8
8.6
Water Surface Elevation, metres (GSC)
9/1/83 13:00
9/2/83 01:00
9/2/83 13:00
9/3/83 01:00
9/3/83 13:00
9/4/83 01:00
9/4/83 13:00
9/5/83 01:00
9/5/83 13:00
9/6/83 01:00
9/6/83 13:00
9/7/83 01:00
Timeline of Event

Figure 31

Precipitation and Stage Hydrographs - Hastings Flats (at cross-section 13.5)
10-year, 2-day Rainfall Event

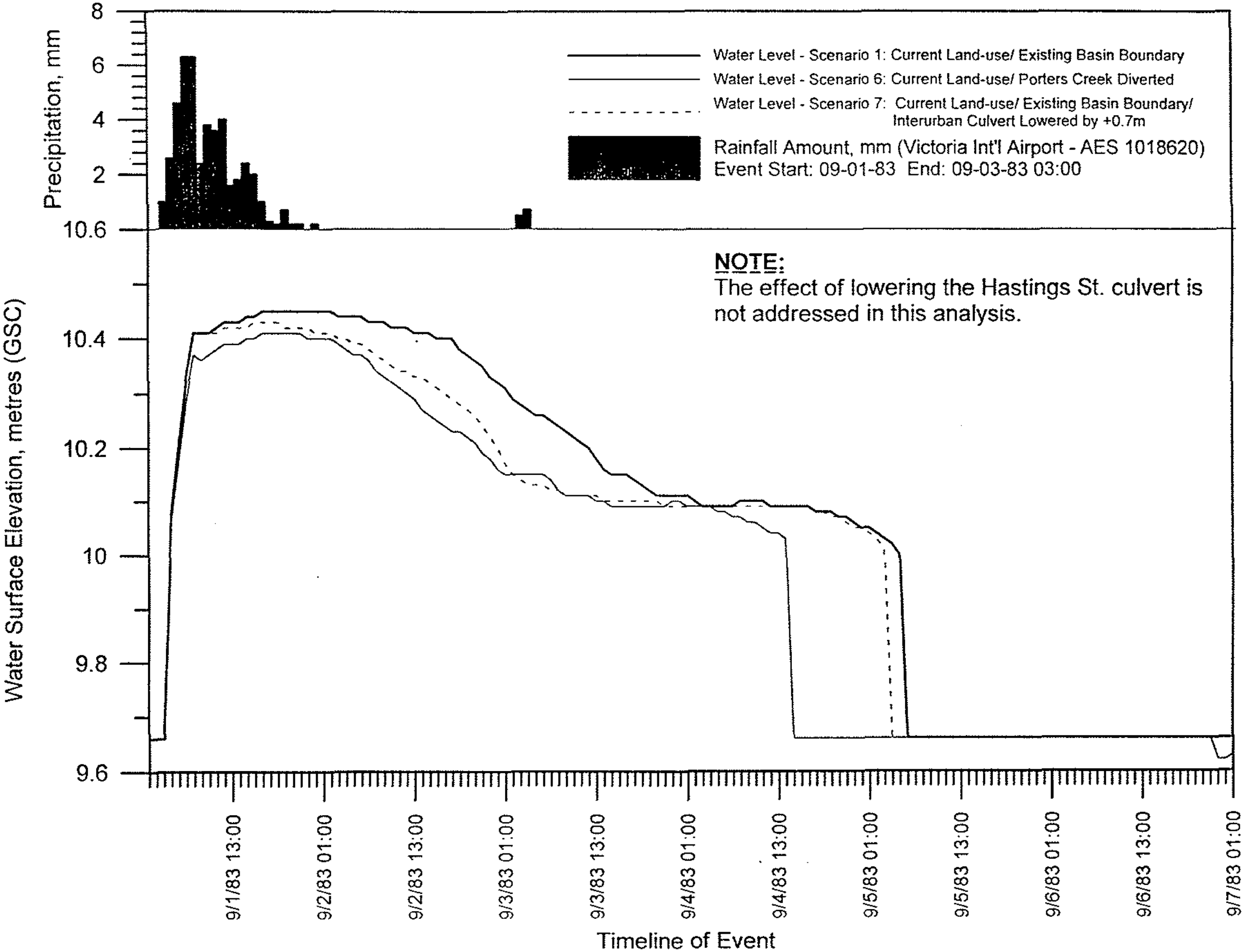


Figure 32

Precipitation and Stage Hydrographs - Courtland Flats
10-year, 5-day Rainfall Event

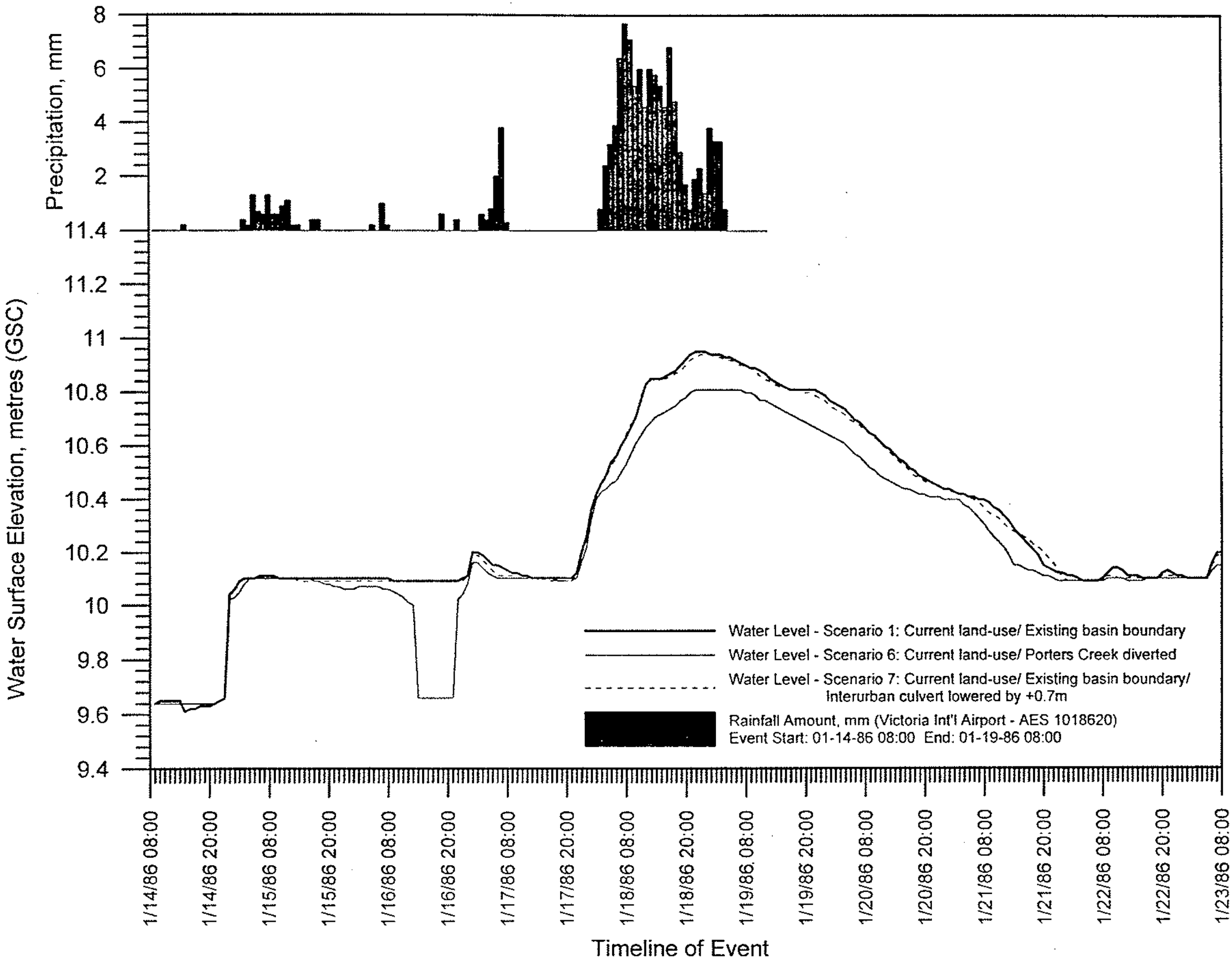
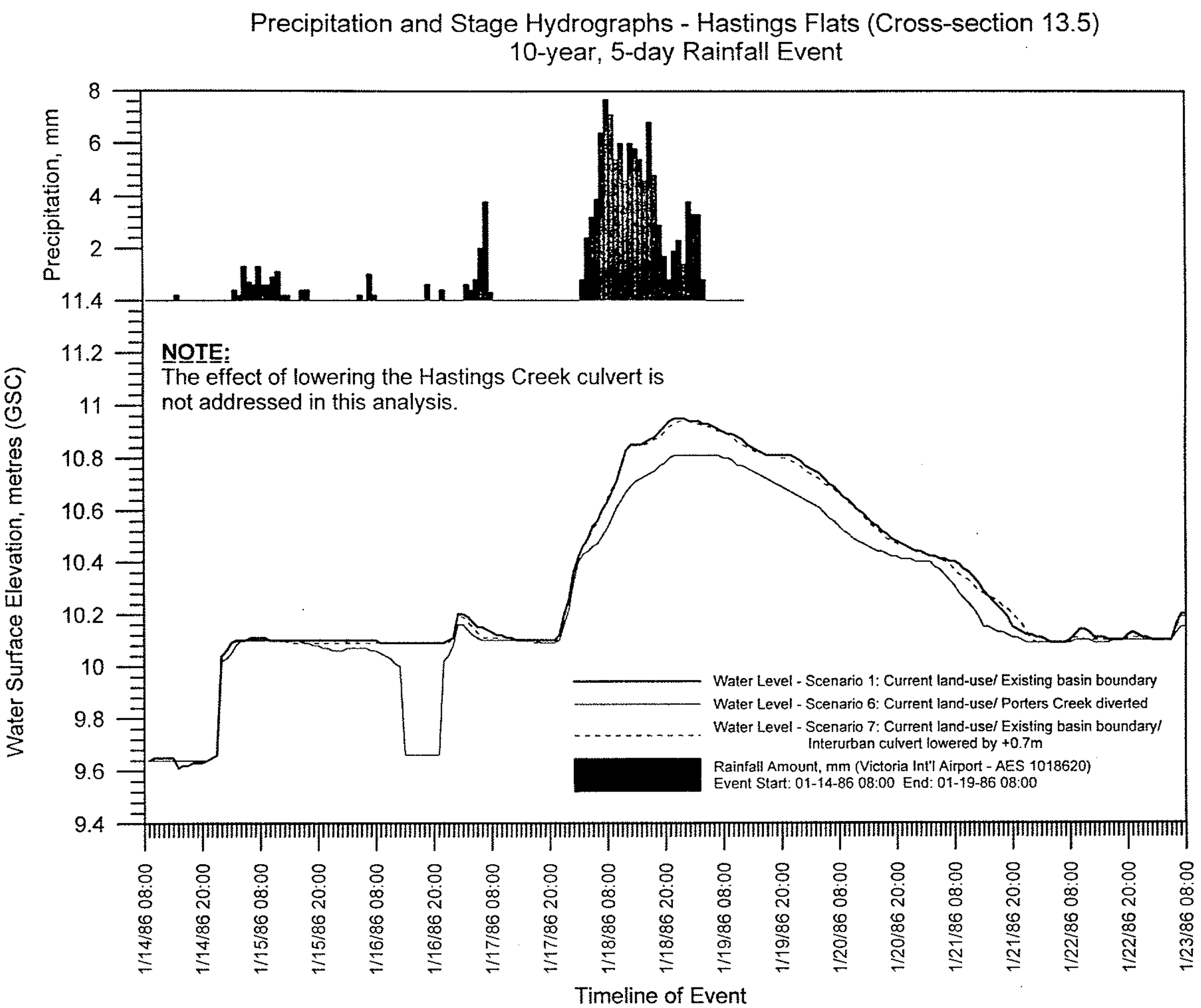


Figure 33



Precipitation and Stage Hydrographs - Hastings Flats (Cross-section 13.5)
10-year, 5-day Rainfall Event
Precipitation, mm
8
6
4
2
Water Surface Elevation, metres (GSC)
11.4
11.2
11
10.8
10.6
10.4
10.2
10
9.8
9.6
9.4
NOTE:
The effect of lowering the Hastings Creek culvert is not addressed in this analysis.
Water Level - Scenario 1: Current land-use/ Existing basin boundary
Water Level - Scenario 6: Current land-use/ Porters Creek diverted
Water Level - Scenario 7: Current land-use/ Existing basin boundary/ Interurban culvert lowered by +0.7m
Rainfall Amount, mm (Victoria Int'l Airport - AES 1018620)
Event Start: 01-14-86 08:00 End: 01-19-86 08:00
1/14/86 08:00
1/14/86 20:00
1/15/86 08:00
1/15/86 20:00
1/16/86 08:00
1/16/86 20:00
1/17/86 08:00
1/17/86 20:00
1/18/86 08:00
1/18/86 20:00
1/19/86 08:00
1/19/86 20:00
1/20/86 08:00
1/20/86 20:00
1/21/86 08:00
1/21/86 20:00
1/22/86 08:00
1/22/86 20:00
1/23/86 08:00
Timeline of Event

Figure 34

TABLE 1
DURRELL CREEK IWMP

Selected AES Climate Stations in the Saanich Area

Station Name	Station I.D.	Period of Record[1] Start	End	Data Available[2] Hourly Precip.	Daily Precip.	Daily Evap.	Temperature
Saanichton CDA	1016940	03/01/14	---		✓	✓	✓
Saanich Densmore	1016942	12/01/65	02/28/92	✓	✓		✓
Saanich Dominion Astrophysical Observatory	10169DK	12/01/16	06/01/77		✓		✓
Saanichton Mount Newton	1016RM0	08/01/80	---		✓		✓
Victoria Francis Park	1018605	09/01/89	---		✓		
Victoria - Gonzales Heights	1018610	08/01/1898	---	✓	✓		
Victoria Highland	1018616	07/01/61	---		✓		
Victoria Holland 2	1018617	08/01/60	---		✓		
Victoria International Airport	1018620	01/01/58	---	✓	✓		✓

NOTES

1. Periods of record are not necessarily continuous. Some records may contain large gaps of missing data.
2. Some types of data such as hourly observations may only be available for a fraction of the total period.

TABLE 2
DURRELL CREEK IWMP

Climate Summary Table
Saanichton-CDA (AES 1016940)

NORMALS AND ANNUAL EXTREMES OF TOTAL PRECIPITATION (all values in mm)[1]

Parameter	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Mean Daily	4.2	3.3	2.3	1.5	1.0	1.0	0.6	0.8	1.2	2.6	4.3	5.0	2.3
Mean Monthly	130.3	93.1	70.4	43.5	31.7	29.8	18.5	24.6	36.1	79.1	126.7	152.3	69.7
Mean Annual	---	---	---	---	---	---	---	---	---	---	---	---	834.6
Max. Annual (1990)	---	---	---	---	---	---	---	---	---	---	---	---	1185.6
Min. Annual (1929)	---	---	---	---	---	---	---	---	---	---	---	---	510.6

TEMPERATURE (all values in °C)[2]

Parameter	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Mean Daily	3.1	4.9	5.7	8.4	11.7	14.3	16.5	16.3	14.4	10.1	6.2	4.3	9.6
Max. Mean Daily	5.6	7.8	9.2	12.4	16.2	18.9	21.6	21.2	18.4	13.6	9	6.7	13.4
Min. Mean Daily	0.5	1.9	2.2	4.4	7.1	9.6	11.3	11.4	9.7	6.5	3.4	1.8	5.8

NOTES

1. Values calculated based on the daily precipitation record (1915/01 - 1998/12) at Saanichton CDA (1016940)
2. Values taken from published climate normals (1951-1980) published by Environment Canada.

TABLE 3

DURRELL CREEK IWMP

Hydrotechnical Summary

Colquitz River at Hyacinth Avenue (WSC 08HA037); Colquitz River at Violet Avenue (WSC 08HA047)[1]

MEAN DAILY DISCHARGE (All values in m^3/s)

Parameter	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Average	1.03	0.86	0.48	0.27	0.12	0.07	0.05	0.04	0.04	0.10	0.49	0.82	0.36
Maximum	1.27	1.20	0.65	0.49	0.17	0.10	0.06	0.06	0.06	0.20	1.07	1.18	0.54
Minimum	0.82	0.64	0.30	0.16	0.08	0.05	0.04	0.03	0.03	0.05	0.19	0.49	0.24

EXTREME DISCHARGE (All values in m^3/s)

Parameter	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Record
Peak Instantaneous	2.25	7.62	6.49	5.44	11.60	10.30	6.02	2.67	10.10	3.79	3.90	4.77	17.10	7.58	6.60	4.76	5.41	8.64	6.38	12.9*	17.10
Max. Daily	2.12	6.42	6.32	5.09	11.20	9.44	5.74	2.16	8.88	3.38	3.67	4.44	16.70	7.31	6.19	4.58	4.94	8.40	5.57	12.30	16.70
Min. Daily	0.018	0.008	0.002	0.007	0.039	0.042	0.022	0.027	0.036	0.019	0.039	0.029	0.049	0.034	0.016	0.033	0.017	0.002	0.003	0.486	0.002

*Estimated

NOTES

1. The streamflow gauge was moved in 1981 from Hyacinth Ave. to Violet Ave. Flow magnitudes have not been adjusted to reflect this change.

TABLE 4a
DURRELL CREEK IWMP

1950's Land Usage for HSPF Modelling[1]

Sub-Basin	Forested (ha)	Grassed (ha)	Agricultural (ha)	LDSFR (ha)	MDSFR (ha)	HDSFR (ha)	Commercial (ha)	Pavement[2] (ha)	**Total** (ha)	**Total EIA[3]** (ha)
1	10.4	37.1	0	9.3	4.4	0	1.4	1	63.6	4.7
2	6.3	0.7	20.5	13.9	11.5	0.7	0.2	0.2	54	5.0
3	8.7	0.5	34.9	19	8	0	0	0	71.2	3.7
4	91.3	12.9	0	20.9	0	0	0	0	124.9	1.8
5	53.4	27.6	0	30.5	2	0	0	0	113.5	2.7
6	7.5	3.1	0	8.3	0	0	0	0	18.9	1.3
7	10.8	0.7	0.4	29.2	0	0	0	0	41.1	2.2
8	9.1	7	5	16.2	2.5	0.5	1.1	0.2	41.6	3.7
Total	197.5	89.6	60.8	147.3	28.4	1.2	2.7	1.4	528.8	25.1

NOTES

1. 1950's land use analysis based on examination of 1956 air photos
2. 'Pavement' refers to multi-lane roadways
3. Effective Impervious Area (EIA) represents that portion of land which is both impervious and directly connected to the natural drainage network.

TABLE 4b
DURRELL CREEK IWMP

1960's Land Usage for HSPF Modelling[1]

Sub-Basin	Forested (ha)	Grassed (ha)	Agricultural (ha)	LDSFR (ha)	MDSFR (ha)	HDSFR (ha)	Commercial (ha)	Pavement[2] (ha)	**Total** (ha)	**Total EIA**[3] (ha)
1	10.4	37.1	0	9.3	3.9	0.5	1.4	1	63.6	4.8
2	6.3	0.7	20.5	12.4	1.5	11.5	0.9	0.2	54	8.4
3	7.4	0.5	34.2	9.9	15.6	3.6	0	0	71.2	6.9
4	91.1	12.8	0	21.1	0	0	0	0	124.9	1.8
5	53.4	27.6	0	30.5	2	0	0	0	113.5	2.7
6	7.5	3.1	0	8.3	0	0	0	0	18.9	1.3
7	10.8	0.7	0.4	29.2	0	0	0	0	41.1	2.2
8	9.1	7	5	16.2	2.5	0.5	1.1	0.2	41.6	3.7
Total	196	89.5	60.1	136.9	25.5	16.1	3.4	1.4	528.8	31.7

NOTES

1. 1960's land use analysis based on examination of 1964 air photos
2. 'Pavement' refers to multi-lane roadways
3. Effective Impervious Area (EIA) represents that portion of land which is both impervious and directly connected to the natural drainage network.

TABLE 4c
DURRELL CREEK IWMP

1970's Land Usage for HSPF Modelling[1]

Sub-Basin	Forested (ha)	Grassed (ha)	Agricultural (ha)	LDSFR (ha)	MDSFR (ha)	HDSFR (ha)	Commercial (ha)	Pavement[2] (ha)	**Total** (ha)	**Total EIA[3]** (ha)
1	10.3	35.8	0	9.3	3.9	0.5	2.8	1	63.6	6.0
2	6.3	0.7	20.5	12.4	1.5	11.5	0.9	0.2	54	8.4
3	7.4	0.5	34.2	9.9	15.6	3.6	0	0	71.2	6.9
4	83.9	19.9	0	21.1	0	0	0	0	124.9	1.8
5	53.4	27.6	0	30.5	2	0	0	0	113.5	2.7
6	7.5	3.1	0	8.3	0	0	0	0	18.9	1.3
7	10.8	0.7	0.4	29.2	0	0	0	0	41.1	2.2
8	9.1	7	5	16.2	2.5	0.5	1.1	0.2	41.6	3.7
Total	188.7	95.3	60.1	136.9	25.5	16.1	4.8	1.4	528.8	33.0

NOTES

1. 1970's land use analysis based on examination of 1975 air photos
2. 'Pavement' refers to multi-lane roadways
3. Effective Impervious Area (EIA) represents that portion of land which is both impervious and directly connected to the natural drainage network.

TABLE 4d
DURRELL CREEK IWMP

1980's Land Usage for HSPF Modelling[1]

Sub-Basin	Forested (ha)	Grassed (ha)	Agricultural (ha)	LDSFR (ha)	MDSFR (ha)	HDSFR (ha)	Commercial (ha)	Pavement[2] (ha)	**Total** (ha)	**Total EIA**[3] (ha)
1	10.3	29.6	0	3.8	12.3	1.1	5.4	1	63.6	10.4
2	6.3	0.8	19.7	12.2	1.5	12.3	0.9	0.2	54	8.7
3	7.4	0.4	33.2	0	23.3	4.6	2.2	0	71.1	10.7
4	83.9	20	0	19.5	1.6	0	0	0	124.9	2.2
5	53.4	27.6	0	27.7	4	0.8	0	0	113.5	3.5
6	7.5	3.1	0	3.1	3.6	1.6	0	0	18.9	2.8
7	10.8	0.7	0.4	25.8	2.8	0.6	0	0	41.1	3.0
8	9.1	6	2.9	11.3	10.3	0.8	1.1	0.2	41.7	5.5
Total	188.7	88.2	56.2	103.4	59.4	21.8	9.6	1.4	528.8	46.8

NOTES

1. 1980's land use analysis based on examination of 1988 air photos
2. 'Pavement' refers to multi-lane roadways
3. Effective Impervious Area (EIA) represents that portion of land which is both impervious and directly connected to the natural drainage network.

TABLE 4e
DURRELL CREEK IWMP

Existing Land Usage for HSPF Modelling[1]

Sub-Basin	Forested (ha)	Grassed (ha)	Agricultural (ha)	LDSFR (ha)	MDSFR (ha)	HDSFR (ha)	Commercial (ha)	Pavement[2] (ha)	**Total** (ha)	**Total EIA**[3] (ha)
1	8.7	23.2	0	0.9	2.8	14.6	12.4	1	63.6	20.7
2	6	0.6	19.7	10.9	0	15.4	0.9	0.2	54	9.8
3	7.3	0.5	32.2	0	24	5.8	1.4	0	71.2	10.8
4	83.9	19.9	0	19.5	1.6	0	0	0	124.9	2.2
5	53.4	27.6	0	27.7	4	0.8	0	0	113.5	3.5
6	7.5	3.1	0	3.1	3.6	1.6	0	0	18.9	2.8
7	10.8	0.7	0.4	25.8	2.8	0.6	0	0	41.1	3.0
8	9.1	6	2.9	10.3	10.3	0.8	2	0.2	41.6	6.2
Total	186.7	81.6	55.2	98.2	49.1	39.6	16.7	1.4	528.8	58.9

NOTES

1. Current land use analysis based on examination of digital cadastral maps supplied by the District of Saanich
2. 'Pavement' refers to multi-lane roadways
3. Effective Impervious Area (EIA) represents that portion of land which is both impervious and directly connected to the natural drainage network.

TABLE 5
DURRELL CREEK IWMP

Land-use Analysis
Breakdown of Pervious and Impervious Area

Land-use	Total Pervious Coverage %	Total Impervious Coverage %	Effective Impervious Coverage %
Low-Density Residential	90	10	4
Medium Density Residential	64	36	24
High Density Residential	40	60	48
Commercial	10	90	85.5
Pavement	0	100	100

Notes

1. Agricultural, grassed and forested areas are considered 100% pervious.
2. All percentages shown are with respect to the gross development area.

TABLE 6
DURRELL CREEK IWMP

HSPF Model Parameters

Land Segment	Abbreviati	LZSN (mm)	INFILT (mm/hr)	LSUR (m)	SLSUR	KVARY (1/mm)	AGWR (1/day)	INFEXP	INFILD	EEPF	BASET	AGWTP	CECPS (mm)	UZSN (mm)	NSUR	INTFW	IRC (1/day)	LZEPT	RETSC (mm)
Well Drained w/ Forest Cover	WDF	115.0	2.00	122.0	0.1	0.02	0.996	2.0	2.0	0.0	0.0	0.0	5.1	12.70	0.35	6.0	0.50	0.60	--
Well Drained w/ Grass Cover	WDG	115.0	0.80	122.0	0.1	0.02	0.996	2.0	2.0	0.0	0.0	0.0	2.5	6.40	0.25	6.0	0.50	0.25	--
Well Drained Overlying Bedrock w/ Forest Cov	WDBRF	110.0	2.00	122.0	0.1	0.02	0.996	2.0	2.0	0.0	0 0	0.0	5.1	12.70	0.35	6.0	0.40	0.60	--
Well Drained Overlying Bedrock w/ Forest Cov	WDBRG	110.0	0.80	122.0	0.1	0.02	0.996	2.0	2.0	0.0	0.0	0.0	2.5	6.40	0.25	6.0	0.40	0.25	--
Poorly Drained w/ Forest Cover	PDF	102.0	51.00	30.0	0.001	0.02	0.996	10.0	2.0	0.0	0.0	0.0	2.5	12.70	0.5	1.0	0.70	0.80	--
Poorly Drained w/ Grass Cover	PDG	102.0	51.00	30.0	0.001	0 02	0 996	10 0	2.0	0.0	0.0	0.0	2.5	12.70	0.5	1.0	0.70	0.80	--
Impervious	EIA	--	--	152.4	0.01	--	--	--	--	--	--	--	--	--	0.1	--	--	--	0.1

Parameter Definitions:

LZSN - Lower-zone nominal storage. An index to soil moisture holding capacity.
INFILT - Infiltration capacity. An index to the infiltration capacity of the soil.
LSUR - Average length of the overland flow plane.
SLSUR - Average slope of the overland flow plane.
KVARY - Groundwater outflow modifier. An index to how much influence recent recharge has on groundwater outflow.
AGWRC - Groundwater recession parameter. An index of the rate at which groundwater drains from the land.
INFEXP - Infiltration equation exponent. Controls the rate at which infiltration decreases with increasing soil moisture.
INFILD Ratio of maximum to mean infiltration rate of a pervious area. Accounts for the degree of spatial variation in infiltration capacity.
DEEPFR - Fraction of groundwater that does not discharge to the surface with the boundary of the modelled area.
BASETP - Fraction of available PET (Potential Evapotranspiration) demand that can be met from groundwater outflow. Simulates ET from riparian vegetation.
AGWTP - Fraction of available PET demand that can be met from stored groundwater. Simulates ET from phreatophtyes in general
CECPS - Interception storage capacity of vegetation.
UZSN - Upper-zone nominal storage. An index to the amount of depression storage and surface layer storage of a pervious area.
NSUR - Average roughness of the overland flow plane.
INTFW - Interflow inflow parameter. An index to the amount of water that infiltrates and flows as shallow sub-surface runoff.
IRC - Interflow recession parameter. An index of the rate at which shallow sub-surface flow drains from the land.
LZEPT - Lower-zone evapotranspiration parameter. An index to the density of deep-rooted vegetation on a pervious area.
RETSC - Retention storage capacity of an impervious area.

TABLE 7
DURRELL CREEK IWMP

Hydrologic Summary for Existing Conditions
Durrell Creek Watershed Model

PREDICTED MEAN DAILY DISCHARGE (All values in m^3/s)

Parameter	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Average	0.18	0.20	0.14	0.10	0.09	0.07	0.05	0.07	0.07	0.18	0.28	0.19	0.13
Maximum	0.96	0.83	0.68	0.41	0.40	0.38	0.36	0.46	0.48	0.81	1.04	0.97	0.65
Minimum	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02

PREDICTED PEAK INSTANTANEOUS DISCHARGES (All values in m^3/sec)

Parameter	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Maximum	1.17	1.13	0.99	2.13	1.88	1.40	2.03	1.73	1.60	1.43	2.59	1.86
	1988	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**Record**	
	1.24	1.36	3.10	1.13	1.53	1.77	1.09	1.84	1.36	1.71	**3.10**	

TABLE 8
DURRELL CREEK IWMP

Hydraulic Summary for Existing Conditions
Durrell Creek Watershed Model

PREDICTED MEAN DAILY WATER LEVELS AT HASTINGS FLATS (All values in m, GSC)

Parameter	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Average	9.8	9.9	9.8	9.8	9.8	9.7	9.7	9.7	9.7	9.8	10.0	9.9	9.8
Maximum	10.5	10.4	10.2	10.2	10.1	10.1	10.1	10.2	10.1	10.3	10.5	10.4	10.3
Minimum	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6

PREDICTED MEAN DAILY WATER LEVELS AT COURTLAND FLATS (All values in m, GSC)

Parameter	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Average	9.7	9.7	9.6	9.6	9.6	9.6	9.5	9.5	9.5	9.6	9.8	9.7	9.6
Maximum	10.4	10.3	10.0	10.0	9.9	9.9	9.8	10.0	9.9	10.1	10.5	10.4	10.1
Minimum	9.3	9.3	9.3	9.3	9.4	9.4	9.4	9.4	9.3	9.4	9.4	9.3	9.4

PREDICTED EXTREME WATER LEVELS THROUGHOUT THE VALLEY (All values in m, GSC)

Parameter	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Maximum	10.5	10.3	10.3	10.8	10.7	10.5	10.9	10.7	10.5	10.4	10.9	10.6
	1988	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**Record**	
	10.4	10.4	**11.6**	10.5	10.6	10.6	10.3	10.7	10.4	10.6	**11.6**	

TABLE 9
DURRELL CREEK IWMP

PEAK INSTANTANEOUS FLOW COMPARISON FOR ALL SCENARIOS
DURRELL CREEK WATERSHED MODEL

Return Period (yrs)	**Peak Instantaneous Flow (m^3/s)[1]**						
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7
2	**1.6**	1.5	1.5	1.5	1.5	1.3	1.6
10	**2.3**	2.3	2.3	2.3	2.3	2.1	2.4
25	**2.8**	2.8	2.7	2.7	2.7	2.6	2.8
50	**3.2**	3.1	3.1	3.1	3.1	3.0	3.2
100	**3.5**	3.5	3.5	3.5	3.5	3.4	3.6
200							

<u>NOTES</u>

1. Based on a 22 year record (1976 - 1997) of annual peak instantaneous flow from the Durrell Creek Watershed Model.

<u>Description of Scenarios</u>

Scenario 1: Existing Conditions
Scenario 2:1980's land-use/ existing basin boundary
Scenario 3:1970's land-use/ existing basin boundary
Scenario 4:1960's land-use/ existing basin boundary
Scenario 5:1950's land-use/ existing basin boundary
Scenario 6: Existing land-use/ Porters Creek diverted
Scenario 7: Existing land-use/ existing basin boundary/ Lowered Culvert at Interurban Road

TABLE 10
DURRELL CREEK IWMP

EXTREME WATER LEVELS COMPARISON FOR ALL SCENARIOS
DURRELL CREEK WATERSHED MODEL

Return Period (yrs)	Water Level (m, GSC)[1]						
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7
2	**10.5**	10.5	10.5	10.5	10.5	10.4	10.4
10	**11.0**	11.0	11.0	11.0	11.0	10.9	11.0
25	**11.3**	11.3	11.3	11.3	11.3	11.2	11.3
50	**11.5**	11.5	11.5	11.5	11.5	11.5	11.5
100	**11.8**	11.8	11.8	11.8	11.8	11.8	11.8
200	**12.1**	12.1	12.1	12.1	12.1	12.1	12.1

<u>NOTES</u>

1. Based on a 22 year record (1976 - 1997) of annual maximum water levels from the Durrell Creek Watershed Model.

<u>Description of Scenarios</u>

Scenario 1: Existing Conditions
Scenario 2:1980's land-use/ existing basin boundary
Scenario 3:1970's land-use/ existing basin boundary
Scenario 4:1960's land-use/ existing basin boundary
Scenario 5:1950's land-use/ existing basin boundary
Scenario 6: Existing land-use/ Porters Creek diverted
Scenario 7: Existing land-use/ existing basin boundary/ Lowered Culvert at Interurban Road

TABLE 11a
DURRELL CREEK IWMP

FLOODING DURATION COMPARISON FOR ALL SCENARIOS
DURRELL CREEK WATERSHED MODEL
COURTLAND FLATS

Water Level (m)	COURTLAND FLATS Fraction of Time Spent at, or Above, each Water Level[1]						
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7
8.8	---	---	---	---	---	---	1.0000
8.9	---	---	---	---	---	---	0.8110
9.0	**1.0000**	1.0000	1.0000	1.0000	1.0000	1.0000	0.6637
9.2	**0.9959**	0.9961	0.9954	0.9956	0.9961	0.9889	0.3758
9.4	**0.9651**	0.9664	0.9651	0.9658	0.9664	0.9496	0.1949
9.6	**0.4104**	0.4125	0.4073	0.4072	0.4085	0.3516	0.1003
10.0	**0.0733**	0.0725	0.0681	0.0679	0.0676	0.0504	0.0285
10.4	**0.0080**	0.0079	0.0071	0.0071	0.0071	0.0057	0.0059
10.8	**0.0006**	0.0006	0.0006	0.0006	0.0006	0.0004	0.0004
11.4	**0.0001**	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
12.0	**0.0000**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

NOTES

1. Based on a 22 year record (1976/01 - 1997/12) of hourly water levels from the Durrell Creek Watershed Model.

Description of Scenarios

Scenario 1: Existing Conditions
Scenario 2:1980's land-use/ existing basin boundary
Scenario 3:1970's land-use/ existing basin boundary
Scenario 4:1960's land-use/ existing basin boundary
Scenario 5:1950's land-use/ existing basin boundary
Scenario 6: Existing land-use/ Porters Creek diverted
Scenario 7: Existing land-use/ existing basin boundary/ Lowered Culvert at Interurban Road

TABLE 11b
DURRELL CREEK IWMP

FLOODING DURATION COMPARISON FOR ALL SCENARIOS
DURRELL CREEK WATERSHED MODEL
HASTINGS FLATS

Water Level (m)	HASTINGS FLATS Fraction of Time Spent at, or Above, each Water Level[1]						
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7[2]
9.6	**1.0000**	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9.7	**0.3947**	0.3951	0.3902	0.3893	0.3892	0.3343	0.3736
9.8	**0.3429**	0.3439	0.3385	0.3390	0.3382	0.2715	0.3259
10.0	**0.2491**	0.2498	0.2463	0.2467	0.2474	0.1783	0.2363
10.1	**0.1354**	0.1353	0.1310	0.1310	0.1316	0.0915	0.1143
10.2	**0.0529**	0.0525	0.0507	0.0504	0.0507	0.0290	0.0413
10.4	**0.0142**	0.0144	0.0130	0.0130	0.0131	0.0082	0.0109
10.6	**0.0031**	0.0032	0.0029	0.0029	0.0029	0.0024	0.0029
10.8	**0.0009**	0.0007	0.0006	0.0006	0.0006	0.0004	0.0007
11.0	**0.0002**	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002

NOTES

1. Based on a 22 year record (1976/01 - 1997/12) of hourly water levels from the Durell Creek Watershed Model.
2. The effect of lowering the Hastings St. culvert is not addressed in this analysis

Description of Scenarios

Scenario 1: Existing Conditions
Scenario 2:1980's land-use/ existing basin boundary
Scenario 3:1970's land-use/ existing basin boundary
Scenario 4:1960's land-use/ existing basin boundary
Scenario 5:1950's land-use/ existing basin boundary
Scenario 6: Existing land-use/ Porters Creek diverted
Scenario 7: Existing land-use/ existing basin boundary/ Lowered Culvert at Interurban Road

APPENDIX C

DURRELL CREEK

INTEGRATED WATERSHED MANAGEMENT PLAN

HYDROLOGIC AND HYDRAULIC MODELLING

APPENDIX 1
FREQUENCY ANALYSIS OF PRECIPITATION
SAANICHTON CDA (AES 1016940)

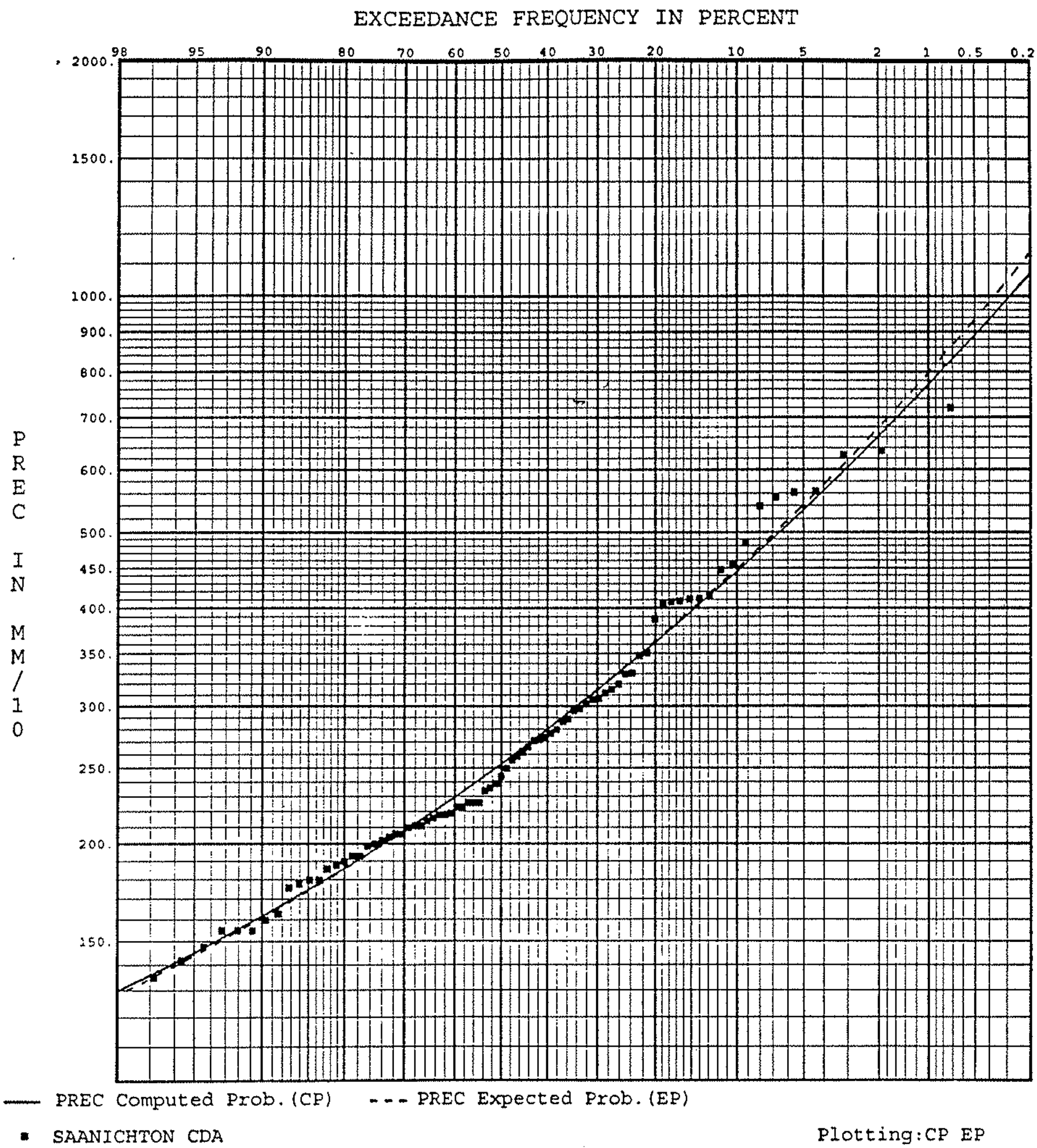
March 2000

TABLE A.1
DURRELL CREEK IWMP

FREQUENCY ANALYSIS OF PRECIPITATION
SAANICHTON CDA (AES - 1016940) 1915-1998

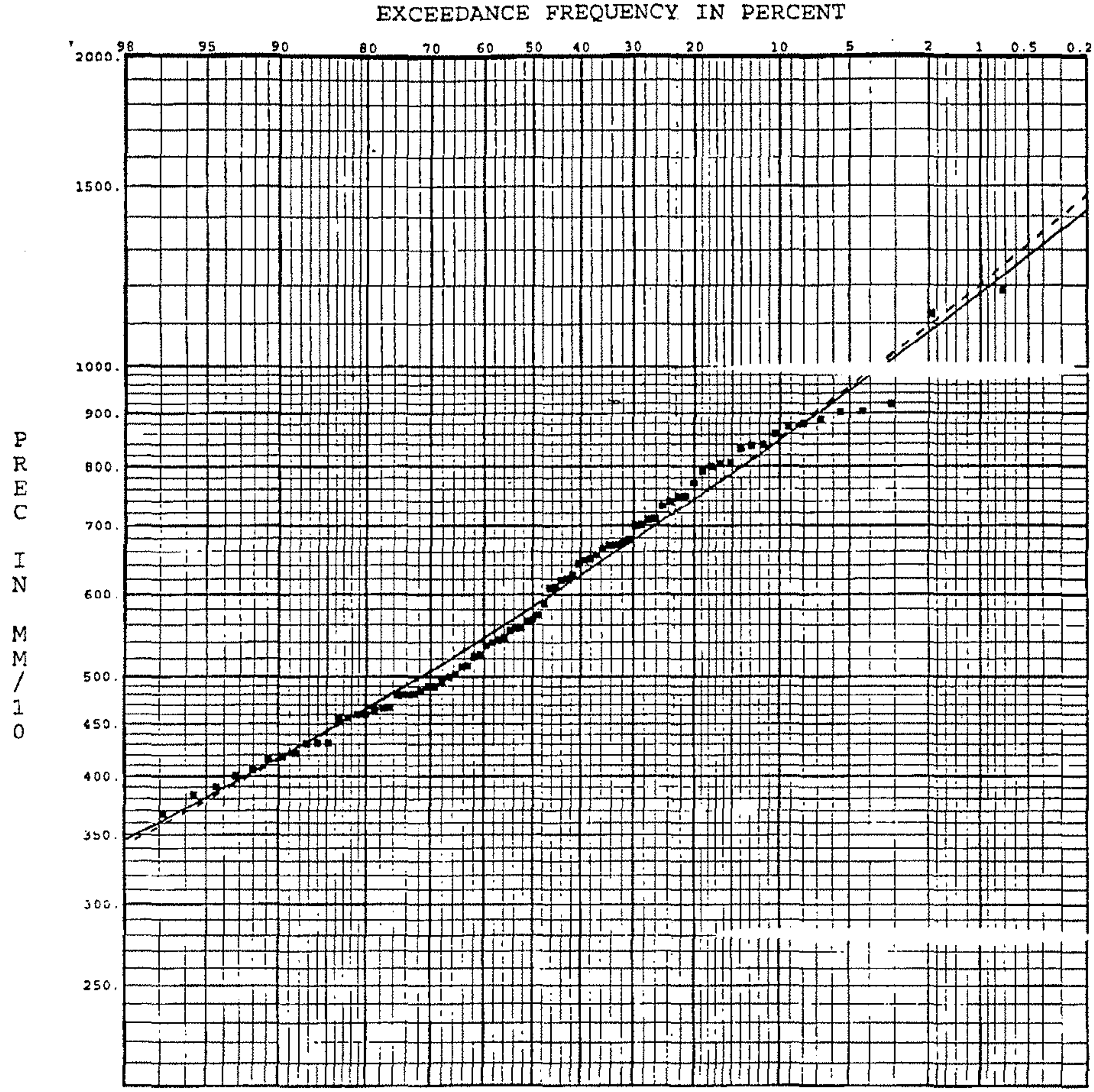
SUMMARY OF RESULTS

Return Period (yrs)	Duration for Summer Storms				Duration for Winter Storms			
	2-day	5-day	5-day	30-day	2-day	5-day	10-day	30-day
	(mm/10)				(mm/10)			
2	253	341	459	862	584	834	1170	2070
5	363	482	623	1110	745	1070	1460	2530
10	**449**	583	727	1250	852	**1240**	1650	2810
20	542	686	823	1370	957	1410	1830	3070
50	680	830	945	1510	1100	1650	2060	3380
100	799	946	1030	1610	1200	1840	2240	3610
200	934	1070	1120	1700	1320	2050	2420	3840



AES Gage No. 1016940
2-Day (Summer) Rainfall Frequency Analysis

WATER YEARS IN RECORD:1915-1997

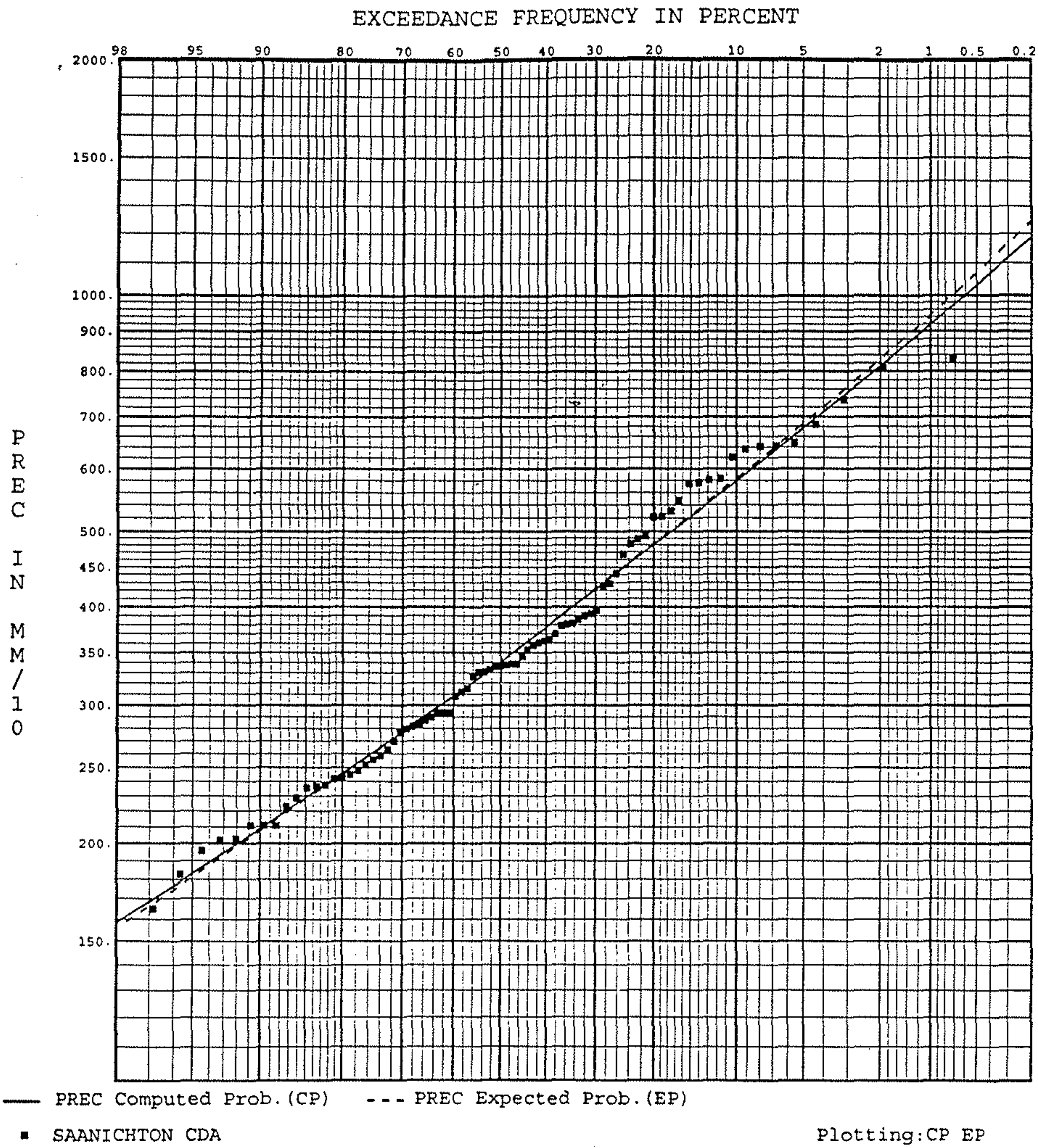


PREC Computed Prob.(CP) - - - PREC Expected Prob.(EP)

■ SAANICHTON CDA Plotting:CP EP

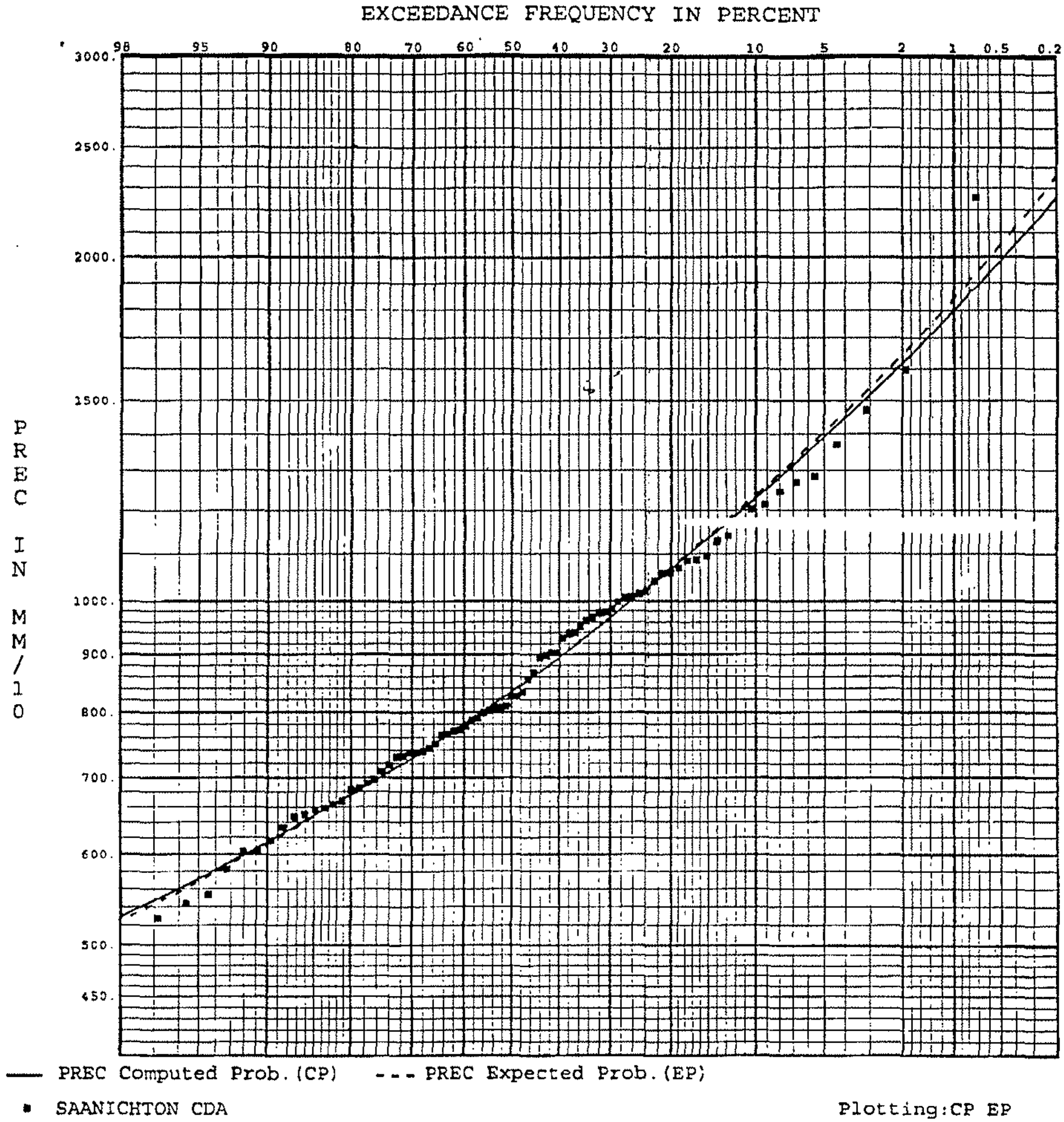
AES Gage No. 1016940
2-Day (Winter) Rainfall Frequency Analysis

WATER YEARS IN RECORD:1915-1997



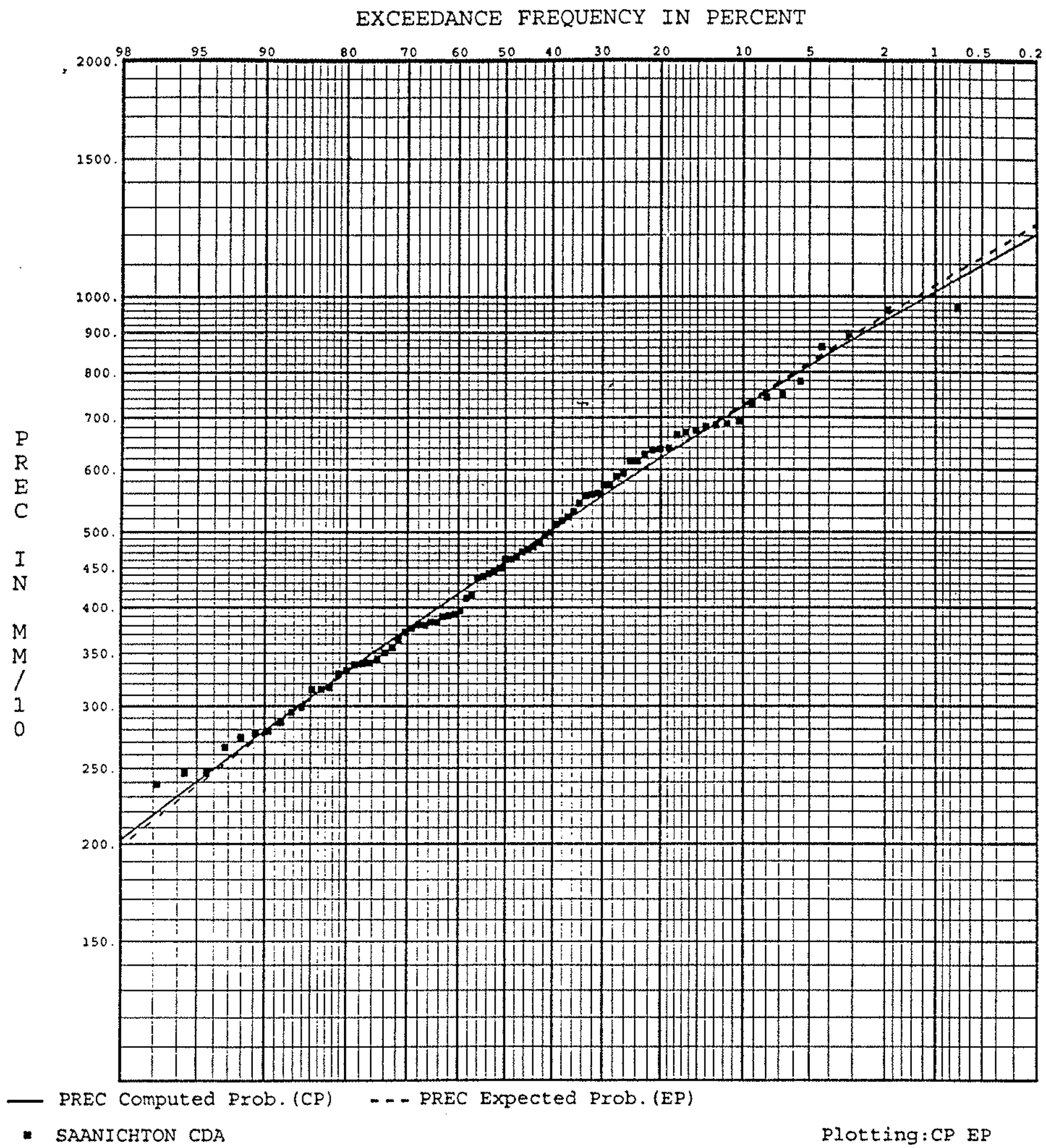
AES Gage No. 1016940
5-Day (Summer) Rainfall Frequency Analysis

WATER YEARS IN RECORD:1915-1997



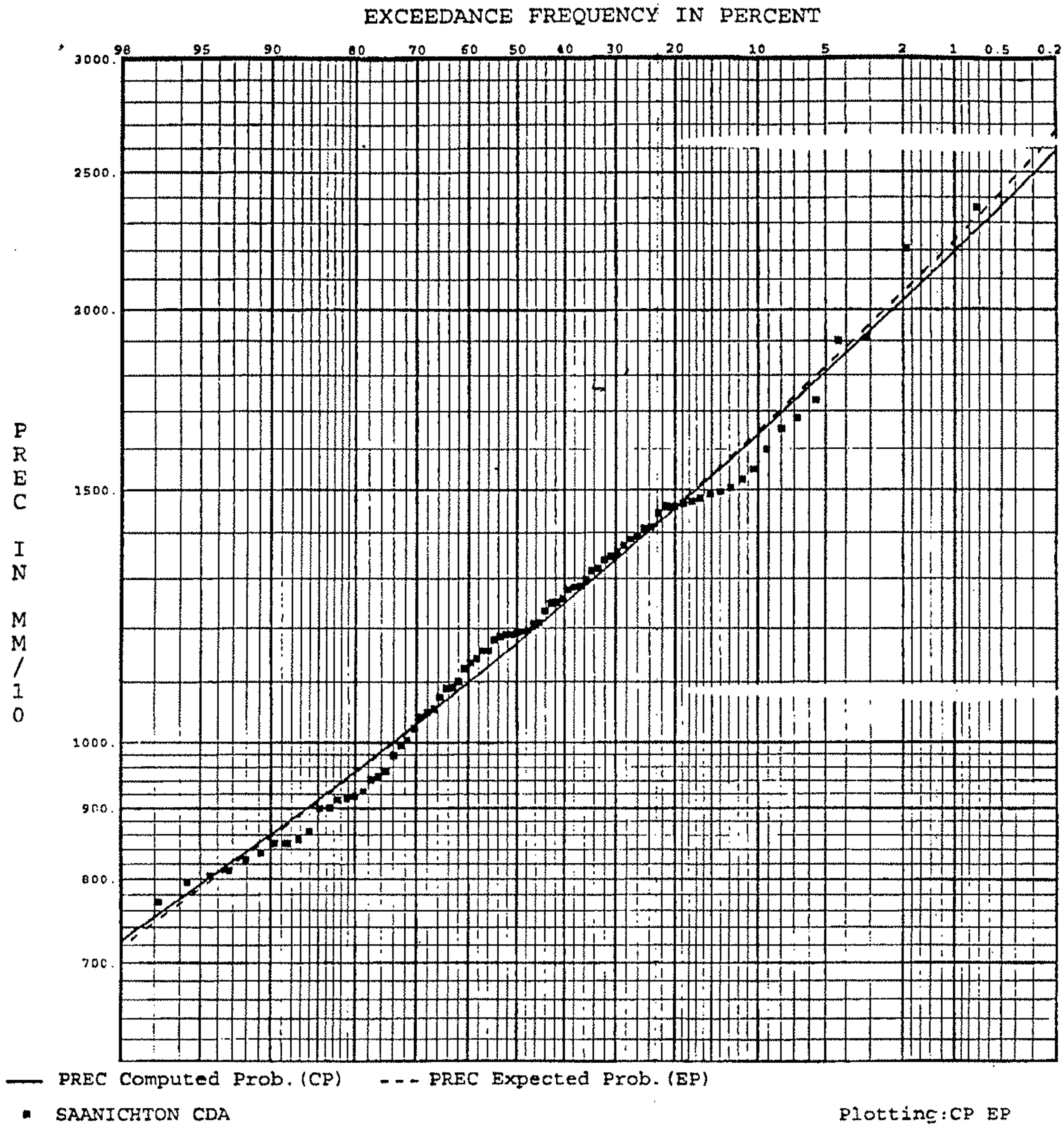
AES Gage No. 1016940
5-Day (Winter) Rainfall Frequency Analysis

WATER YEARS IN RECORD:1915-1997



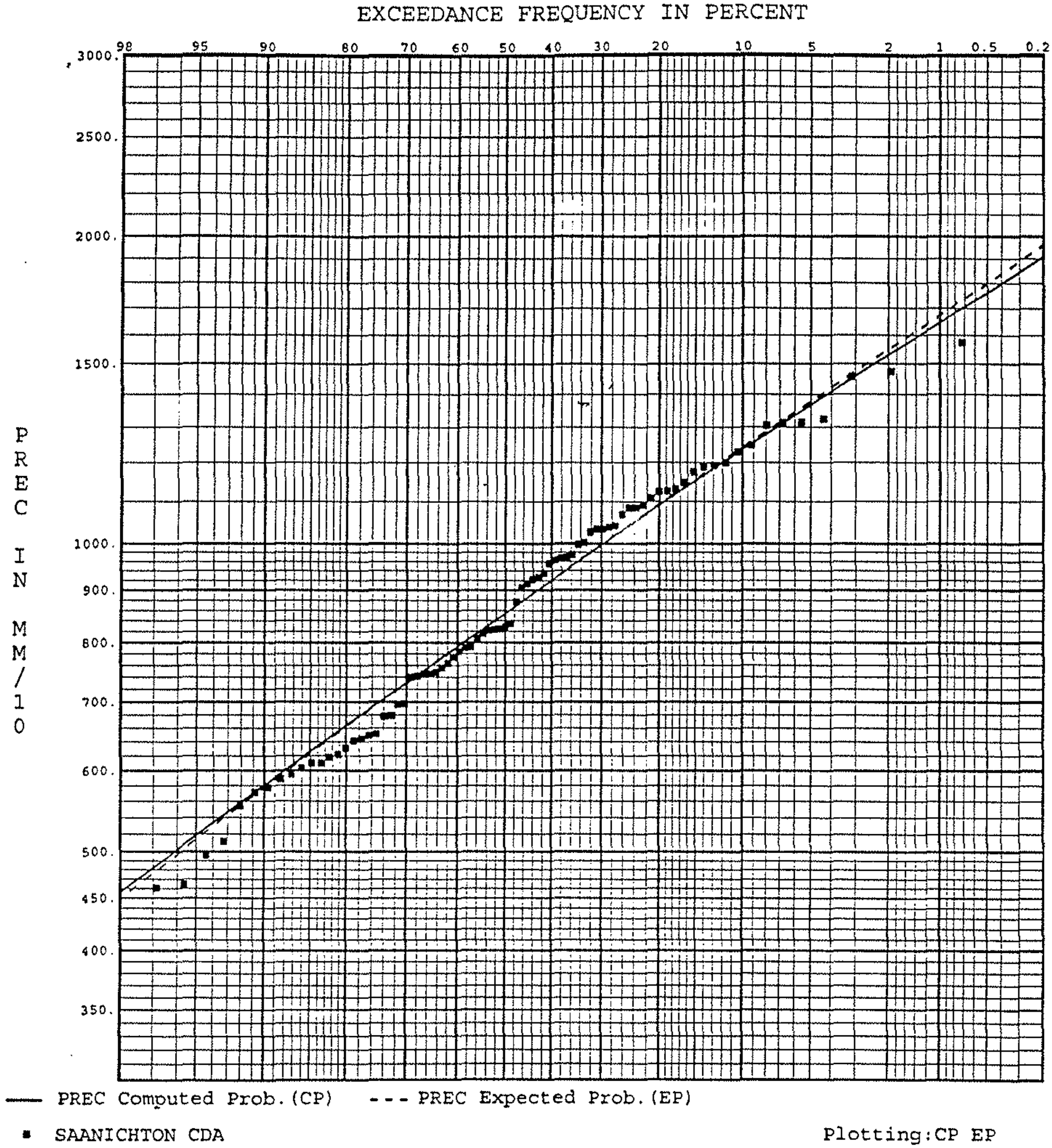
AES Gage No. 1016940
10-Day (Summer) Rainfall Frequency Analysis

WATER YEARS IN RECORD:1915-1997



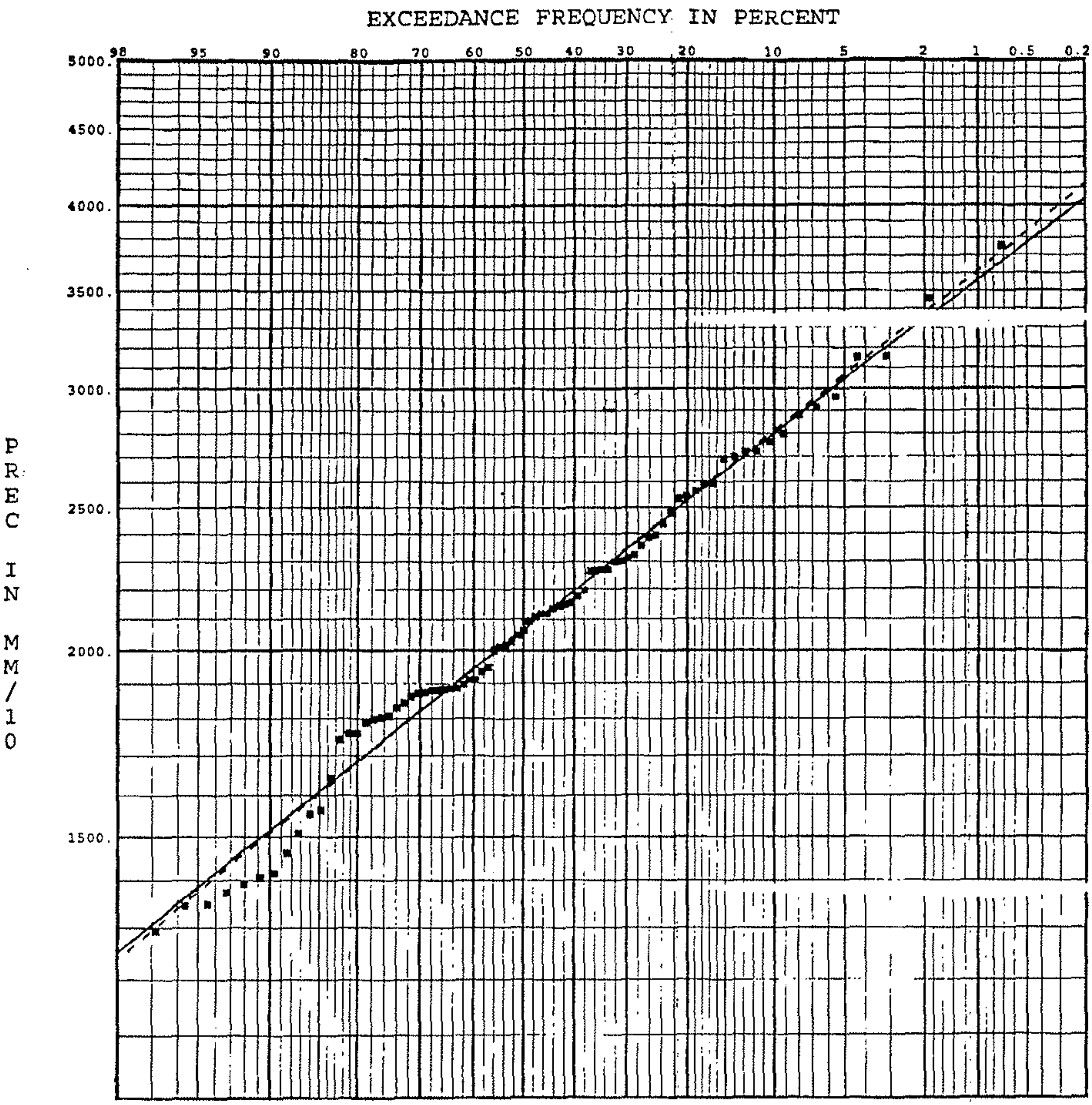
AES Gage No. 1016940
10-Day (Winter) Rainfall Frequency Analysis

WATER YEARS IN RECORD:1915-1997



AES Gage No. 1016940
30-Day (Summer) Rainfall Frequency Analysis

WATER YEARS IN RECORD:1915-1997



— PREC Computed Prob.(CP) --- PREC Expected Prob.(EP)

■ SAANICHTON CDA

Plotting:CP EP

AES Gage No. 1016940
30-Day (Winter) Rainfall Frequency Analysis

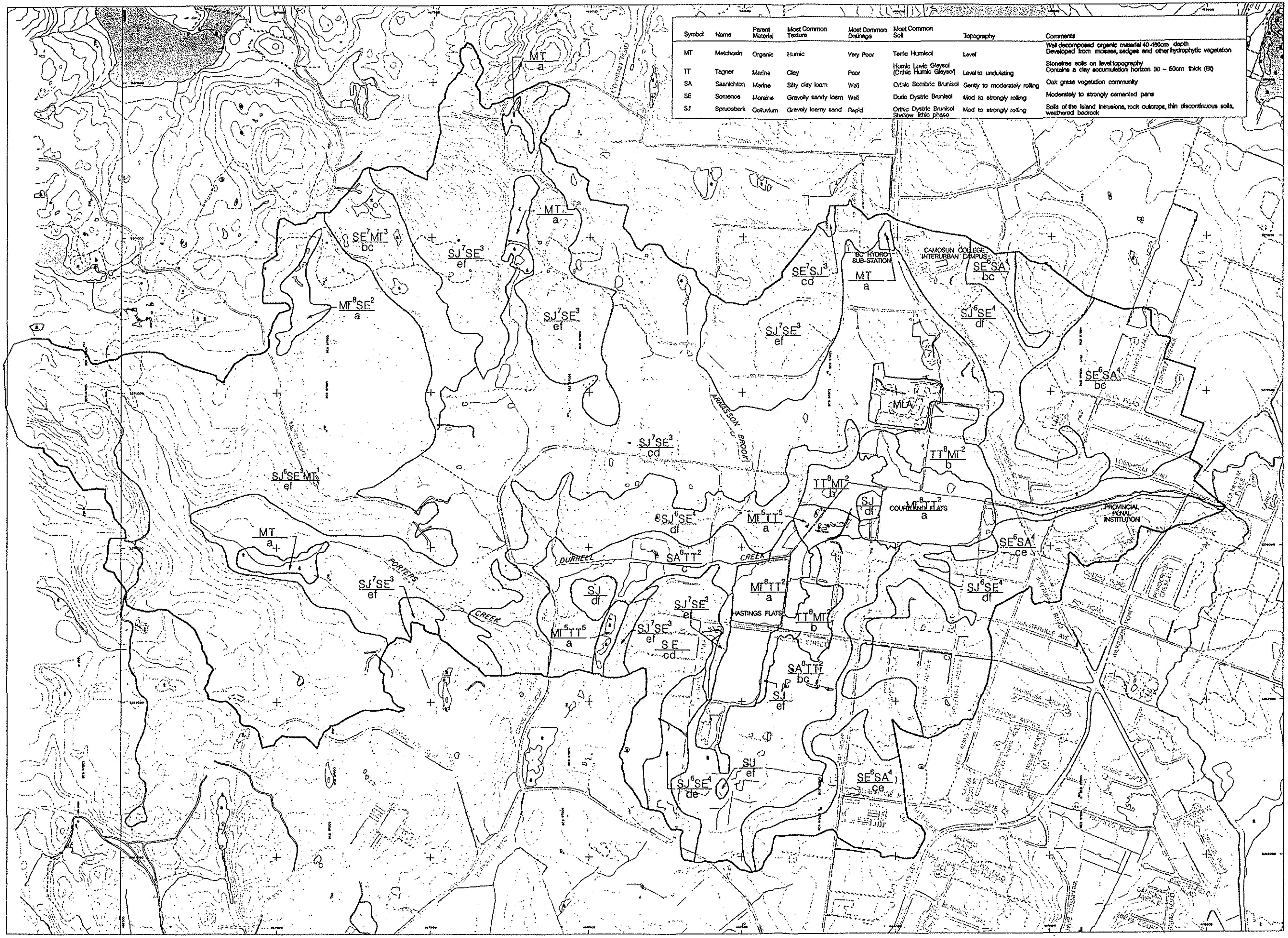
WATER YEARS IN RECORD:1915-1997

APPENDIX D

INVENTORY MAPPING


The Corporation of the District of Saanich
Durrell Creek
Integrated Watershed
Management Plan
0
250
500
Agriculture Capability
Base Map
Approximate Watershed Boundary
Drainage
Wetland
Treed Wetland
Seasonally Flooded Land
Lake
Contour
Indefinite Contour
Depression Contour
Road 2 Lane
Loose Road
Trail
TN
UTM N
mN
Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 1980 FOR CENTRE OF MAP
Annual change decreasing 4.1'
MAP REFERENCE
AGRICULTURE CAPABILITY
Pottinger Gaherty
Environmental Consultants Ltd.
a member of the Pottinger Gaherty Group
MLA

2



Symbol	Name	Parent Material	Most Common Texture	Most Common Drainage	Most Common Soil	Topography	Comments
MT	Metchosin	Organic	Humic	Very Poor	Terric Humisol	Level	Well decomposed organic material 40-160cm depth Developed from mosses, sedges and other hydrophytic vegetation
TT	Tagner	Marine	Clay	Poor	Humic Luvic Gleysol (Orthic Humic Gleysol)	Level to undulating	Stonefree soils on level topography Contains a clay accumulation horizon 30 – 50cm thick (Bt)
SA	Saanichton	Marine	Silty clay loam	Well	Orthic Sombric Brunisol	Gently to moderately rolling	Oak grass vegetation community
SE	Somenos	Moraine	Gravelly sandy loam	Well	Duric Dystric Brunisol	Mod to strongly rolling	Moderately to strongly cemented pans
SJ	Sprucebark	Colluvium	Gravely loamy sand	Rapid	Orthic Dystric Brunisol Shallow lithic phase	Mod to strongly rolling	Soils of the Island Intrusions, rock outcrops, thin discontinuous soils, weathered bedrock

The Corporation of
the District of Saanich
Durrell Creek
Integrated Watershed
Management Plan

0 250 500

Soil Survey

Base Map

Approximate Watershed Boundary

Drainage

Wetland

Treed Wetland

Seasonally Flooded Land

Lake

Contour Interval 5m

60 Contour & Elevation

Indefinite Contour

Depression Contour

Road 2 Lane

Loose Road

Trail

TN

UTM N

mN

0°41'

22°14'

Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 1980 FOR CENTRE OF MAP
Annual change decreasing 4.1'

Soil Map Unit Symbol

Soil Association Symbol

$\frac{SJ^7SE^3}{ef\ f}$

Slope Classes

Slope Classes

Simple topography Single slopes (regular)	Complex topography Multi slopes (irregular surface)	Slope %
A depressional to level	a nearly level	0 to 0.5
B very gently sloping	b gently undulating	0.5 to 2
C gently sloping	c undulating	2+ to 5
D moderately sloping	d gently rolling	5+ to 9
E strongly sloping	e moderately rolling	9+ to 15
F steeply sloping	f strongly rolling	15+ to 30
G very steeply sloping	g hilly	30+ to 60
H extremely sloping	h very hilly	over 60

MLA – miscellaneous Landfill Unit A – Fill

SOIL SURVEY

The Corporation of the District of Saanich, Surficial Materials in Landscape and Habitat Survey Atlas, Scale 1:2400, 1978

Ministry of Environment, Lands, and Parks. Soils of Southern Vancouver Island 1985.

Ministry of Agriculture and Food. Correspondence to Sonja Nienaber from Geoff Hughes Games re: Organic Soil Management. May 11, 1998.

Preliminary Soil Assessment of Hourigan/Nienaber properties. May 1998.

RGF Land Resource Consultants Ltd. Soils on Site Report – Parcel A, Section 1, Lake Land District (Plan 1313?). December 1998.

Pemming, T. Terrestrial Ecosystem Mapping of Francis King Park, [illegible]. CRD Parks.

Pottinger Gaherty Environmental Consultants Ltd.
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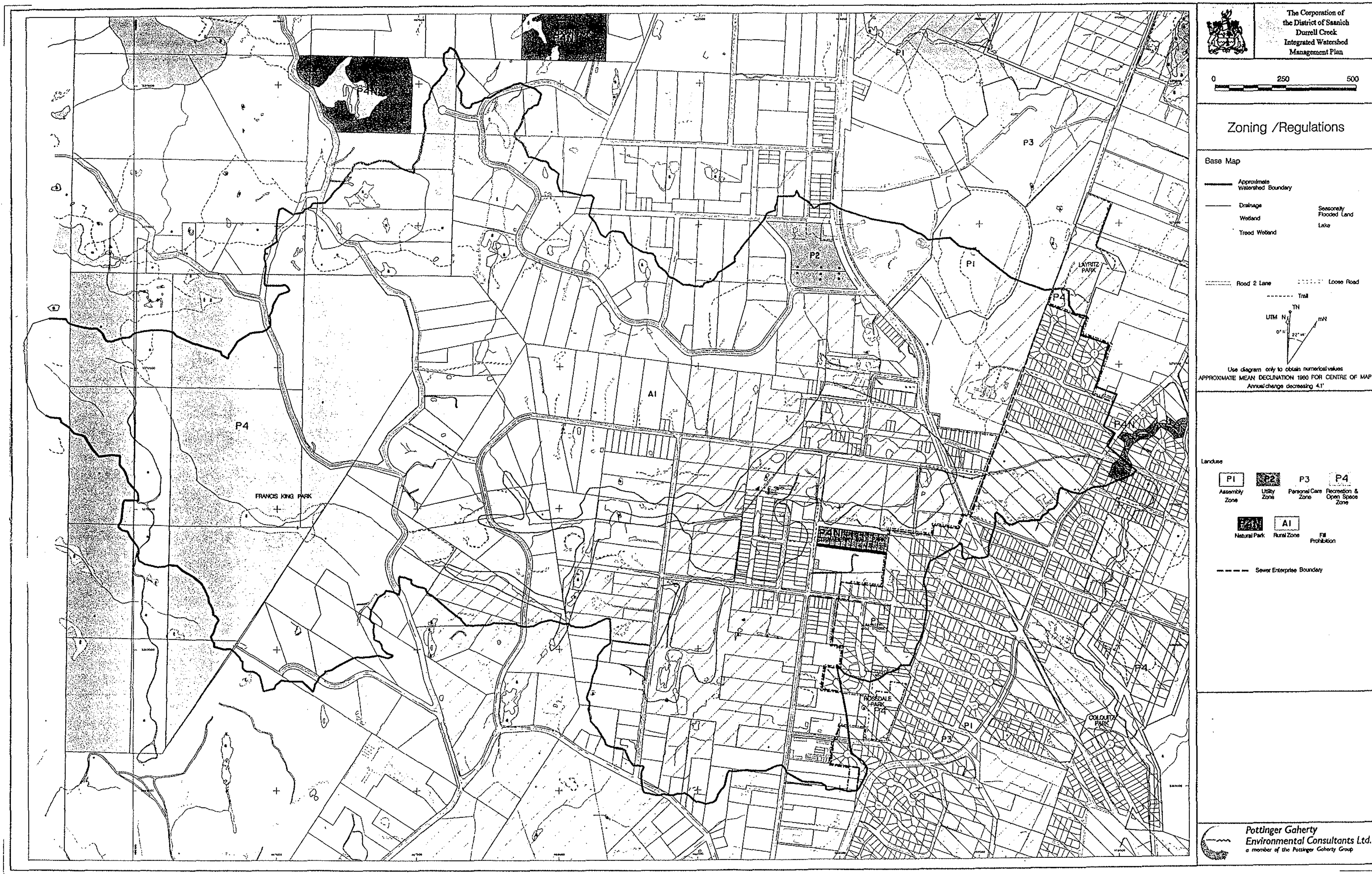
3



The Corporation of the District of Saanich
Durrell Creek
Integrated Watershed Management Plan
0 250 500
Zoning /Regulations
Base Map
Approximate Watershed Boundary
Drainage
Wetland
Treed Wetland
Seasonally Flooded Land
Lake
Road 2 Lane
Loose Road
Trail
TN
UTM N
mN
Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 1990 FOR CENTRE OF MAP
Annual change decreasing 4.1'
Landuse
P1 Assembly Zone
P2 Utility Zone
P3 Personal Care Zone
P4 Recreation & Open Space Zone
P4N Natural Park
A1 Rural Zone
Fill Prohibition
Sewer Enterprise Boundary
Pottinger Gaherty Environmental Consultants Ltd.
a member of the Pottinger Gaherty Group
P1
P2
P3
P4
A1
P4N
LAYRITZ PARK
FRANCIS KING PARK
ROSEDALE PARK
COLQUITZ PARK


The Corporation of
the District of Saanich
Durrell Creek
Integrated Watershed
Management Plan
0
250
500
Floodplain Mapping
Base Map
Approximate Watershed Boundary
Drainage
Wetland
Treed Wetland
Seasonally Flooded Land
Lake
Road 2 Lane
Loose Road
Trail
TN
UTM N
mN
0°11'
22°14'
Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 1990 FOR CENTRE OF MAP
Annual change decreasing 4.1'
FLOODPLAIN LEVELS
10 YEAR @ 11.0m
25 TEAR@ 11.3m
200 YEAR @ 12.1m
Pottinger Gaherty
Environmental Consultants Ltd.
a member of the Pottinger Gaherty Group
BC HYDRO SUB-STATION
CAMOSUN COLLEGE INTERURBAN CAMPUS
ARMASSON BROOK
DURRELL
CREEK
PORTERS
CREEK
PROVINCIAL PENAL INSTITUTION


The Corporation of
the District of Saanich
Durrell Creek
Integrated Watershed
Management Plan
0
250
500
Current Agricultural Practices
Base Map
Approximate Watershed Boundary
Drainage
Wetland
Treed Wetland
Seasonally Flooded Land
Lake
Road 2 Lane
Loose Road
Trail
TN
UTM N
mN
Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 1990 FOR CENTRE OF MAP
Annual change decreasing 4.1'
Forage
Orchard
Vegetable
Livestock
Horse / Equestrian
Nursery
Mixed
Hobby
Other
MAP REFERENCES
AGRICULTURAL PRACTICES
BC Assessment, Farm Classification. 1998.
1999 Landowner Survey
Pottinger Gaherty
Environmental Consultants Ltd.
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6


The Corporation of
the District of Saanich
Durrell Creek
Integrated Watershed
Management Plan
0
250
500
Black – Tailed Deer Habitat
Suitability Classification &
Wildlife Sightings
Base Map
Approximate Watershed Boundary
Drainage
Wetland
Treed Wetland
Seasonally Flooded Land
Lake
Road 2 Lane
Loose Road
Trail
TN
UTM N
mN
Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 1980 FOR CENTRE OF MAP
Annual change decreasing 4.1'
CALIFORNIA QUAIL Wildlife Sighting Location
Polygon Classification Symbol
65-3
Polygon Number
Suitability Class
Suitability Classes
1. High
2. Moderately High
3. Moderate
4. Low
5. Very Low
6. Nil
CONWAY ROAD
CAMOSUN COLLEGE INTERURBAN CAMPUS
CHARLTON ROAD
COURTLAND FLATS
PROVINCIAL PENAL INSTITUTION
HASTINGS FLATS
PORTERS CREEK
DEER
MUSKRAT
CHORUS FROG
GREAT HORNED OWL
BATS
CALIFORNIA QUAIL
SWANS
BUFFLEHEAD
COOPER'S HAWK
GREAT BLUE HERON
COUGAR
BLACKTAIL DEER
RACOON
GULLS
Pottinger Gaherty
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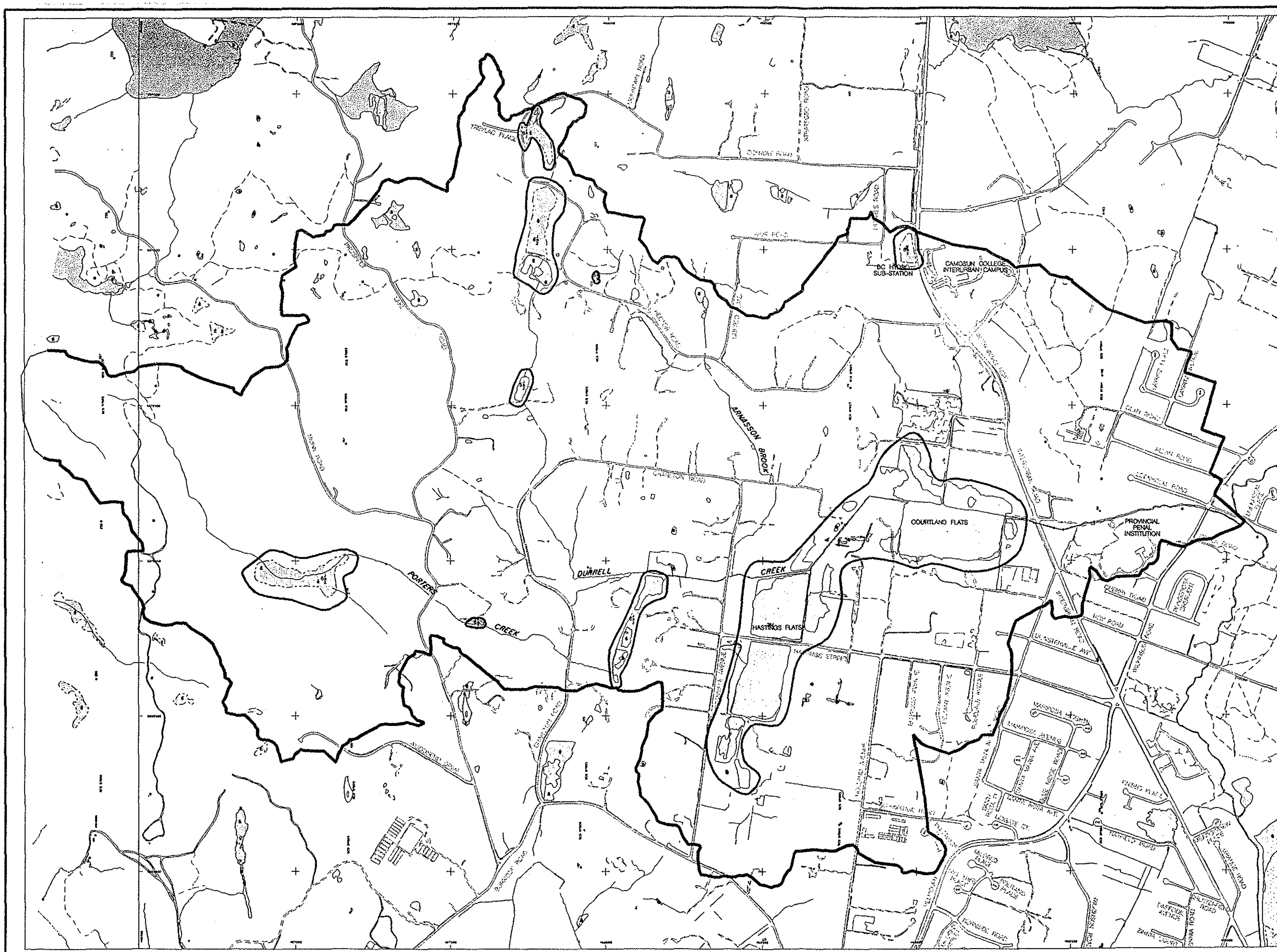

The Corporation of the District of Saanich
Durrell Creek
Integrated Watershed Management Plan

0 250 500

Waterfowl Habitat Capability Classification

Base Map

Approximate Watershed Boundary
Drainage
Wetland
Treed Wetland
Seasonally Flooded Land
Lake
Road 2 Lane
Loose Road
Trail

UTM N, TN, mN, 0°11', 22°14'

Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 1980 FOR CENTRE OF MAP
Annual change decreasing 4.1'

CLASS 1 Lands in this class have no significant limitations to the production of waterfowl

CALSS 2 Lands in this class have very slight limitations to the production of waterfowl

CLASS 3 Lands in this class have slight limitations to the production of waterfowl

CALSS 3M Lands in this special class may not be useful for waterfowl production, but are important as migration or wintering areas. This class has no subclasses

CLASS 4 Lands in this class have moderate limitations to the production of waterfowl

CLASS 5 Lands in this class have moderately severe limitations to the production of waterfowl

CLASS 6 Lands in this class have severe limitations to the production of waterfowl

CLASS 7 Lands in this class have such severe limitations that almost no waterfowl are produced

The above classes, with the exception of special class 3M are divided into subclasses according to the nature of the limitations that determine the class. Only those that apply to Durrell Creek watershed are reproduced here.

SUBCLASS J reduced marsh edge – the limitations are topographic features that adversely affect development of optimum marsh conditions along the edge of water areas.

SUBCLASS R soil depth – excessively deep or shallow waters limit the development of optimum waterfowl habitat.

SUBCLASS Z water depth – excessively deep or shallow waters limit the development of optimum waterfowl habitat.

HASTINGS AND COURTLAND FLATS
SUMMARY OF CHRISTMAS AND SPRING BIRD COUNT

SPECIES/ SPECIES GROUP	CHRISTMAS ([illegible])		SPRING ([illegible])	
	Min	Max	Min	Max
Trumpeter Swan	7	38	1	1
Canada Geese	158	412	82	110
Dabbling Ducks	868	1216	60	87
Diving Ducks	74	288	1	6
Raptors	9	16	7	16
Shorebirds	11	86	21	32
Other Birds	77	263	43	71

MAP REFERENCES

Environment Canada 1976.
Canada Land Inventory :
Capability for Wildlife – Waterfowl
Map 92 /B.

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The Corporation of
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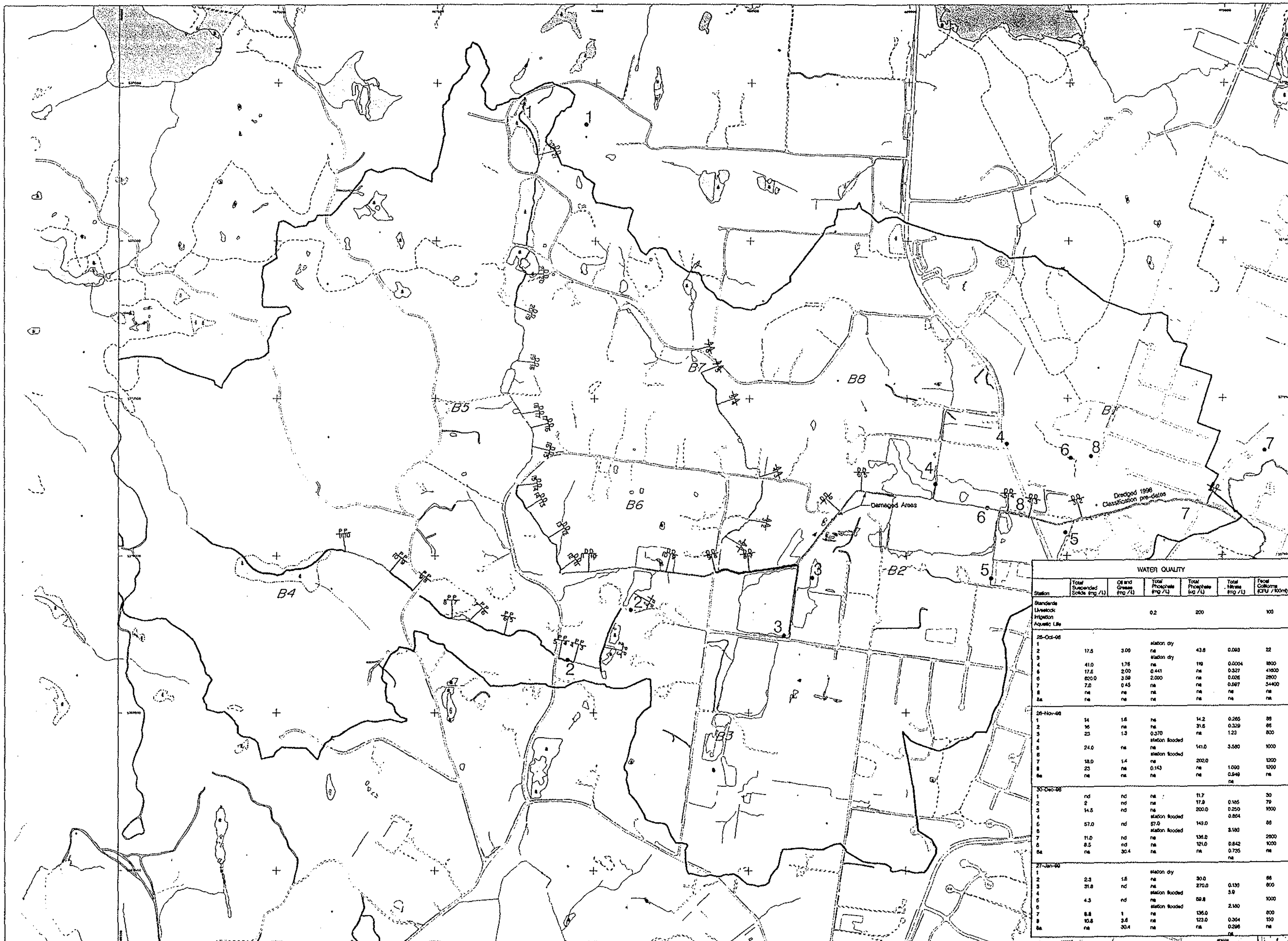
Durrell Creek
Integrated Watershed
Management Plan

0 250 500

Riparian Classification & Water Quality



Station	Total Suspended Solids (mg /L)	Oil and Grease (mg /L)	Total Phosphate (mg /L)	Total Phosphate (ug /L)	Total Nitrate (mg /L)	Fecal Coliforms (CFU /100ml)
Standards Livestock Irrigation Aquatic Life			0.2	200		100
25-Oct-98						
1			station dry			
2	17.5	3.09	na	43.8	0.093	22
3			station dry			
4	41.0	1.76	na	119	0.0004	1800
5	17.5	2.00	0.441	na	0.327	41600
6	820.0	3.59	2.090	na	0.026	2800
7	7.0	0.45	na	na	0.597	34400
8	na	na	na	na	na	na
8a	na	na	na	na	na	na
26-Nov-98						
1	14	1.6	na	14.2	0.265	86
2	16	na	na	31.6	0.329	66
3	23	1.3	0.370	na	1.23	800
4			station flooded			
5	24.0	na	na	141.0	3.580	1000
6			station flooded			
7	18.0	1.4	na	202.0		1200
8	23	na	0.143	na	1.090	1200
8a	na	na	na	na	0.949	na
					na	
30-Dec-98						
1	nd	nd	na	11.7		30
2	2	nd	na	17.0	0.165	79
3	14.5	nd	na	200.0	0.250	1000
4			station flooded		0.604	
5	57.0	nd	57.0	149.0		86
6			station flooded		3.180	
7	11.0	nd	na	136.0		2600
8	8.5	nd	na	121.0	0.842	1000
8a	na	30.4	na	na	0.735	na
					na	
27-Jan-99						
1			station dry			
2	2.3	1.5	na	30.0		66
3	31.8	nd	na	270.0	0.130	800
4			station flooded		3.9	
5	4.3	nd	na	59.8		1000
6			station flooded		2.160	
7	8.8	1	na	136.0		800
8	10.8	3.6	na	123.0	0.364	150
8a	na	30.4	na	na	0.296	na
					na	

Base Map

Approximate Watershed Boundary
Drainage
Wetland
Treed Wetland
Seasonally Flooded Land
Lake
Road 2 Lane
Loose Road
Trail

TN
UTM N
mN
0° ′
22° 14′

Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 1980 FOR CENTRE OF MAP
Annual change decreasing 4.1′

Fish Habitat & Water Quality

Riparian Classification

Riparian 1 – Tree dominant
Riparian 2 – Shrub Dominant
Riparian 3 – no shade
7 Water Quality Station
Reach Break

Good Environmental, 1999.
Durrell Creek Water Quality Assessment
(Preliminary Study) October
1998–January 1999.

District of Saanich, 1998.
Environmental Inventory to
Saanich Environmentally Significant Areas

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9

Wetland Number	Location	Wetland Classification	Comments	Dominant Vegetation
1	between Densmore Avenue, Interurban Road, north of power station	tall shrub basin swamp		willows, red-osier dogwood, hardhack, Pacific crabapple, common rush, reed canary grass
2	Liberto Road	not applicable	heavily grazed/trampled, wet depression, some standing water	not applicable
3	Hector Road	low shrub basin swamp	likely farmed in the past	hardhack, reed canary grass
4	Hector Road, near Trevlac Place	mixed shrub basin swamp some standing water	some standing water	willows, red-osier dogwood, hardhack, common rush, reed canary grass
5	private driveway off Granville Avenue	seasonally flooded	old fields	reed canary grass, hardhack
6	Courtland Avenue	seasonally flooded	seasonally flooded fields in current use	edges: reed canary grass
7	Hastings Avenue	seasonally flooded	seasonally flooded fields in current use	edges: reed canary grass
8	Francis King Regional Park	tall shrub basin swamp	large, well-developed swamp, in park least disturbed of assessed wetlands	willows, red-osier dogwood, Pacific crabapple, hardhack rich herbaceous layer, incl. slough sedge, skunk cabbage, lady fern, small-flowered bulrush, Cooley's hedge-nettle, Pacific water-parsley, American brooklime

The Corporation of the District of Saanich
Durrell Creek
Integrated Watershed
Management Plan

0 250 500

Wetland Classification

Base Map

Approximate Watershed Boundary
Drainage
Wetland
Treed Wetland
Seasonally Flooded Land
Lake
Road 2 Lane
Loose Road
Trail

UTM N TN mN
0°11' 22°14'

Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 1980 FOR CENTRE OF MAP
Annual change decreasing 4.1'

5 Wetland Classification Number

MAP REFERENCES

Zoltai S.C. and D.H. Vitt, 1995. Canadian Wetlands: environmental gradients and classification Vegetatio 118 (1-2) : 131 – 137.

Roemer, H.C. 1972. Forest Vegetation & Environments on the Saanich Peninsula, Vancouver Island, PhD. Dissertation, University of Victoria.

Vitt, D.H. 1994. An overview of factors that influence the development of Canadian peatlands, Memoirs of the Entomological Society of Canada 169 : 7 – 20

McMinn et al. 1976. Native Vegetation in B.C.'s capital region, Environment Canada, Canadian Forest Service, Victoria, B.C.

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The Corporation of
the District of Saanich
Durrell Creek
Integrated Watershed
Management Plan

0 250 500

Vegetation Communities

Site Series Symbol	Subzone /Site Series Number	Site Series Name	Typical Site Conditions	Typical Site Modifiers	Typical Soil Moisture Regime	CDC Classification
GB**	CDFmm00	Og-Brome	gentle slope, upper slope to crest position, richer nutrient regime	j,r	xeric	red
RL**		Rhacomitrium – Selaginella	Upper crest, very thin soil over bedrock,gentle slopes		xeric	red
DS	CDFmm01	Douglas fir – Salal	gentle slope, mid to upper slope position, deep, medium-textured soil	d,j,m	subxeric-mesic	red
DA	CDFmm02	Douglas fir – Arbutus	gentle slope, upper slope to crest position	j,r	xeric	blue
DO	CDFmm03	Douglas fir Gary Oak Onlongrass	gentle slope, upper slope to crest, deep medium -textured soils	d,m,r	xeric	red
DG	CDFmm04	Douglas fir Grand fir Oregon grape	gentle slope, lower slope receiving position, deep, medium -textured soils	j	subxeric-mesic	red
RK	CDFmm05	Western redcedar – Douglas fir – Oregon beaked moss	gentle slope, lower slope receiving position, deep, medium -textured soils	d,j,m	subhygric-hygric	red
RF	CDFmm06	Western redcedar – Grand fir – Foamflower	gentle slope, lower slope receiving position, deep, medium -textured soil, richer nutrient regime	d,j,m	subhygric-hygric	red
CW	CDFmm09	Act – Willow	low bench floodplain, deep medium-textured soil	a,c	subhygric-hygric	red
RC	CDFmm10	Pl – Sphagnum	depression to flat, organic bog wetland	d,j,m	subhygric	
	CDFmm11	Cw – Sunkcabbage	depression to flat, forested swamp, poorly drained, deep, medium-textured soil		subhygric	red
RR	n /a	Rural				
CF	n /a	Cultivated field				

Base Map

Approximate Watershed Boundary

Drainage

Wetland

Treed Wetland

Seasonally Flooded Land

Lake

Road 2 Lane

Loose Road

Trail

TN

UTM N

mN

0° 11'

22° 14'

Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 1980 FOR CENTRE OF MAP
Annual change decreasing 4.1'

*Site Modifiers
a active floodplain
c coarse textured soils
d deep soil (< 100 cm to bedrock)
j gentle slope
m medium textured soils
p peaty material
r rigid terrain

**Non-correlated units

Map Notes:

1. Vegetation communities in order of decreasing abundance.
2. Many polygons have some degree of disturbance and do not reflect pre-disturbance conditions.

1. CRD Parks. 1999. Terrestrial Ecosystem Mapping of Francis-King Park.

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11

The Corporation of the District of Saanich
Durrell Creek
Integrated Watershed
Management Plan

0 250 500

Land Use

Base Map

Approximate Watershed Boundary
Drainage
Wetland
Treed Wetland
Seasonally Flooded Land
Lake
Road 2 Lane
Loose Road
Trail

UTM N
TN
mN

Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 1980 FOR CENTRE OF MAP
Annual change decreasing 4.1'

Land Use

BC Hydro Row
Institutional
Park
Municipal Ownership
Industrial
Agriculture /Residential
General Residential
Rural Residential
Undeveloped Rows

MAP REFERENCE
LANDUSE
Rural Saanich Local Area Plan

Pottinger Gaherty Environmental Consultants Ltd.
a member of the Pottinger Gaherty Group

The Corporation of
the District of Saanich
Durrell Creek
Integrated Watershed
Management Plan

0 250 500

Environmentally Significant Areas

Base Map

Approximate Watershed Boundary

Drainage

Wetland

Treed Wetland

Seasonally Flooded Land

Lake

Road 2 Lane

Loose Road

Trail

TN

UTM N

mN

Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION 1980 FOR CENTRE OF MAP
Annual change decreasing 4.1'

Flooded Areas

Riparian Polygons

Significant Native Vegetation

Ponds

Streams with field data

CDC rare plant sites

MAP REFERENCES

District of Saanich
Environmentally Significant Areas
December 1998, sheets 8,11,12.

District of Saanich Base map.

Pottinger Gaherty
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APPENDIX E

PUBLIC CONSULTATION

The following public consultation materials were prepared, and the results were incorporated in the report.

Landowner Survey, mailed out to all residents in the watershed, June 1999.

Results of the Landowner Survey, compiled and distributed to the Committee, November, 1999.

Handouts and questionnaire distributed at the first Open House, October, 1999.

Handouts and questionnaire distributed at the second Open House, March, 2000.

June 1999

Pottinger Gaherty

Attention: Residents of the Durrell Creek Watershed

RE: LANDOWNER SURVEY - DURRELL CREEK INTEGRATED WATERSHED MANAGEMENT PLAN

Pottinger Gaherty Environmental Consultants Ltd. (PGL) and Northwest Hydraulic Consultants Ltd. (NHC) are developing an Integrated Watershed Management Plan (IWMP) for the Durrell Creek Watershed on behalf of the Corporation of the District of Saanich. The work of PGL is being guided by a community-based steering committee.

Development of a IWMP involves modelling of water flows, inventory and mapping of the biology and land use of the watershed, and assessment and integration of various watershed management options. The plan will outline strategies to manage water flows, practices to enhance the agriculture sector, methods to protect and/or enhance unique or environmentally significant habitats, strategies to provide for recreational opportunities, and guidelines for land development.

As part of this assignment, we are conducting a survey of landowners in the study area. We wish to ensure that the concerns and opinions of the residents of the watershed are available to the consulting team at the early stages in the planning process. Because feedback from the community is essential, we have also scheduled two public open houses at later stages of the process. The first public open house will give you an opportunity to provide early feedback on the various management options the study team has developed for the area. The second public open house will be held after a draft Watershed Management Plan has been prepared.

We appreciate your assistance in filling out the attached survey and forwarding it to our office or to Colin Doyle at the Corporation of the District of Saanich. Your feedback is important to us. If you have any questions on the contents of the survey or require clarification with regards to any of the questions, or if you would like to obtain more information about the IWMP process, please contact Colin Doyle of the Corporation of the District of Saanich at 475-1775.

POTTINGER GAHERTY ENVIRONMENTAL CONSULTANTS LTD.

Per:

Susan Wilkins, M.Sc., P.Geo.
Vice President

Attachment: Landowner Survey

1.0 GENERAL

1.1 Name and Address: ______________________
(Please provide address of property owned ______________________
within the watershed) ______________________
____

Phone Number: ______________________

1.2 Please indicate the area within which your property is located, as shown on the attached map:

Residential Lots within the Urban Containment Boundary ______
Rural Lots within the Agriculture Land Reserve (ALR) ______
Rural Lots outside the ALR ______

1.3 Please circle the approximate location of your property on the attached map.

1.4 How long have you resided in the study area?

< 1 year ______
1-5 years ______
5-10 years ______
> 10 years ______

1.5 Indicate below the reasons why you live in the Durrell Creek Watershed.

Good schools	______	More natural environment than urban	______
Lifestyle	______	Close to employment	______
Born here	______	Agriculture opportunities	______
Friends live here	______	Inexpensive, suitable housing	______
Relatives live here	______	Better Municipal services	______
Want large land parcel	______	Recreational opportunities	______
Chance	______	Privacy	______
Other (please specify)	______		

2.0 AGRICULTURE

2.1 How important is the protection of agricultural land and food production to you?

Very important ______
Somewhat important ______
Not important ______
Unsure ______

2.2 Do you think it is possible to improve the viability of agriculture on agricultural lands in the Durrell Creek Watershed?

Yes________ No ________ Unsure___________

If yes, please indicate what you believe is required to improve agriculture viability:

Development of a regional drainage strategy	______
Improvement of on-farm drainage practices	______
Improvements to irrigation water supply	______
Improvements to water quality	______
Improvements to transportation network	______
Promotion of sustainable agriculture practices	______
Reduction of vandalism/trespassing on agriculture land	______
Improvements in agriculture land capability	______
Other (please specify)	______

If you have never used your property for agricultural use or other land-based operations (see Question 2.5 for examples), please skip to Section 3.0 - Water on page 5.

2.3 Is your property within the Agriculture Land Reserve?

Yes________ No ________ Unsure___________

2.4 Is your property zoned for Agricultural Use?

Yes________ No ________ Unsure___________

2.5 Is your parcel classified as a farm under the BC Assessment Act?

Yes________ No ________ Unsure___________

If yes, please indicate parcel size: ___________

2.5 If you currently have agriculture or other land-based operations on your property, please indicate the following:

Activity	Specify Type (i.e., potatoes, apples, raspberries, beef, dairy, goats, sheep, etc., Christmas trees)	Quantity (# hectares or # of animals)	Yield (kg/ha)
Vegetables			
Orchard			
Berries			
Nursery Stock			
Forage (hay, silage, pasture)			
Horse/Equestrian			
Greenhouse			
Specialty Crop Agriculture			
Livestock			
Other (please specify)			

2.6 Other than the activities indicated above, what other types of agriculture or land-based operations have been conducted on your property in the past, to your knowledge?

Crop/Farming Type	Specify Type	Quantity (# hectares or # of animals)	Date (s)

2.7 Are your agriculture or other land-based operations affected by trespassing or vandalism?

Yes________ No _______ Unsure___________

If yes, please specify:

____

____

2.8 What is the average gross annual revenue of agriculture and other land-based operations on your property?

< $2499	______
$2500-$5000	______
$5000-$10,000	______
$10000-$20000	______
$20000-$30000	______
$30000-$50000	______
> $50000	______

2.9 What is the average employment contribution of agriculture and other land-based operations on your property in employee-days/year?

< 15 days	______
15-30 days	______
31-60 days	______
61-90 days	______
> 90 days	______

2.10 With drainage and/or irrigation improvements, would you anticipate any change in the gross annual revenue and employment contributions to be on your property?

Increase in Revenue ($/year)		Increase in Employment Contribution (employee-days/year)	
< $2499	______	< 15 days	______
$2500-$5000	______	15-30 days	______
$5000-$10,000	______	31-60 days	______
$10000-$20000	______	61-90 days	______
$20000-$30000	______	> 90 days	______
$30000-$50000	______		
> $50000	______		

3.0 WATER

Flooding

3.1 Does flooding impede or prevent agriculture or residential development on your property?

Yes________ No _______ Unsure___________

If no, please skip to Question 3.8.

3.2 Please indicate the nature of the problem caused by flooding:

Late seeding due to early season floods ______
Harvest losses due to floods in early fall ______
Pasture flooded ______
Existing buildings affected ______
Prevent development of new buildings ______
Other (please specify) ______

3.3 Indicate the approximate number of acres that are affected in each of the following seasons:

Spring/Summer (April 15-September 30)	Fall/Winter (October 1-Apr 15)	Date
______	______	______
______	______	______
______	______	______
______	______	______
______	______	______

If possible, please provide records on an annual basis for as far back in time as information is available (use space on back of page if necessary).

3.4 Indicate the approximate number of times you have flooding problems during the following seasons:

Spring/Summer (April 15-September 30)	Fall/Winter (October 1-Apr 15)	Date
______	______	______
______	______	______
______	______	______
______	______	______
______	______	______

3.5 Provide a range of the number of days each flood event lasts during the following seasons:

Spring/Summer (April 15-September 30)	Fall/Winter (October 1-Apr 15)	Date
________	________	________
________	________	________
________	________	________
________	________	________
________	________	________

3.6 Do you have an opinion on the cause of the flooding problem?

____
____
____

3.7 Do you know of any drainage improvements on your land? If yes, what type?

____
____
____

Irrigation

3.8 Do you use irrigation on your property?

Yes_________ No ________ Unsure____________

If no, please skip to Question 3.11.

3.9 Please indicate the following:

Source of irrigation water:
Municipal supply_____ Well water_____ Surface water_____
Timing of irrigation: ______________________________
Amount of irrigation used:___________________________
Would you expand productions if water was cheaper in price?____________

3.10 Do you have enough water for irrigation?

Yes_________ No ________ Unsure____________

If no, please indicate the following:

How much additional water do you need for acres already irrigated? ________________

How many additional acres would be irrigated if a supply was available? ______________

Would you expand crop productions if water was available? ______________________

Water Use/Quality

3.11 Would you make changes in your agricultural or other land-based operations in the next five years if water problems were improved? (i.e. through improvements to regional flood control, drainage, or irrigation).

Yes________ No ________ Unsure___________

If yes, please indicate how:

Expansion of existing operations ________
Production of new crops (specify type and acreage) ________
Changes to current on-farm drainage practices ________
Changes to current on-farm irrigation practices ________
Other changes (please specify) ________
Unsure ________
No changes would be made ________

Please explain.

____
____
____

3.12 Is your property adjacent to a watercourse(s)?

Yes________ No ________ Unsure ________

3.13 Are you aware of any water quality problems in your area?

Yes________ No ________ Unsure ________

- If yes, what do you believe to be the possible source?

  Faulty Septic Systems ________
  Urban Runoff ________
  Wildlife ________
  Livestock ________
  Herbicides ________
  Fertilizers ________
  Cross connections ________
  Other (please specify) ________

3.14 If you rely on well water, please answer the following questions:

Is your water supply adequate?
Yes________ No ________ Unsure ________

Do you have problems with water quality?
Yes________ No ________ Unsure ________

H[illegible] you needed to truck in water?
Y[illegible] ________ No ________ Unsure ________

A[illegible] [illegible]ou concerned about not having municipal water?
Yes________ No ________ Unsure ________

4.0 BIOLOGY

4.1 Have you noticed any changes to your observations of the frequency and type of wildlife found in the watershed over time?

Yes________ No ________ Unsure ________

If yes, please explain.

____
____
____

4.2 Is your property and/or farming operations affected by "problem" wildlife?

Yes________ No ________ Unsure ________

- If damage to crops is occurring, please indicate type of losses and amount in dollar value.

____

____

____

4.3 Are you aware of any rare or unique plant species, plant communities or wildlife species your property or in the watershed?

Yes________ No ________ Unsure ________

If yes, please explain and indicate location.

____

____

____

4.4 Are there any natural features of the Durrell Creek Watershed that you particularly like?

____

____

____

4.5 How important is the protection and enhancement of fish and wildlife habitat in this watershed to you?

Fish:
Very important ________
Somewhat important ________
Not important ________
Unsure ________

Wildlife:
Very important ________
Somewhat important ________
Not important ________
Unsure ________

4.6 What changes would you like to see in the protection and management of fish and wildlife habitat in the Durrell Creek Watershed?

Activity	More	Same	Less
Habitat enhancement			
Habitat protection			
Pollution control			
Control of development			
Remediation of development impacts			
Education			
Other (Please specify)			

5.0 STEWARDSHIP

5.1 Would you support actions by local Stewardship groups, Provincial Agencies or the Municipality to undertake streamside enhancement work on your property, such as planting of native plant species?

Yes________ No ________ Unsure ________ Not Applicable________

If you are in favour, why?

Protect what's left for future generations ________
Improve aesthetics ________
Improve recreational opportunities ________
Improve water quality ________
Enhance fish/wildlife habitat ________
Other (please specify) ________

If you are not in favour, please explain:

____

____

____

5.2 Please indicate which of the following stewardship activities you might be willing to have undertaken on your property to maintain or enhance fish and wildlife habitat:

Activity	Yes	No	Unsure	Not Applicable
Planting of native plant species				
Creation of a buffer strip around riparian or wetland areas				
Construction of a fence around sensitive areas (i.e. riparian zones or nesting areas) to restrict access by livestock				
Use of a winter cover crop for wildlife forage				
Removal of invasive plant species				
Environmentally responsible stormwater management				
Construction of nest boxes for birds				
Other (please specify)				

5.3 Might you be willing to undertake some of these activities by yourself on your property to maintain or enhance wildlife habitat?

Yes________ No _______ Unsure _______ Not Applicable_______

If yes, please indicate which of the above activities you might be willing to undertake:

____

____

5.4 Might you be willing to enter into an agreement to protect the natural environment on your property?

Yes________ No _______ Unsure _______ Not Applicable_______

If yes, please indicate which of the following options you might consider:

Verbal agreements	_______
Written stewardship agreements without tax incentives	_______
Written stewardship agreements with tax incentives	_______
Leases	_______
Licenses	_______
Conservation covenants	_______
Restrictive covenants	_______
Easements	_______
Outright sale of property	_______
Donation or bequest	_______
Unsure	_______
Other (please specify)	_______

6.0 LAND USE

6.1 Do you think the mix of land uses in the watershed is appropriate? Please indicate your opinion on the amount of area allocated to the following land uses:

Land Use	Increase	Decrease	Same	Unsure
Agriculture				
Urban Residential				
Rural Residential				
Recreation				
Parks				
Nature Preserves				
Commercial				
Industrial				
Institutional				
Other (please specify)				

6.2 Indicate the number of days per year that you participate in the following recreational activities in this study area. Indicate how you would rate the study area in terms of recreational value (P=Poor, F=Fair, G=Good, E=Excellent)?

Activity	No. Days/Year	Rating
Hiking or walking		
Cycling		
Birdwatching		
Horseback Riding		
Picnicking		
Other (Please specify)		

6.3 Would you like to see an expansion in the following recreational opportunities provided in this watershed?

Hiking Trails Yes________ No ________ Unsure________
Birdwatching Blinds Yes________ No ________ Unsure________
Mountain Biking Trails Yes________ No ________ Unsure________
Commuter Cycling Network Yes________ No ________ Unsure________
Picnicking Areas Yes________ No ________ Unsure________
Equestrian Trails Yes________ No ________ Unsure________
Playgrounds Yes________ No ________ Unsure________
Playing fields Yes________ No ________ Unsure________
Other (Please specify)

6.4 Indicate what you believe to be the possible positive and/or negative aspects of increasing recreational opportunities in the watershed:

Negative:
Increase in traffic/parking ________
Impacts on agriculture ________
Increased vandalism ________
Impacts on wildlife ________
Other (please specify) ________

Positive:
Healthy lifestyle ________
Boost local business ________
Promote protection of natural areas ________
Educational opportunities ________
Other (please specify) ________

6.5 A number of undeveloped road allowances/public rights of way exist in the watershed. Indicate whether you would be in favour of the following uses of these areas:

Road development	Yes________	No ________	Unsure________
Pedestrian trails	Yes________	No ________	Unsure________
Equestrian trails	Yes________	No ________	Unsure________
Cycling trails	Yes________	No ________	Unsure________
Purchase by adjacent landowners	Yes________	No ________	Unsure________
Preserve as natural areas	Yes________	No ________	Unsure________
Safe walking routes to school network	Yes________	No ________	Unsure________
Other (please specify)	________		

6.6 Do you know of any areas in the watershed that should be acquired for parks and/or recreation purposes? If yes, please explain why and provide location(s).

____
____
____

6.7 Do you have a problem with trespassing or vandalism on your property?

Yes________ No ________ Unsure____________

If yes, please specify:

____
____

RESULTS OF LANDOWNER SURVEY

The results of the landowner survey of the Durrell Creek Watershed are outlined below. A summary is given for all respondents, and where interesting trends were observed, results were also summarized for the three geographical areas (sub-areas) identified in the survey namely residents within the Urban Containment Boundary, residents of rural lots within the ALR, and residents of rural lots outside the ALR.

A total of 60 residents responded to our survey of approximately 600 surveys that were mailed, giving a response rate of 10%. The actual number of residents in the watershed may be lower than the number mailed as some surveys were mailed to residents just outside of the watershed boundary, some residents own more than one property and thus received more than one survey, and some surveys were returned unopened.

GENERAL

- *Please indicate the area within which your property is located, as shown on the attached map:*

28% of respondents reside in residential lots within the Urban Containment Boundary (UCB), 19% reside in rural lots within the Agriculture Land Reserve (ALR) and 53% reside in rural lots outside the ALR.

- *How long have you resided in the study area?*

The majority of residents in the watershed have resided in the area for more than 10 years. Out of the total respondents in all areas, 2% resided for <year, 15% resided for 1-5 years, 25% resided for 5-10 years, and 53% resided > 10 years.

Within the UCB, 7% resided < 1 year, 33% resided 5-10 years and 40% resided > 10 years. Within the ALR, 10% resided 1-5 years, 40% resided 5-10 years and 50% resided > 10 years. Rural lots outside the ALR, 25% resided 1-5 years, 14% resided 5-10 years and 61% resided > 10 years.

- *Indicate below the reasons why you live in the Durrell Creek Watershed.*

Several respondents indicated more than one reason for living in the Durrell Creek Watershed. Following, is a list of reasons (in order of preference):

1. More natural environment than urban *(71%)*
2. Privacy *(66%)*
3. Lifestyle *(56%)*
4. Want large land parcel *(40%)*
5. Close to employment *(21%)*
6. Agriculture opportunities *(13%)*
7. Recreational opportunities *(13%)*
8. Relatives live here *(12%)*
9. Inexpensive, suitable housing/Good schools *(12%)*
10. Chance *(10%)*
11. Born here *(6%)*
12. Friends live here *(4%)*
13. Better Municipal services *(2%)*

Results were similar within each of the geographical areas; all areas indicated more natural environment than urban, privacy, and lifestyle as the top three reasons for living in the Durrell Creek Watershed. Wanting a large land parcel was also important for rural residents inside and outside the ALR. Other reasons indicated include having neighbours who care about the environment, picturesque scenery, location of a residential care facility, horseback riding opportunities, presence of a natural creek, suitable housing, and parks.

AGRICULTURE

- *How important is the protection of agricultural land and food production to you?*

Of the 53 respondents, 71% indicated that it was very important, 19% said it was somewhat important, 8% said it was not important and 2% were unsure about their opinion.

Residents within the ALR have a stronger opinion about the importance of agricultural land than residents within the UCB and rural residents outside the ALR. Within the UCB, 67% indicated that protection of agricultural land and food production is very important, 13% said it is somewhat important and 13% indicated it is unimportant. Within the ALR, 90% of residents indicated it is important and 10% indicated it is not important. Of the residents of rural lots outside the ALR, 64% agreed it is very important, 28% said it was somewhat important, 8% indicated it was not important and 2% were unsure about their opinion.

- *Do you think it is possible to improve the viability of agriculture on agricultural lands in the Durrell Creek Watershed?*

Of the 53 total respondents, 45% said yes, 15% said no and 36% were unsure about their opinion. Within the UCB, 27% said yes, 13% said no and 53% were unsure; within the ALR 70% said yes, 10% said no and 20% were unsure; rural lots outside the ALR 46% said no, 18% said no and 32% were unsure.

Of the total respondents, the following is the list (in order of preference) of methods believed are required to improve agriculture viability:

1. Development of a regional drainage strategy *(38%)*
2. Promotion of sustainable agriculture practices *(25%)*
3. Improvements in agriculture land capability *(19%)*
4. Improvement of on-farm drainage practices *17%)*
5. Reduction of vandalism/trespassing on agriculture land *(15%)*
6. Improvements to irrigation water supply *(13%)*
7. Improvements to water quality *(9%)*

Within each of the three sub-areas, development of a regional drainage strategy and promotion of sustainable agriculture practices were the preferred answers. Some agreed with a drainage strategy as long as wildlife & wetland natural areas are protected. Other comments include prevent encroachment of residential housing on agricultural land, return water diverted into valley through 40+ culverts to original destination, a new larger culvert is required under Granville Ave to replace present one that is flattened and much too small, provide more equestrian opportunities, and clean-up local businesses and contaminated run-off. Another suggestion is for the Municipality to install a flood control weir such as the one at Cumberland Road, Saanich and to install two horse power 3 phase volume pumps similar to what is installed at No. 3 Road and Steveston Highway, Richmond, BC to lift the water out at critical times in spring and fall.

If you have never used your property for agricultural use or other land-based operations, please skip to Section - Water on page 5.

The following questions were answered by 24 respondents.

- *Is your property within the Agriculture Land Reserve?*

Of the respondents 38% said yes, 42% said no and 19% were unsure. The majority of residents that indicated yes are located within the ALR.

- *Is your property zoned for Agricultural Use?*

Of the respondents, 33% indicated yes, 33% indicated no and 33% were unsure.

- *Is your parcel classified as a farm under the BC Assessment Act?*

Of the 53 respondents, 33% indicated yes, 58% indicated no and 8% were unsure. The majority of residents who had parcel classified as a farm were located within the ALR. Parcel sizes ranged from 1.01 to 4.1 hectares.

- *If you currently have agriculture or other land-based operations on your property, please indicate the following:*

The majority of response came from residents within the ALR. Equestrian operations were the most common. Vegetables (corn, potatoes), orchard crops (apples, pears, plums, grapes), hay, pasture, berries, livestock (chickens, eggs), equestrian (training and boarding), and walnuts/hazelnuts are also farmed. A number of rural residents outside the ALR have hobby farms, equestrian, pasture and livestock (eggs, beef, pigs, sheep, goats, rabbits, llamas, and veal) operations. Agriculture activity was not noted for residents within the UCB.

- *Other than the activities indicated above, what other types of agriculture or land-based operations have been conducted on your property in the past, to your knowledge?*

Much of the response was from residents within the ALR. Within the ALR historic operations have included beef, dairy, chickens, pigs, horses, cattle, goats, silage, orchard, raspberries, and vegetable farming. Historic operations in rural areas outside the ALR include beef, horse, duck, pigs and cattle farming.

- *Are your agriculture or other land-based operations affected by trespassing or vandalism?*

Few residents from all the study areas indicated problems with trespassing and vandalism. The problems which were mentioned included partying by teens and minor property and crop theft. These incidences were mainly noted from residents in the ALR.

- *What is the average gross annual revenue of agriculture and other land-based operations on your property?*

There were few responses to this question and most responses were from residents within the ALR. Generally revenues from agriculture and other land based operations are <$2,499, with several farms reporting incomes up to $10,000 and one <$50,000.

- *What is the average employment contribution of agriculture and other land-based operations on your property in employee-days/year?*

There were few responses to this question and most responses were from residents within the ALR. Generally, average employment from agriculture and other land-based operations is <15 days per year, with one landowner reporting 15-30 days and one landowner reporting 61-90 days.

- *With drainage and/or irrigation improvements, would you anticipate any change in the gross annual revenue and employment contributions to be on your property?*

There were few responses to this question but generally the answer was < $2499 increase in revenue and < 15 days increase in employment contribution. Most response came from residents within the ALR.

WATER

Flooding

1. Does flooding impede or prevent agriculture or residential development on your property?

Out of the total 53 responses, 23% indicated their property had flooding problems, 66% did not and 8% were unsure.

Within the UCB, 7% of respondents had flooding problems, 73% did not and 7% were unsure. Within the ALR, 70% of respondents had flooding problems, 10% did not and 20% were unsure. Outside the ALR, 23% of respondents had flooding problems, 66% did not and 8% were unsure.

If no, please skip to Question 3.8.

'The following questions were answered by 12 respondents.

2. Please indicate the nature of the problem caused by flooding:

Much of the problems associated with flooding were reported by residents within the ALR. Of those who responded,, problems with flooding include late seeding due to early season floods (33%), harvest losses due to floods in early fall (17%), pasture flooding (42%), flooding affecting existing buildings (17%), and flooding preventing development of new buildings (42%). Few rural residents outside the ALR reported flood problems. Those that did indicated flooding mainly affected pastures and prevented the development of new buildings. Only one resident within the UCB had flooding problems and indicated flooding affected the development of new buildings. One resident indicated the quality of soil is diminished by winter flooding as it cannot be used for pasture in fall and winter due to flooding, therefore also reducing quality of hays

3. Indicate the approximate number of acres that are affected in each of the following seasons. If possible, please provide records on an annual basis for as far back in time as information is available (use space on back of page if necessary).

There were few responses to this question. On average approximately 0.6 to 2.0 acres are affected by flooding within and outside the ALR areas, with much of it occurring in the fall/winter.

4. Indicate the approximate number of times you have flooding problems during the following seasons:

There were few responses to this question. Some indicated flooding occurs every year during the fall/winter, and flooding is uncommon in spring/summer. Some indicated flooding is most common after significant rainfalls.

5. Provide a range of the number of days each flood event lasts during the following seasons:

There were few responses to this question. Some respondents indicated that fall/winter flooding lasts 1-2 days following heavy rain, others say flooding lasts from November through April. One respondent indicated water has to be pumped each year (Apr., May & June) before the land can be worked.

6. Do you have an opinion on the cause of the flooding problem?

The main reasons for the cause of flooding are assumed to be from inadequate culverts, poor drainage, and heavy rainfall. Comments include:

- *The municipality is using the valley for a catchment basin and storage area,*

- *Siltation & absence of watercourse maintenance in section b/w Interurban and Wilkinson; inadequate function of culvert at Interurban*
- *Need larger culvert under Granville Ave; Granville culvert partially collapsed*
- *More storm drains from upland development pointed down here; Restriction from road base and culvert on Interurban Rd; Channel behind jail choked up with canary grass & silt*
- *Poor ditch maintenance*
- *Heavy rainfall*
- *Colquitz River*
- *Increased run-off on Colquitz Creek caused by development on its drainage areas.*
- *Camosun college*
- *The culvert which crosses Hastings has insufficient capacity and is not deep enough to handle the volume of water*
- *Small culverts*

7. Do you know of any drainage improvements on your land? If yes, what type?

Only a few residents responded to this question. Most respondents indicated that they were not aware of any improvements. A few residents in the area outside the ALR were aware of some improvements such as ditches, ditched field margins, and drainage pipe.

Irrigation

8. Do you use irrigation on your property?

Of the total 53 respondents, 17% said yes and 77% no. Within the UCB 7% said yes and 87% said no. Within the ALR, 30% said yes and 60% said no. Residents of rural lots outside the ALR, 18% said yes and 79% said no.

If no, please skip to Question 3.11.

The following questions were answered by 9 of 53 respondents.

9. Please indicate the following:

Of those who use irrigation (mainly inside and outside the ALR), municipal supply is the most popular method followed by well water. Generally irrigation is used in the summer as required, maybe a few times a week. Most respondents in all the study areas indicated that they would not expand productions if water were cheaper in price.

10. Do you have enough water for irrigation?

Most of the residents indicated that they had enough water for irrigation. One indicated there is not enough pressure.

If no, please indicate the following:

How much additional water do you need for acres already irrigated?

How many additional acres would be irrigated if a supply was available?

Would you expand crop productions if water was available?

There was not much response to these questions. A few rural residents inside and outside the ALR) indicated that they would not expand crop productions if water were available.

Water Use/Quality

11. Would you make changes in your agricultural or other land-based operations in the next five years if water problems were improved? (i.e. through improvements to regional flood control, drainage, or irrigation).

Of the total 53 respondents, 17% said yes, 60% said no and 6% were unsure. Within the UCB, 7% said yes and 53% said no. Within the ALR 50% said yes, 30% said no and 10% were unsure. Rural residents outside the ALR, 11% said yes, 75% said no and 7% were unsure.

If water problems were improved, several rural residents within and outside the ALR would consider expansion of existing operations, production of new crops (i.e. corn, carrots, onions & cauliflower) and changes to current on-farm irrigation practices. Some other comments by respondents about the improvement of irrigation and its effects on their agricultural practices are: that it would provide more pasture for livestock, cover crops could be used to replenish organic soil, quality of hay would be improved as well as quantity if land not so soggy all winter, grass seed would survive winter, some would look into fruit tree & berry crops, with the installation of a dam and pump most of the land could be double-cropped in one season, and one would consider the construction of another residence on their property. One resident was concerned drainage would reduce a man-made on their property and therefore lessen the value of the property.

12. Is your property adjacent to a watercourse(s)?

Out of the 53 respondents, 30% said yes, 43% said no and 11% said they were unsure. The majority of the residents located adjacent to the watercourse are rural residents living within and outside the ALR.

13. Are you aware of any water quality problems in your area?

Out of the 53 respondents, 15% said yes, 64% said no and 11% said they were unsure. The majority of residents who indicated they are aware of the water quality problems are located in the ALR area. Respondents indicated they believe the primary sources of the problem to be faulty septic systems and urban runoff. Wildlife, cross-connections, fertilizers and herbicides were also noted as possible sources however, livestock was not implicated as a potential source. One respondent was concerned about run-off from the MacNutt operation. Another respondent advised of the necessity of retaining treed and bushy areas in order to prevent flooding -- the more clearing, the more problems, the more roads, the more runoff.

14. If you rely on well water, please answer the following questions:

The following questions were answered by rural residents within and outside the ALR.

Is your water supply adequate?
All respondents answered yes.

Do you have problems with water quality?
One respondent said yes and all other respondents said no.

Have you needed to truck in water?
All respondents said no.

Are you concerned about not having municipal water?
17% said yes, 78% said no and 6% said they were unsure.

BIOLOGY

1. Have you noticed any changes to your observations of the frequency and type of wildlife found in the watershed over time?

Of the total 53 respondents, 53% said yes, 40% said no and 4% were unsure. Within the UCB, 40% said yes, 40% said no and 7% were unsure. Within the ALR, 70% said yes and 30% said no. Outside the ALR, 53% said yes, 43% said no and 4% were unsure. Comments include the following:

- *Disappearance of California Quail & Ring-Necked Pheasant*
- *Sudden appearance of bullfrogs and reduction of other frog populations*
- *Increase in deer*
- *Reduced numbers of wintering waterfowl*
- *Reduction in nesting species (e.g. marsh wren, blackbird)*
- *Fewer wild rabbits and song birds, more Canada Geese and starlings*
- *Less swans, less great blue herons*
- *Higher the water on flats in winter, less ducks & trumpeter swans as they can't dabble for food, this in turn makes hunting more difficult for eagles*
- *Used to have a neighbour who shot wildlife, increase in squirrels & deer since he died*
- *Less snakes in last 2 yrs, also less racoons*
- *No longer see deer around the vicinity of the Wilkinson Correctional Institution*
- *More turkey vultures*
- *Beaver dam on Hastings Flat ploughed under years ago*
- *No river otters in recent years*
- *With increased rabbit & squirrel populations, hawk and eagle populations have expanded noticeably*

2. Is your property and/or farming operations affected by "problem" wildlife?

Of the total 53 respondents, 40% said yes and 55% said no. Within the UCB, 27% said yes and 60% said no. Within the ALR, 60% said yes and 40% said no. Outside the ALR, 39% said yes and 57% said no.

If damage to crops is occurring, please indicate type of losses and amount in dollar value.

Few residents responded to this question indicating there are few problems in the watershed related to wildlife damage to crops. Generally, comments regarding crop damage included garden damage by deer, rabbits, starlings and rats. Comments include:

- Deer can be a problem at times
- Grey squirrels strip apple trees
- Half of hay pasture lost to geese, crows, starlings

- Soil loss next to watercourse when gees stirring up topsoil and it is carried downstream – huge problem because fill prohibition prevents elevations from being restored, land now lower than before
- Deer eat all domestic plants, racoons kill chickens, ducks, peasants, etc.
- The deer are a nuisance as they eat both vegetables & flower gardens

3. Are you aware of any rare or unique plant species, plant communities or wildlife species your property or in the watershed?

Of the total 53 respondents, 38% said yes, 38% said no and 11% said they were unsure. Within the UCB, 33% said yes, 27% said no and 13% said they were unsure. Within the ALR, 50% said yes, 20% said no and 20% were unsure. Rural residents outside the ALR, 36% said yes, 50% said no and 7% said they were unsure. Rare or unique plant species indicated by respondents include garry oaks, lilies, camas, trilliums, yew, black choke cherry, indian plum, pacific crabapple, black hawthorn. Rare or unique wildlife include pheasants, blue heron, merlin hawks, and presence of an eagle nest. Others indicated rare plants such as chocolate lilies, white fawn lilies, shooting stars, sea blush, blue eyed mary, and calypso are present but disappearing, some implicated residential encroachment.

4. Are there any natural features of the Durrell Creek Watershed that you particularly like?

Comments from residents include:

- Garry oaks with cmas and rocky outcroppings
- The combination of rich farmland, forested areas, streams and wildlife
- Eagle Habitat, rolling wide open spaces, seasonal water features, rich soils, vegetation
- Abundant wildlife and low human impact, winter waterfowl, agriculture in spring, summer and fall
- Floodplains
- Trails, rural feel
- Rocks covered with moss, firs, arbutus
- Trestle Valley has a man-made ditch which is called Durrell Creek, so Saanich may claim flood-plain designation for the valley
- The fact that it is left natural for wildlife (eg.swans, geese, deer, frogs), it can also be farmed
- Enjoy the rural lifestyle & natural surroundings
- Banks in creek of our property have been left in there natural condition
- None, it produces too many mosquitoes
- Low population density

- Close to downtown, but yet urban
- Migratory birds, muskrats
- Seasonal ponding & natural wetland, bird breeding areas created by the seasonal lakes
- Lack of development, pristine view from my address
- I like the seasonal flooding & the subsequent waterfowls it attracts
- Francis King-Freeman Park superb, Porters creek still in natural state at midstream – would like to see it protected
- Habitat diversity – Garry oak, Douglas fir, Cedar communities & wetlands

5. How important is the protection and enhancement of fish and wildlife habitat in this watershed to you?

Of the total 53 respondents, 55% agreed it was very important to protect and enhance fish habitat and 66% agreed that it was very important to protect and enhance wildlife habitat. 23% said it was somewhat important to protect the fish and 21% said it was somewhat important to protect wildlife. 13% said it was not important to protect the fish and 8% said it was not important to protect the wildlife. Responses were similar within each of the three sub-areas. Comments included there is no fish.

6. What changes would you like to see in the protection and management of fish and wildlife habitat in the Durrell Creek Watershed?

Habitat enhancement	*34% said more, 40% said same*
Habitat protection	*45% said more, 40% said same*
Pollution control	*49% said more, 34% said same*
Control of development	*47% said more, 30% said same*
Remediation of development impacts	*38% said more, 25% said same*
Education	*47% said more, 26% said same*

Other comments included that there are too many ducks & geese in most parks making a mess, recreational opportunities should be increased, and to limit road construction in environmentally sensitive areas.

STEWARDSHIP

1. Would you support actions by local Stewardship groups, Provincial Agencies or the Municipality to undertake streamside enhancement work on your property, such as planting of native plant species?

Of the total 53 respondents, 30% said yes, 23% said no, 13% said they were unsure and for 32% it was not applicable. Of the 30% that would support stewardship, the majority were rural residents within and outside the ALR.

If you are in favour, why?

Protect what's left for future generations – 32%
Improve aesthetics – 26%
Improve recreational opportunities – 6%
Improve water quality – 17%
Enhance fish/wildlife habitat – 34%

Resident opinions between the three sub-areas did not differ much. Some of the reasons why respondents did not support stewardship were:

- because it is "their property"
- don't want to pay additional taxes
- it is best to just leave nature alone
- we use the land for grazing horses and don't want to take away from that use
- it is undeveloped, does not need enhancement if it is protected in a natural state
- need land to feed cows and goats
- freeze development, enforce present pollution laws and let nature heal
- If the municipality wishes to use this agricultural land for recreation or park purposes, they should buy the land
- Would not approve of some local groups
- Leave the watershed as is!
- I have not even seen where government or other bureaucracies have made good choices for me and my land. Stay off my property!

2. Please indicate which of the following stewardship activities you might be willing to have undertaken on your property to maintain or enhance fish and wildlife habitat:

Construction of nest boxes for birds	*45%*
Removal of invasive plant species	*45%*
Planting of native plant species	*36%*
Environmentally responsible stormwater management	*34%*

Creation of a buffer strip around riparian or wetland areas	*23%*
Use of a winter cover crop for wildlife forage	*19%*
Construction of a fence around sensitive areas (i.e. riparian zones or nesting areas) to restrict access by livestock	*13%*

Other stewardship programs for which interest was expressed included trail building, and education programs.

3. Might you be willing to undertake some of these activities by yourself on your property to maintain or enhance wildlife habitat?

Of the total 53 respondents, 45% said yes, 19% said no, 8% were unsure and for 25% it was not applicable.

If yes, please indicate which of the above activities you might be willing to undertake:

Some activities that residents would be interested in were planting, wildlife enhancement and the removal of invasive species. Some residents are already participating in such activities such as nest box construction.

4. Might you be willing to enter into an agreement to protect the natural environment on your property?

Of the total 53 respondents, 36% said yes, 17% said no, 9% were unsure and for 23% said it was not applicable.

If yes, please indicate which of the following options you might consider:

Verbal agreements	*(19%)*
Written stewardship agreements without tax incentives	*(9%)*
Written stewardship agreements with tax incentives	*(21%)*
Leases	*(2%)*
Licenses	*(0%)*
Conservation covenants	*(13%)*
Restrictive covenants	*(2%)*
Easements	*(2%)*
Outright sale of property	*(4%)*

Donation or bequest *(6%)*
Unsure *(8%)*
Other (please specify) *(2%)*

Most of the response to these options came from rural residents within and outside the ALR. Most of the options would be considered with the exception of licenses. The most commonly chosen options were written stewardship agreements with tax incentives (21%), verbal agreements (19%) and conservation covenants (13%).

LAND USE

1. Do you think the mix of land uses in the watershed is appropriate? Please indicate your opinion on the amount of area allocated to the following land uses:

Land Use	Increase	Decrease	Same	Unsure
Agriculture	*20%*	*4%*	*50%*	*13%*
Urban Residential	*11%*	*28%*	*43%*	*6%*
Rural Residential	*9%*	*9%*	*60%*	*6%*
Recreation	*19%*	*2%*	*47%*	*15%*
Parks	*25%*	*8%*	*42%*	*13%*
Nature Preserves	*36%*	*6%*	*36%*	*11%*
Commercial	*26%*	*19%*	*40%*	*6%*
Industrial	*2%*	*13%*	*36%*	*9%*
Institutional	*6%*	*25%*	*50%*	*9%*
Other (please specify)				

The majority of residents felt most land uses should remain the same. Of the total 53 respondents, the top three choices for increased land use are nature preserves (36%), commercial (26%) and parks (25%). The top three choices for decreased land use are industrial (43%), commercial (40%) and urban residential (28%).

CORPORATION OF THE DISTRICT OF SAANICH
DURRELL CREEK INTEGRATED WATERSHED MANAGEMENT PLAN

Thank you for taking the time to visit the first of two public open houses for the Durrell Creek Integrated Watershed Management Plan (IWMP). The next open house is scheduled to take place in February 2000 when the draft IWMP will be presented. We value your input and would appreciate a few more minutes of your time to provide us with your thoughts and comments on the progress of the IWMP to date.

Please print or write your information clearly.

1. What do you like about the Durrell Creek IWMP process so far?

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2a. Do you have any concerns with the IWMP process?

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2b. If you do, have you any suggestions on how to address your concerns?

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3. Please provide us with any additional comments you have on the IWMP project.

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4. If you would like us to send you the information regarding the date and location of the next public open house for the Durrell Creek IWMP project, please provide us with the following information:

Name: ____

Address: ____

Fax: ____

Email: ____

Please complete now or fax/mail back to:
Colin Doyle at the Municipality of Saanich
770 Vernon Avenue, Victoria, BC V8X 2W7
Phone: 475-1775 Fax: 475-5450
Email: doylec@gov.saanich.bc.ca

Pottinger Gaherty
Environmental Consultants Ltd
1200-1185 West Georgia Street
Vancouver BC V6E 4E6
Tel 604.682 3707
Fax 604.682 3497

CORPORATION OF THE DISTRICT OF SAANICH
DURRELL CREEK INTEGRATED WATERSHED MANAGEMENT PLAN

Thank you for taking the time to visit the second public open house for the Durrell Creek Integrated Watershed Management Plan (IWMP). The study is drawing to a conclusion and we will be presenting a report to Council by the end of March. The Committee and their consultants are prepared to make a recommendation to Council, based in part on the feedback we receive from the public tonight. We value your input and would appreciate a few more minutes of your time to provide us with your thoughts and comments on the IWMP.

Please print or write your information clearly.

1. What do you like about the Durrell Creek draft IWMP plan?

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2a. Do you have any concerns with the draft IWMP plan?

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3. What are your thoughts on the 4 Scenarios presented? Which one would you prefer and why?

3. Please provide us with any additional comments you have on the IWMP project.

Please complete now or fax/e-mail back by March 15 to:
Colin Doyle, Engineering Dept., Municipality of Saanich
770 Vernon Avenue, Victoria, BC V8X 2W7
Phone: 475-1775 Fax: 475-5450
Email: doylec@gov.saanich.bc.ca

DURRELL CREEK
INTEGRATED WATERSHED MANAGEMENT PLAN

APPENDIX F: SPECIFIC INFORMATION REQUIRED BY THE MUNICIPALITY

submitted by

northwest hydraulic consultants ltd
#2-40 Gostick Place
North Vancouver, B.C.
V7M 3G2

submitted to

Pottinger Gaherty Environmental Consultants Ltd
1200 – 1185 West Georgia Street
Vancouver, BC V6E 4E6

&

The Corporation of the District of Saanich
770 Vernon Avenue
Victoria, BC V8X 2W7

May 2000

3-2792

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INTRODUCTION

This Appendix addresses nine (9) specific questions regarding Durrell Creek that were included in "Stage 4: Specific Information Required by the Municipality" of the Terms of Reference (see Appendix A). Each question is addressed in a separate section of this Appendix.

In answering the specific questions we have referred to figures and tables included in Appendix C of the report, titled "Durrell Creek Hydrologic and Hydraulic Modeling". Please refer to that Appendix to view this material. It is not repeated in this Appendix.

1. HEIGHT AND DURATION OF FLOODING

Has the height of flooding and the duration of water on the land increased over the past 50 years? If so, why has this occurred?

1.1 BACKGROUND

Background information on water levels in the Durrell Creek Valley is included in Appendix C, based on predictions from the combined hydrologic and hydraulic model of Durrell Creek watershed. Appendix C discusses the operation of the model and the limitations on its results.

1.2 THE HEIGHT OF FLOODING

The height of flooding in the Durrell Creek Valley may potentially be increased by any of the following:

- Increases in extreme discharges, or increases in water levels during extreme discharges, on the Colquitz River;
- Urbanization and development in the Durrell Creek watershed that increases the extreme flows in Durrell Creek and its tributaries;
- Diversion of flows from Porter (Francis King Park) Creek into the Durrell Creek watershed;
- Installation of the Interurban Road culvert;
- Climate change, resulting in increased precipitation over Durrell Creek and Colquitz River watersheds;

The role of each of these factors is discussed separately in the following sections.

1.2.1 Colquitz River

As is discussed in the following section, Durrell Creek Valley is part of the flood plain of the Colquitz River. Elevations in the valley bottom are well below the water level associated with the current 200-year instantaneous maxima in the Colquitz River and consequently the valley lies within its flood plain. The valley bottom may also be flooded by Durrell Creek, independent of high water in the Colquitz River, though the elevation or height of flooding from Durrell Creek alone would be much less than occurs from the Colquitz River.

The current maximum height of flooding in Durrell Creek Valley is defined by the 200-year instantaneous maximum water level on Durrell Creek, plus an appropriate freeboard. This elevation and our freeboard recommendation are described in Appendix C.

The historic height of flooding in the Colquitz watershed would be the 200-year instantaneous water level in Durrell Creek prior to current development in the area, plus an appropriate freeboard. Unfortunately, we are not able to predict the 200-year water level in the Durrell Creek Valley prior to the period of record at the Water Survey of Canada gauge on the Colquitz River, or prior to 1976. This occurs because backwater from the Colquitz River into the Durrell Valley is the main control on extreme water levels.

It is our contention that extreme water levels in the past may have been slightly lower than now occur. Recent development in the Colquitz River watershed may have increased the magnitude of the 200-year instantaneous maximum and development along the Colquitz River downstream of Durrell Creek (bridges, culverts, fill, etc) may have raised water levels during flood discharges. On the other hand, storage development in Elk and Beaver Lakes may now contribute to a lowering of instantaneous discharges and a slight reduction in extreme water levels.

1.2.2 Development in Durrell Creek Watershed

Table 10 of Appendix C summarizes extreme water levels for return periods of 2, 10, 25, 50, 100 and 200 years for the land use from the 1950s, the 1960s, the 1970s, the 1980s, and present conditions. Note that these extremes are calculated as the water levels that would result for that land use in Durrell Creek, given the precipitation and temperature recorded from 1976 to 1997 and the water levels that were recorded in Colquitz River from 1976 to 1997. Consequently, the model tests the effect of land use on flooding for the same sequence of climate and tailwater levels.

As Table 10 shows, the changes in land use, from 1950 to present have no effect on extreme water levels, independent of climate and Colquitz River levels.

1.2.3 Diversion of Porters (Francis King) Creek

Table 10, of Appendix C, summarizes extreme water levels, for return periods of 2, 10, 25, 50, 100 and 200 years for present conditions and with Porters Creek diverted out of the watershed. Note that these are calculated as the water levels that would result from the precipitation and temperature recorded from 1976 to 1997 and the water levels that were recorded in Colquitz River from 1976 to 1997. Consequently, the model tests the effect of diverting Porters Creek for the same sequence of climate and tailwater levels.

As Table 10 shows, the diversion of Porters Creek would only have a very small effect on extreme water levels, reducing them by 10 cm for fairly frequent floods and having no effect during extreme floods. Evidence for the diversion is discussed in Chapter 3 of the main report.

1.2.4 Installation of the Interurban Road Culvert

Table 10, of Appendix C, summarizes extreme water levels, for return periods of 2, 10, 25, 50, 100 and 200 years for present conditions and with the Interurban Road culvert lowered by 0.6 m. Note that these are calculated as the water levels that would result from the precipitation and temperature recorded from 1976 to 1997 and the water levels that were recorded in Colquitz River from 1976 to 1997. Consequently, the model tests the effect of lowering the culvert for the same sequence of climate and Colquitz River levels.

As Table 10 shows, lowering the culvert has only a very small effect on extreme water levels, reducing them by 10 cm for fairly frequent floods and having no effect during extreme floods.

1.2.5 Climate Change

As is discussed in the main body of the report there is evidence of climate change at some of the long term AES stations in Saanich. However, there is no evidence for increased annual daily maximum precipitation at any of the stations (Figure 2). Note that several large rainstorms have resulted in large floods on the Colquitz River in the past ten years providing an appearance that high water levels may be more frequent (Figure 2; Figure 8).

1.3 THE DURATION OF FLOODING

The duration of flooding in the Durrell Creek Valley may potentially be increased by any of the following:

- Climate change, resulting in increased precipitation over Durrell Creek and Colquitz River watersheds;
- Increases in water levels during the spring, summer and fall on the Colquitz River;
- Urbanization and development in the Durrell Creek watershed that increases the flows from summer storms in Durrell Creek and its tributaries;
- Diversion of flows from Porter (Francis King Park) Creek either into or out of the Durrell Creek watershed;
- Installation of the Interurban Road culvert; and
- Reduced field elevations from compaction or other damage to the organic soils on the Courtland and Hastings Flats.

1.3.1 Climate Change

As is discussed in the main body of the report, a statistically significant change in annual total precipitation has occurred at the Saanichton CDA AES station, with annual totals increasing by about 20% over the period of record (see also Figure 2). There also appears to be changes in the total precipitation that falls in April and May, at the start of the growing season. Figure 4 shows much higher totals in these two months since about 1984 or 1985. On the other hand, no particular trend is observed for total precipitation in September and October at the end of the growing season (Figure 5). However, unusually high totals were recorded in both 1997 and 1998, which may have prevented harvesting of crops.

It is our opinion that these changes in the climate recorded at Saanichton CDA have affected the duration of flooding in Durrell Creek Valley, both through increased water levels on Colquitz River and through increased flows in Durrell Creek.

1.3.2 Increased Water Levels on the Colquitz River

The greater precipitation recorded at Saanichton CDA AES station has coincided with higher annual discharges, and more importantly, greater flows during May and September since the mid-1980s (Figure 8). These higher flows in the Colquitz River, combined with greater flows in Durrell Creek, have resulted in a reduction of number of days when water levels are below minimum field elevations in Courtland and Hastings Flats over the past 10 to 15 years.

1.3.3 Development in Durrell Creek Watershed

Tables 11a and 11b of Appendix C summarize the percentage of time that water levels exceed various elevations for the land use from the 1950s, 1960s, 1970s, 1980s and present conditions. Note that these are calculated as the water levels that would result for that land use in Durrell Creek, given the precipitation and temperature recorded from 1976 to 1997 and the water levels that were recorded in Colquitz River from 1976 to 1997. Consequently, the model tests the effect of land use on flood duration for the same sequence of climate and Colquitz River levels.

As Tables 11a and 11b show, the changes in land use from the 1950s to present day have a minor effect on the predicted duration of flooding throughout the year. The tables show less frequent flooding for the 1950s, 1960s and 1970s land uses when compared to those of present day. The additional flooding near all occurs during the growing season.

1.3.4 Diversion of Porters (Francis King) Creek

Tables 11a and 11b, of Appendix C, also summarize the percentage of time that water levels exceed various elevations both for present conditions and with Porters Creek diverted out of the watershed. Note that these are calculated as the water levels that would result for that land use in Durrell Creek, given the precipitation and temperature recorded from 1976 to 1997 and the water levels that were recorded in Colquitz River from 1976 to 1997. Consequently, the model tests the effect of land use on flood duration for the same sequence of climate and Colquitz River levels.

As Tables 11a and 11b show, the diversion of Porter Creek would reduce the duration of flooding. The frequency that the typical field elevation on Courtland Flat would be exceeded is reduced on average by about 6% by the diversion of Porter Creek, or by about 22 days per year. Much of this reduced duration of flooding would occur during the growing season, when high water levels result from floods from Durrell Creek watershed rather than high water on the Colquitz River.

1.3.5 Installation of the Interurban Road Culvert

Tables 11a and 11b of Appendix C also summarize the percentage of time that water levels exceed various elevations for the present conditions and with the Interurban culvert lowered by 0.6 m. Note that these are calculated as the water levels that would result for that land use in Durrell Creek, given the precipitation and temperature recorded from 1976 to 1997 and the water levels that were recorded in Colquitz River from 1976 to 1998. Consequently, the model tests the effect of land use on flood duration for the same sequence of climate and Colquitz River levels.

As Tables 11a and 11b show, lowering of the Interurban Culvert greatly reduces the duration of flooding on Courtland Flats. The frequency that the typical field elevation on Courtland Flat would be exceeded is reduced on average by about 30%, so that the typical field elevation would only be exceeded about 37 days per year, on average. The lowered culvert would reduce the duration of flooding during the growing and dormant seasons. The reduction is much less on Hastings Flat where the culvert beneath Hastings Road partly controls flood duration.

1.3.6 Reduced Field Elevations

It is apparent when surveying and examining the agricultural fields on Courtland and Hastings Flats that they are below the elevation of the adjacent, or surrounding, terrain. This may result from deterioration and loss of the organic soils from waterlogging or compaction from traffic. The extent to which the fields may have been lowered, and when the lowering occurred, are not known and may not be a significant contributor to increased flooding.

1.4 CONCLUSIONS

It seems most likely that only small changes have occurred in the extreme water levels recorded in Durrell Creek Valley over the past fifty years. Urbanization in Durrell Watershed, diversion of Francis King Creek, and installation of the Interurban Road culvert all have insignificant effects on extreme water levels. Water levels in the Colquitz River are the most important determinant of extreme water levels in the Durrell Creek Valley. Extreme water levels in the Colquitz River may have increased slightly over the past fifty years from increased discharges as a result of development in the Colquitz watershed and higher water levels for extreme floods from development along the Colquitz River. Storage development in Elk and Beaver Lakes may have helped mitigate the potential increases.

On the other hand, the duration of flooding is thought to have increased, particularly during the growing season. Climate change, with higher annual totals and greater precipitation in April and May, accompanied by higher discharges and water levels in Colquitz River, since the mid-1980s is thought to have increased the duration of flooding. This has not been tested directly by the model because we do not have a long-term record of water levels in the Colquitz River.

Urbanization in the Durrell Watershed has an effect on flood durations, increasing flooding during the summer months. The diversion of Porters Creek would have had a small effect on increasing flood durations, if it occurred. However, installation of the Interurban Road culvert may potentially have had a large effect on the duration of flooding, if it was installed about 0.6 m above the invert of the old ditch (see **Question 5**). If it was installed this much above the previous channel bed, it greatly increased the duration of flooding on Courtland Flats. The increase in flooding would be less, accordingly, if it was installed a lower distance above the bottom of the old ditch.

2. THE NATURAL FLOOD PLAIN

Describe the boundaries and elevations of the original natural flood plain.

2.1 BACKGROUND INFORMATION

Background information on water levels is included in Appendix C, based on predictions from the combined hydrologic and hydraulic model of Durrell Creek watershed.

2.2 DISCUSSION OF INFORMATION

A flood plain is defined by the Province of British Columbia as "a low lying land area, whether diked, flood proofed, or not, which by reason of its natural land elevation is susceptible to flooding from an adjoining watercourse, lake or other body of water, including the sea, and is taken to be that area submerged by the designated flood plus freeboard". On most rivers in British Columbia, the Province defines the designated flood as that discharge which is equivalent to a flood with a 200-year return period or recurrence interval.

Based on the above definition, Durrell Creek Valley is part of the flood plain of the Colquitz River. Elevations in the valley bottom are well below the water level associated with the current 200-year discharge in the Colquitz River and consequently the valley lies within its flood plain. The valley bottom may also be flooded by Durrell Creek, independent of high water in the Colquitz River, though the elevation and extent of flooding from Durrell Creek alone would be much less than occurs from the Colquitz River.

Consequently, the current flood plain of Durrell Creek is defined by the area inundated by the 200-year instantaneous water level on Colquitz River, plus an appropriate freeboard. This elevation and our freeboard recommendation are included in Appendix C and in the main body of the report.

The boundaries and elevations of the original natural flood plain would then be the water level associated with the 200-year discharge on the Colquitz River prior to current development in the area. As described in Appendix C, we are not able to predict the 200-year water level on the Colquitz River, or in the Durrell Creek Valley, prior to the period of record at the Water Survey of Canada gauges on the Colquitz River, or prior to 1976.

It is our contention that the "original" flood plain may have been slightly smaller than occurs now. Recent development in the Colquitz River watershed may have increased the magnitude of the 200-year discharge and development along the Colquitz River downstream of Durrell Creek (bridges, culverts, fill, etc) may have raised water levels during flood discharges. On the other hand, storage development in Elk and Beaver Lakes may now contribute to a lowering of instantaneous discharges and a slight reduction in extreme water levels.

The 1956 maps of Durrell Creek provide some information on the elevation of historic flooding. On these maps, all buildings were above the 135 foot contour which is equivalent to an elevation of above 12 m geodetic. Note also that no permanent structures were located on the Courtland and Hastings Flats. This suggests that the flood plain has changed little over time.

2.3 CONCLUSIONS

The bottom of Durrell Creek Valley is part of the Colquitz River flood plain. It may also be flooded by Durrell Creek independently of high water in the Colquitz River, but Durrell Creek is expected to produce much lower water levels and a much smaller area of flooding.

It is our contention that the 200-year discharge in the Colquitz River has been increased by development and that water levels associated with extreme floods may also have been raised by development. Consequently, we feel that contemporary flood levels are slightly higher than historic ones, but likely only by a few tens of centimeters. The area that is now flooded (the "flood plain") would only be slightly larger.

3. LENGTH OF THE GROWING SEASON

Describe the current and historic length of the growing season in Durrell Creek Valley. Identify the extent of pumping and ditching used by previous landowners and farmers to extend the growing season and whether such measures are currently used.

3.1 BACKGROUND INFORMATION

The evidence for the historic length of the growing season in Durrell Creek Valley is primarily contained in affidavits collected by Mr. B. Sawyer, from long-term residents of the valley quoted below. Evidence for the current length of the growing season was obtained from active farmers in the valley, primarily Mr. R. Galey.

Ditches used by previous landowners are partly visible on the historic air photographs and maps. Evidence for historic pumping was obtained by discussions with residents; current practices were described by Mr. R. Galey.

3.2 DISCUSSION OF INFORMATION

3.2.1 Historic Length of Growing Season

The following are quotes from affidavits gathered by Mr. B. Sawyer:

Bernard Gillie "My father James, throughout all the years he farmed with horse-drawn implements, always aimed at May 21 as the day when the crop should be planted." I heard it at least a hundred times each spring. Mr. B.C. Gillie in a letter addressed to the District of Saanich, notes that "but since the area always dried out by early May it did no great harm" when writing about the effect of the Porter Creek diversion on flooding.

John James Edward Gosnell "First Trestle Valley is a wetland during the Winter months but crops including our vegetable garden could always be planted in May."

Robert Archibald Simpson "First Trestle Valley was a wetland in the Winter months. However, the valley could be planted in April or early May each year when the First Trestle was in place, on what is now Interurban Road, and the water could run freely from First Trestle Valley down to Colquitz Creek."

Elvaretta Grace Bradshaw "We used four and one half acres of the valley for gardening. We were always able to plant our garden no later than May 1st of each year."

Benjamin Charles Ewell "The Inmates also planted and raised large crops of carrots, corn and cabbage. The crops were always planted in April or May of each year."

Arthur M. Burnham "As a young boy I worked for Albert Hull harvesting potatoes grown in the Valley. These were usually planted in early May."

The evidence from the above quotes from affidavits suggests that, historically, the valley flat of Durrell Creek was planted by early May each year. The date of planting may have varied from site to site along the valley bottom.

3.2.2 Present Length of the Growing Season

Based on discussions with Mr. R. Galey and others in the Durrell Creek valley, the growing season now starts in May in most years.

3.2.3 Historic Ditching and Pumping

Inspection of the historic air photos shows that the main drainage was through Durrell Creek, as described in **Section 6**. The larger fields on Hastings and Courtland Flats were surrounded by ditches that branched from Durrell Creek. It also appeared on the older air photos that berms had been constructed along the right bank of Durrell Creek through Courtland Flats, likely from material excavated from the creek.

There is little evidence of open ditches on the fields on Courtland and Hastings Flat; however, they may not be visible because of small scale and poor quality of the oldest air photos. The 1964 air photos show a large ditch (possibly a berm) across the field on Courtland Flats south of Durrell Creek. Durrell Creek appears to pass through the middle of the fields west of Granville Street, with ditches across the fields and around their perimeters.

Nothing is known of historic pumping practices associated with agriculture in the Durrell Creek Valley.

3.2.4 Current Ditching and Pumping

Durrell Creek, and its branches around fields, remains the main ditch through the Courtland and Hastings Flats. The most recent air photographs show ditches along the edges or perimeters of most of the fields.

Based on discussions with Mr. R. Galey and others in the Durrell Creek valley, since 1996, a small pump has operated on Durrell Creek, just upstream of Interurban Road. Early in the season, the Interurban culvert is blocked and the pump has operated to lower water levels in Durrell Creek. The pump, which has a capacity of about 1,000 gallons per minute is inadequate to reduce water levels during summer storms.

3.3 CONCLUSIONS

Planting typically began in late April or early May historically. Planting now typically begins in May, as reported by Mr. R. Galey.

Nothing is known of historic pumping practices associated with agriculture in Durrell Creek Valley. Currently, the Interurban Road culvert is blocked in — and water pumped to reduce water levels in Durrell Creek and the surrounding fields. This has occurred since 1996.

4. DIVERSIONS INTO DURRELL CREEK VALLEY

Determine whether a diversion has occurred into Durrell Creek Valley in or about the BC Hydro Property, near Strawberry Vale School, or along Hector Road, west of Interurban Road.

4.1 BACKGROUND INFORMATION

The potential diversions into Durrell Creek Valley were examined on the following maps and air photos:

12. Air photos from 1997 (15BC97005), 1992 (15BCB 92139), 1988 (PIM 88-001), 1980 (BCC 248), 1975 (BC5666), 1964 (BC 5091), 1956 (BC2042) and 1946 (BC245). Nominal scales vary from about 1:10,000 to 1:32,000.
13. Maps of the Corporation of the District of Saanich (Saanich Municipality). Scale 1:4,800. (Contour Interval 5 feet or 10 feet). Compiled by Aero Surveys Ltd from the 1956 air photographs and amended to 1963.
14. Cadastral Maps of the Corporation of the District of Saanich. Scale 1:2,500. Numbered in the BC Geographic System. Date unknown.
15. Durrell Creek Watershed. Cadastral Map. Scale 1:5,300. Date unknown.
16. BC Hydro Goward Substation: Fencing, Finish Surfacing, Drainage and Services, and BC Hydro Goward Substation: Site Preparation Plan.

The 1956 contour maps and air photos provided the best evidence of historic drainage patterns.

4.2 DISCUSSION OF INFORMATION

A "diversion" would usually be interpreted as taking water that previously did not flow into the Durrell Creek watershed and altering its stream course or drainage pattern so that it now flows to Durrell Creek. A "diversion" could also occur within Durrell Creek, if water is diverted from one tributary basin to another tributary basin.

4.2.1 Strawberry Vale School

Strawberry Vale School lies south of Courtland Flats, between Rosedale and Delmar Streets, south of Hastings Street. It is well within the watershed boundaries and land continues to rise to a hill behind, or south of, the school. In 1956, it appears that water drained north from the school, into a gully, crossing Roy Road about 100 to 150 m west of North Road. It is likely that most water drained by groundwater flow to Courtland Flats.

Water from the school now drains in the same general direction but it is collected by a storm drain system, crossing Roy Road further to the east before discharging onto the Pansy Street right-of-way, and then onto Courtland Flats. It is our impression that the storm drain system may have reduced the area that drains to Durrell Creek from near Strawberry Vale School. Part of the area south of the School now drains to the south away from Durrell Creek instead of north to Durrell Creek.

It is likely that urbanization and storm drain systems have resulted in more frequent surface flows to Courtland Flats and higher peak discharges from the area near Strawberry Vale School, despite the slight reduction in drainage area.

4.2.2 BC Hydro (Goward) Substation

The Goward substation of BC Hydro sits on an area of flat land -- partly created by fill -- north of Hector Road and just west of Interurban Road. The substation was originally constructed between 1946 and 1956.

Goward Substation lies within the watershed boundaries of Durrell Creek. In 1956, Interurban Road continued to rise to the north, past the substation, and a hill behind the substation drained to the south, as did part of the area along Ivor Road. The substation is at an elevation of about 35 to 40 m geodetic, or well above Courtland Flats.

In 1956, a depression and stream channel at the east end of the substation drained the area to the north and east of the substation, extending to Ivor Road. It is not clear how the Goward site was drained. The channel continued past the end of Hector Road, then across the fields, following the low area to the east end of Alan Road. We estimate that the total area draining to the Hector Road alignment was about 5 hectares, as shown on the 1956 topographic maps.

Goward substation now drains mostly to the east, although part of the property seems to drain to the west, joining the ditch along Interurban Road. About 1 hectare of this property lies within the watershed draining to Hector Road. Drainage from Goward Substation enters a 600 mm concrete culvert at the east end of the property, discharging through a 24-inch culvert below Hector Road and then into the old drainage channel. It is not clear if the drainage from north of the substation and along Ivor Road also discharges through the concrete culvert and across Hector Road.

It is thought that paving of the substation property and adding storm drainage has increased the frequency of surface flows and the magnitude of the peak discharges that cross Hector Road and onto the property below. The property occupies about 20% of the watershed area that drains to Hector Road and the paving and altered drainage patterns are expected to substantially increase peak flows and the frequency of surface flows at Hector Road. The lowest flows, during long dry periods in the summer are thought to be reduced by the development.

4.2.3 Hector Road, West of Interurban Road

In 1956, Hector Road only extended about 150 m west from Interurban Road. Between 1964 and 1975, it was extended across the low area containing the channel east of the Goward substation to about its present alignment. Hector Road rises about 20 to 30 m in elevation, on a fairly constant grade, from near the BC Hydro Goward Substation. All of Hector Road lies within Durrell Creek watershed.

Prior to extension of Hector Road, the steep area that it crosses drained to the southeast, through a gully or depression, likely mostly as groundwater flows. The 1956 air photos show some evidence of a channel or drainage across the fields that joins to the drainage channel flowing south past the Goward Substation.

Groundwater and surface flows from an area of about 5 hectares are now intercepted by a ditch on the north, or inboard side, Hector Road. They flow down the hill, then cross Hector Road through a culvert that is located about 300 m west of Interurban Road, discharging onto the property below. The culvert is located about 100 m east along Hector Road from the old gully and stream crossing.

The extension of Hector Road has concentrated flows by intercepting groundwater and surface flows and delivering them to a different discharge point, further to the east, towards Interurban Road.

4.3 CONCLUSIONS

None of the three sites are "diversions", in the sense that drainage patterns have been re-arranged so that flows that once did not enter Durrell Creek watershed now flow into it. At Strawberry Vale School, water continues to drain north, to Courtland Flats. Development has resulted in a slightly smaller drainage area, and flows now discharge further to the east. Development is also thought to have increased the frequency of surface flow discharge, the total volume of water discharging as surface flow, and the magnitude of peak flows.

At the Goward Substation, the surface drainage pattern has not been changed. However, paving of the substation and installation of storm drains are thought to have increased the frequency of surface flow and the magnitude of peak flows in the drainage channel. The substation occupies about 20% of the area of the watershed draining to Hector Road so it potentially has a substantial effect on increasing peak flows.

The extension of Hector Road has resulted in collecting surface and groundwater flows, concentrating them, and discharging them to the east of the gully where they may once have flowed. The road extension represents a diversion of flow from one small tributary to another site within Durrell Creek Watershed.

5. INTERURBAN ROAD CULVERT

Review the history of the Interurban Road culvert and whether its elevation was increased, decreased or remained about the same as the natural drainage channel.

5.1 BACKGROUND INFORMATION

The crossing of Interurban Road by Durrell Creek was examined on the following maps and air photos:

- Air photos from 1997 (15BC97005), 1992 (15BCB 92139), 1988 (PIM 88-001), 1980 (BCC 248), 1975 (BC5666), 1964 (BC 5091), 1956 (BC2042) and 1946 (BC245). Nominal scales vary from about 1:10,000 to 1:32,000.
- Maps of the Corporation of the District of Saanich (Saanich Municipality). Scale 1:4,800. (Contour Interval 5 feet or 10 feet). Compiled by Aero Surveys Ltd from the 1956 air photographs and amended to 1963.
- Cadastral Maps of the Corporation of the District of Saanich. Scale 1:2,500. Numbered in the BC Geographic System. Date unknown.
- Durrell Creek Watershed. Cadastral Map. Scale 1:5,300. Date unknown.

In addition, the elevations of the culvert are shown on:

- Survey of Jail Creek by Stefan Svec, Site Surveyor, dated January 20, 1995
- Survey of Jail Creek by the District of Saanich, Wilkinson Road to Interurban. Dated April 21, 1998.
- Survey of Durrell Creek by northwest hydraulic consultants ltd, April 1999.

The following letter provides information on the material beneath and around the culvert:

- letter of April 20, 2000 to Dal Haftner of the District of Saanich from Levelton Engineering Ltd, titled "Field Investigation of Culvert, Interurban Road, Saanich."

5.2 DISCUSSION OF INFORMATION

The existing Interurban Road culvert is thought to have been installed in about 1960, based on affidavits and interviews with individuals who live in the area, replacing a bridge. Neither the 1956 nor the 1964 air photographs provide unequivocal evidence of whether the crossing is a bridge or culvert; however it appears to be a bridge on both photos. On the other hand, the District of Saanich map (1956; amended to 1963) appears to show the crossing as a culvert, though a complete legend of symbols is not provided.

The District of Saanich surveyed the elevations of the existing culvert beneath Interurban Road as 9.55 m at the upstream invert and 9.29 m at the downstream invert (1998). Svec surveyed elevations of 9.44 m at the upstream invert and 9.20 m at the downstream invert (1995). In 1999, nhc surveyed elevations of 9.4 m at the upstream invert and 9.3 m at the downstream invert. All these elevations agree reasonably closely, varying depending on where the survey rod was positioned on the invert, and the benchmarks chosen for elevations. We were unable to locate any drawings that show elevations of the culvert at earlier dates, though it seems unlikely that they have greatly changed since the culvert was installed.

Hand augering upstream and downstream of the culvert entrance and exit encountered up to 0.85 m of loose, sand gravel overlying native clays. The sand gravels are interpreted as a "fill". A borehole beside the culvert encountered the native clays at an elevation of about 10 m or about halfway up the culvert barrel. The hand auger sites may have been disturbed by cleaning of Durrell Creek and other activities.

Field elevations on Courtland Flats are at about 9.7 m, on average. Based on these ground elevations, the culvert invert is now set about 0.2 to 0.3 m below the average field elevation.

As described in Section 6 of this Appendix, Durrell Creek is a ditch that has remained in the same location since at least 1946. The bed of Durrell Creek upstream of the culvert now averages about 8.5 m, or about 1 m below the culvert invert, based on nhc surveys (Figure XX). The bed was lowered in the 1990s by the District of Saanich as part of a program of creek maintenance, and its present elevations do not necessarily reflect the previous or historic ditch elevations, when the culvert was installed.

5.3 CONCLUSIONS

The upstream invert of the Interurban Road culvert appears to have been installed about 0.3 m below the average field elevation on Courtland Flat. It is not entirely clear whether or not the culvert was installed above the old streambed.

Hand augering in the vicinity of the entrance and exit of the culvert suggests that fill material may extend beneath the culvert. However, this fill material was not found in the borehole adjacent to the culvert so it is not entirely clear if the fill does extend beneath it.

If the fill does extend beneath the culvert it is likely that the culvert was placed above the elevation of the old bed of Durrell Creek. It is possible that the creek bed was excavated before the fill was placed and the culvert may not be very far above the old creek bed at all. Further drilling or excavation would be required to confirm where the culvert was placed relative to the old streambed.

6. LOCATION OF DURRELL CREEK

Research the history of the current creek location. When was it constructed, how did it differ from the original creek, and where was the original creek?

6.1 BACKGROUND INFORMATION

The historic location of Durrell Creek was examined on the following maps and air photos:

- Air photos from 1997 (15BC97005), 1992 (15BCB 92139), 1988 (PIM 88-001), 1980 (BCC 248), 1975 (BC5666), 1964 (BC 5091), 1956 (BC2042) and 1946 (BC245). Nominal scales vary from about 1:10,000 to 1:32,000.
- Maps of the Corporation of the District of Saanich (Saanich Municipality). Scale 1:4,800. (Contour Interval 5 feet or 10 feet). Compiled by Aero Surveys Ltd from the 1956 air photographs and amended to 1963.
- Cadastral Maps of the Corporation of the District of Saanich. Scale 1:2,500. Numbered in the BC Geographic System. Date unknown.
- Durrell Creek Watershed. Cadastral Map. Scale 1:5,300. Date unknown.

As well, affidavits from long-term residents of the valley, collected by Mr. B. Sawyer, provide some general information on the nature and location of Durrell Creek prior to the record from maps and air photos.

6.2 DISCUSSION OF INFORMATION

Downstream of Interurban Road, Durrell Creek flows in a narrow valley through the Provincial Government property before crossing Wilkinson Road. It then flows along the south side of Loenholm Road and joins the Colquitz River. Durrell Creek appears to have maintained this path since at least 1946. Inspection of the air photos shows that some minor changes may have occurred just downstream of Interurban Road between 1946 and 1956. These apparent changes may be a result of the indistinct creek pattern on the older air photos.

Upstream of Interurban Road, Durrell Creek flows along the Charlton Road right-of-way to just east of the extension of the Holland Road right-of-way. It has occupied this position since 1946. Note that the creek path is indistinct on the oldest air photographs. It may have been cleared or maintained between 1946 and 1956; it is very distinct on the 1964 photos, and appears larger again on the 1975 photos. The 1964 photos show a berm along the right bank of the creek and evidence of recent ditch cleaning upstream.

The creek turns southeast, then east, crossing Granville Road about midway between the Hastings and Charlton intersections. It has remained in this path since at least 1946. All the air photos also show that a branch of the creek continues south to Hastings Road, then flows along Hastings Road, connecting to that culvert, then north along the field boundary to join the other branch, west of Granville Street. Recent field inspections suggest that the southern branch now takes most of the flow.

East of Granville Street, Durrell Creek flows nearly east through the middle of a field, crossing to the north of a pond that collects drainage from tributaries to the south. The creek has remained in this same path since at least 1946; the pond was constructed between 1964 and 1975.

Porter Creek joins Durrell Creek east of Granville Street. Hall Engineering Ltd (1996) and Santos (1998) both report that a diversion of Porter Creek occurred in the early 1960s. They report that it previously flowed south along Charlton Road to Portage Inlet. However, the date when the diversion occurred is not certain. The 1946 air photos show a connection from Porter Creek to Durrell Creek as well as one, potentially, to Portage Inlet. Mr. B.C. Gillie reports that the diversion occurred before his parents came to Durrell Creek in the early part of the century.

The affidavits collected by Mr. B. Sawyer indicate that the First Trestle Valley (Durrell Valley) was drained by a man made ditch as early as the 1930s (Elvaretta Grace Bradshaw). The location of this ditch is not known but it may have been along property or field boundaries, in about the same location where it now sits.

6.3 CONCLUSION

Durrell Creek has flowed along the same path since at least 1946. Since then, it appears to have been maintained or cleaned at various times, as it appears more and less distinct on the various air photos. There is no longer any evidence of the natural creek path through the valley bottom.

Porter (Francis King) Creek appears to have been diverted to Durrell Creek, possibly in the early years of the twentieth century.

7. WATER QUALITY IN DURRELL CREEK

Address the quality of water entering Durrell Creek from drainage sources, including the presence of contaminants from BC Hydro property or other sources.

7.1 BACKGROUND INFORMATION

We are aware of three main sources of water quality data for the Durrell Creek watershed:

The Courtland Hastings Agricultural Preservation Society, in cooperation with the Department of Fisheries and Oceans, conducted water quality sampling as streamkeeper survey in 1998-99. They collected data on temperature, pH, turbidity, and dissolved oxygen at 3 stations on Durrell Creek (at Wilkinson, Interurban and Granville culverts) and at Tuckers Pond on Prospect Lake Road.

The District of Saanich contracted a four month sampling program at eight stations from October/98 to January/99 on the Durrell system (Good Environmental, 1999). They collected water samples and had the following analyses performed by MB Research Analytical and Testing Services, Sidney, BC: total suspended solids, oil and grease, total phosphate, total nitrate and fecal coliforms. The location of the sample stations and a summary of the results is presented on the Riparian Classification and Water Quality map in Appendix D of the main report.

The third source, which we have not seen, was sampling undertaken in 1999 by the Capital Regional District Health Department. It our understanding that fecal coliform was the main parameter monitored, as part of a program to detect leaking septic systems or cross-connections.

7.2 DISCUSSION OF INFORMATION

The first study cited above collected water quality data of interest as measures of fish habitat quality. This study also sampled on the mainstem Durrell Creek, which does not provide data suitable to discuss presence of contaminants from specific sources.

The Good Environmental (1999) study indicated several samples that exceeded the BC Water Quality Standards for total suspended solids, phosphates and fecal coliforms. The higher levels of these parameters were found to be correlated with periods of high rainfall. Total suspended solids typically result from erosion, entrainment of soil, and road runoff. Leakage from human septic systems, livestock and wildlife (waterfowl) can all contribute to the elevated fecal coliform levels. Small amounts of hydrocarbons (various parameters: total oil and grease, heavy and light extractable hydrocarbons, diesel, heavy oil) were detected, both visually and in the samples collected, at sampling stations #7, 8 and 8a. These stations are located on the mainstem Durrell just upstream of the Wilkinson and Interurban culverts. Good Environmental's discussion of the elevated hydrocarbon results indicated that fields adjacent to the creek were flooded and that vehicle tire tracks were noted adjacent to one of the sample sites.

We cannot comment on the third study, as we have not seen the results.

7.3 Conclusions

There are insufficient water quality data to fully describe the quality of water entering Durrell Creek from drainage sources. Sampling during the dry season as well as a longer time series of data are required to establish any patterns. From the available data, it is impossible to attribute the elevated levels of any parameter to a particular source. To determine whether a particular property is a source of contaminants requires a more directed sampling program, immediately adjacent to the suspect site.

8. MACNUTT PROPERTY AND BC HYDRO

Address whether MacNutt property is flooded from diversion of water from the Hydro Substation and whether such flooding is affecting the viability of this land for crops.

8.1 BACKGROUND INFORMATION

The diversion of water from the Goward Substation is discussed in Section 4.2.2, where it was concluded that the BC Hydro property did not divert water onto the MacNutt Property but instead added additional storm runoff to a pre-existing drainage channel.

The current viability of this land for crops is based on discussions with Galey Brothers and Ian Vantreight, a farmer who used to work part of the Durrell Creek flats.

8.2 DISCUSSION OF INFORMATION

The Gower Substation occupies about 20% of the watershed area that drains to the culvert beneath Hector Road, based on the topography shown on the 1956 maps. The substation is paved and provided with sub-surface drainage connected to a concrete culvert that is buried along the east side of the property. It is thought that the substation development has increased peak flows from the area that it occupies and also substantially increased peak flows from the overall watershed to Hector Road and the upper end of the MacNutt property. It is likely that these flows have resulted in higher water levels along the drainage channel and higher groundwater levels near the stream, particularly during the winter or rainy season.

8.3 CONCLUSIONS

Development of the Gower Substation is thought to have increased flows in a drainage channel, raising winter water levels and nearby groundwater levels. This has affected the viability of this land for crops by causing saturated soils and ponding, which affects soil structure at or near the soil surface. Saturated soils prevent the use of cover cropping, which leads to a gradual decline in organic matter in the soil.

9. MACNUTT PROPERTY AND MOUNT VIEW PROPERTY

Address the drainage of the Mount View Property over MacNutt Property.

9.1 BACKGROUND INFORMATION

We understand that the Mount View Property is the steep land crossed by Hector Road that is northwest of the MacNutt property. The diversion of water from the extension of Hector Road is discussed in **Section 4.2.3**, where it was concluded that the road ditch intercepts surface and groundwater drainage from about 5 hectares of land and concentrates it at a culvert, where it flows onto the MacNutt property. Previously, it is thought that much of this flow discharged downed the steep slopes as ground and surface water, flowing onto the MacNutt property over a broad area through a depression or gully.

9.2 DISCUSSION OF INFORMATION

The ditch along the extension of Hector Road drains about 5 hectares of steep hillslope to a culvert which then discharges onto the MacNutt property. The road extension and ditch have increased peak flows and added surface water to a site where it appears that previously only groundwater flows occurred.

9.3 CONCLUSIONS

The ditch along Hector Road is thought to intercept water from the Mount View property and deliver it to a culvert, where it drains onto the MacNutt property, flooding part of the property.

One option to reduce the flooding would be to add additional culverts across the long slope on Hector Road, spreading the drainage over the slope and returning it to groundwater. Further analysis would be required to determine the number of culverts that should be installed. We recommend careful consideration of the potential for erosion below the culvert outfalls and installation of appropriate erosion protection works.